

Cost Analysis of the Mongolian ATLS© Program: A Framework for Low- and Middle-Income Countries

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Abstract

Background Trauma is the leading cause of death among Mongolians aged 24–44. To improve initial management of injured patients, the Mongolian National University of Medical Sciences (MNUMS) implemented the American College of Surgeons' (ACS) Advanced Trauma Life Support (ATLS) training program in 2015. Cost analysis demonstrates that such programs can have clear pathways to self-sufficiency.

Methods Costs associated with an ACS Mongolian ATLS program were quantified based on discussions with the Mongolian government, MNUMS, ATLS Australasia headquarters, and existing pricing data. Costs were then classified as either essential or contingencies. These classifications determined budgetary items for each program. Savings projections for contingencies included training Mongolian instructors and educators. Scenarios for funding the budget were then assessed.

Results The minimum annual cost of ATLS in Mongolia, which includes 3 ATLS student courses/1 instructor course, is \$10,709. A budget of \$19,900 includes additional contingencies. The scenario that involves foreign instructors is the most expensive one. An initial investment of \$85,000 to train Mongolian instructors reduces annual costs by \$48,305 (71% reduction). An investment of \$4050 to train a Mongolian educator will reduce costs by \$1750 annually. ATLS can be sustained with 0.04% of Mongolia's current spending on public health and preventative services.

Conclusions Initial investment to train Mongolian ATLS instructors leads to substantial savings. Training a Mongolian educator lowers long-term costs. When minimum costs for ATLS courses are understood, these can be scaled up and supported with different contingencies and minimal funding by government or third-party stakeholders.

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Introduction

Injury is the third leading cause of all deaths in Mongolia and the leading cause in the most productive years of life, ages 24–44 [1]. The burden of trauma in Mongolia is increasing with urbanization, as evidenced by a 29% increase in motor vehicle deaths over the last decade [1, 2]. In Mongolia, the public medical system includes regionalized care and 2 dedicated tertiary trauma hospitals in Ulaanbaatar, the capital city [2–5].

Outside of Ulaanbaatar, the traditional nomadic way of life persists where over half of the population lives across a

vast countryside. Primary and secondary hospitals in these areas are lacking in specialty-trained physicians and supplies, and often fall short of World Health Organization (WHO) guidelines in emergency surgical care [2–4, 6, 7]. Mongolian healthcare leaders identified the need for ongoing education in trauma care, particularly for rural providers. Evidence suggests provider education alone may have a significant impact on outcomes in low- and middle-income countries (LMICs) [8–17]. Advanced Trauma Life Support (ATLS) is a training program designed by the American College of Surgeons (ACS) and geared toward teaching a systematic approach for the initial care of injured patients [18]. ATLS training has been shown to significantly advance knowledge and skills in caring for the multi-trauma patient [17, 19, 20].

Accordingly, in 2015 the Mongolian National University of Medical Sciences (MNUMS), in partnership with the ACS, began a multi-year initiative to establish ATLS training in Mongolia. Initially dependent on foreign faculty, Mongolia now has fully trained ATLS directors, coordinators, and instructors. The ATLS educator, the person responsible for teaching the instructor course (requires at least a master's degree in education and experience in post-secondary education), remains dependent on foreign participation.

However, as in other LMICs, cost proves to be a significant challenge for continued development and expansion of the program. A cost analysis and roadmap of potential funding scenarios for ATLS in Mongolia could provide a framework for establishing a self-sustaining ATLS program and serve as evidence to advocate for continued support from the Mongolian government and garner support from third parties. Furthermore, a cost analysis can provide insights into other LMICs looking to promulgate ATLS.

Materials and methods

The minimum requirements for an ATLS program in Mongolia were defined through consultation with ACS Committee on Trauma members, ATLS coordinators, Australasia headquarters, reviewing relevant literature, existing pricing data and discussions with Mongolian stakeholders (MNUMS, Mongolian physicians and the Mongolian government) [21–23]. Mongolian stakeholders were interviewed to assess their needs, resource availability, and goals. All information was cross-referenced and integrated to define the minimum required inventory and expenses for a Mongolian ATLS program that could meet the ACS gold standard for its program (Table 1). The budget assumes that enough Mongolian instructors have received adequate training to run student courses independently. The annual instructor course, however, requires a foreign educator as well as the cost of a translator, and the travel, room and board for a foreign educator. The cost of the annual foreign educator is split evenly between student courses and instructor course expenses to allow the foreign educator to provide oversight for newly trained instructors when they subsequently teach a student course. The instructor course does not include a manual printing cost at this time because the Mongolia course uses an electronic English version of the instructor manual.

Components of high-income country ATLS programs that were not deemed necessary for a minimum ATLS program were considered contingencies. The contingency budget (Table 2) includes an emergency fund in order to provide a safeguard in case of unexpected expenses, such as broken equipment. The training mannequins are the most expensive piece of equipment owned by the program, valued at \$24,000. This budget includes annual deposits into the emergency fund over the course of 5 years to reach the \$24,000 buffer, after which no further deposits would be necessary, assuming no further expenses. Both budgets account for 3 student courses (16 students per student course) and 1 instructor course (9 student-instructors per

Table 1 Annual cost of the minimum requirements necessary for running an ATLS program in Mongolia

	Minimum budget		
	3 Student courses	1 Instructor course	Total
Foreign instructor/educator (travel and board)	\$850	\$850	\$1700
Translators	\$261	\$261	\$522
Copyright fee	\$240	n/a	\$240
Manual printing cost	\$852	n/a	\$852
Equipment costs	\$3600	\$135	\$3735
Instructor pay	\$1890	\$420	\$2310
Coordinator pay	\$1050	\$300	\$1350
Total	\$8743	\$1966	\$10,709

Table 2 Annual cost of contingencies in addition to the minimum budget

	Contingency budget	
	3 Student courses	1 Instructor course
Minimum budget	\$8743	\$1966
Emergency fund	\$3600	\$1200
Regional conferences	\$1500	n/a
International conferences	\$3000	n/a
ATLS edition updates	\$2626	n/a
Educator initial investment (training)	n/a	\$402
Educator's pay	n/a	\$70
Remote courses	\$1260	n/a
ATLS Mongolia website	\$135	\$45

instructor course) per year. The number of instructor courses is based on the capacity the program can achieve at this point in its initiation. Costs were modeled for both budgets starting from the decade of course introduction: 2015–2025.

A cost analysis was performed on the modeled minimum budget comparing 2 scenarios: *foreign instructors* and *Mongolian instructors*. The *foreign instructor* scenario is composed of 3 student courses per year and no instructor courses. It accounts for expenses associated with 6 foreign ATLS instructors. These expenses include English-Mongolian translators, and travel, room and board for the instructors.

In contrast, the *Mongolian instructor* scenario, which most closely resembles the current state of the Mongolian ATLS program, is composed of an initial investment to train Mongolian instructors, Mongolian instructor pay for 3 student courses per year, and the cost of 1 Mongolian instructor course per year. The initial investment is based on the process previously achieved in Mongolia, which consisted of a *train-the-trainers* approach. This approach started with 5 visits over 3 years by international instructors and educators. Mongolian instructors were then trained by these international instructors and prepared to operate the Mongolian ATLS program independent of foreign instructors (besides an annual instructor course operated by a foreign educator). The cost of the annual instructor course includes expenses for a translator, and the travel, room and board for a foreign educator.

An analysis for training a Mongolian educator was also performed. It accounts for the initial costs of training a Mongolian instructor internationally and the subsequent costs of an annual Mongolian-run instructor course including the Mongolian educator's salary. This is in addition to the minimum budget. It was subsequently

compared to the minimum budget with Mongolian instructors and a foreign educator.

Finally, sources of ATLS course funding were explored. All calculations for funding amounts were based on offsetting the cost associated with the minimum budget. Mongolian government healthcare expenditures and average physician salaries were obtained from the World Bank, WHO and the Mongolian Health System Review [7, 22, 24–28]. The appropriate course fee for participation in the ATLS program was assessed through a 1-year follow-up questionnaire distributed to participants in the October 2016 course. The average response was subsequently compared to external sources of funding to develop 3 potential funding scenarios.

Results

The model represents the use of Mongolian trained instructors and projects a minimum annual cost of ATLS in Mongolia to be \$10,709 for 3 student courses and 1 instructor course per year (Table 1). This yields a cost of \$2914 for 1 student course or \$182 per student given 16 students participating in each student course. This also yields a cost of \$1966 for 1 instructor course or \$218 per student-instructor given 9 student-instructors participating in an instructor course. These projections do not include the initial investment of \$84,875 to train Mongolian instructors.

The more comprehensive contingency-based budget projects an average annual cost of \$19,926 for 3 student courses and 1 instructor course per year. Items included in the contingency budget are shown in Table 2. This yields a cost of \$5984 per student course and \$374 per student. This also yields a cost of \$1972 per instructor course and \$219 per student-instructor.

In contrast to the original model with Mongolian instructors, the total annual cost for the minimum budget with foreign instructors was projected to be \$68,038 for 3 student courses and no instructor courses (Table 3). This yields a cost of \$1417 per student and a total of \$680,378 per decade. A cost analysis comparing the minimum budget with Mongolian instructors—including an initial investment in training—to the minimum budget with foreign instructors revealed an overall average annual savings of \$48,305 or a 71% cost reduction, achieved by initially investing in training Mongolian instructors in lieu of foreign instructors (Fig. 1). The initial investment in training Mongolian instructors will be recouped within 2 years. Modeling shows that over the course of the next 10 years this will result in nearly half of a million dollars (\$483,048) in cumulative reduced costs (Fig. 1).

Further cost savings can be achieved with the training of a Mongolian educator. Relative to the cost of a foreign educator, an initial investment of \$4050 to train a Mongolian educator would reduce program costs by \$1750 per year, assuming 1 instructor course per year. This initial investment will be recouped within 2.1 years. Again, the bulk of the cost reduction comes from eliminating the travel expenses associated with a foreign educator.

Three sources of revenue to support the ATLS program in Mongolia were explored: government subsidies, course fees, and donations from third-party stakeholders. Healthcare expenditures in Mongolia as of 2014 totaled \$568 million USD [29]. From 1995 to 2010, health care expenditures rose from 3.6 to 5.4% of Mongolia's GDP. Despite this increase, Mongolia still lags behind its neighbors in medical expenditures for the WHO Western Pacific Region [28]. Of the \$568 million spent on health care in Mongolia, currently only 4.5% is spent on public health and prevention [28]. Mongolia's government provides almost a third of these expenditures, with the Ministry of Health controlling most of the government's health care budget. The Ministry of Health has the responsibility to provide preventative services, among other tasks [28]. In Scenario A (Table 4), we explore the possibility of a nationally supported ATLS program with funding provided by the Ministry of Health. The cost of supporting the student ATLS courses would represent 0.04% of Mongolia's current spending on public health and preventative services. In Scenario B (Table 4), ATLS student courses include student fees, with the difference made up by support from the Ministry of Health.

As a 1-year follow-up to the October 2016 ATLS course held in Ulaanbaatar, a questionnaire was distributed to participating physicians to assess their experience with the program. One of the questions asked was: What is an appropriate fee that physicians should pay to participate in the ATLS course work? Responses in the survey ranged from 50,000 ₮–150,000 ₮ (\$20.40–\$61.22 USD as of 11/14/17). Using an average of the responses, we established a 100,000 ₮ or \$41.82 USD for the student fee. This amount was used in determining course funding from students for Scenarios B and C (see "Discussion" section) in the "Comparison of Possible ATLS Course Funding" table (Table 4). An average annual salary of 10,527,044 ₮ or \$4297 USD was used to calculate student fees as a percentage of physician salaries [24].

Discussion

Trauma education programs are a vital component of advancing any trauma system. Established in 1978, ATLS has reached more than one million doctors in over 80

countries. Now in its 10th edition, it serves as the foundation of trauma education by providing a "common language and a common approach" [30]. ATLS was developed in a resource-rich setting and is expensive to implement, however, which raises questions over the suitability of ATLS in LMICs. Alternative courses exist but are often complementary or meant for different audiences. For example, the ACS Trauma Evaluation and Management (TEAM) has shown value in resource poor areas but is brief and designed for medical students. The Rural Trauma Team Development Course (RTTDC), also from the ACS, focuses on team-oriented training in rural settings. RTTDC would fit well into large sparsely populated countries such as Mongolia but is not meant to be a substitute for ATLS, and would be inappropriate for the metropolitan center of Ulaanbaatar. The International Association for Trauma Surgery and Intensive Care offers two excellent courses: Definitive Surgical Trauma Care (DSTC) and the National Trauma Management Course (NTMC). DSTC focuses on surgical technique after resuscitation while NTMC shares the goals of ATLS, but is meant for resource-limited settings. Other low-cost alternatives include Primary Trauma Care (PTC) and modules from the WHO called Emergency and Trauma Care Training Course. These options were discussed with Mongolia's surgical leaders, but they felt that joining a robust ATLS program considered the world standard, and its commitment to regular updates, was an important direction for their trauma system.

The Mongolian program was able to overcome the significant hurdle of startup costs while working within the framework established by the ATLS Australasia region. Still, real financial constraints threaten the course. The goal of this study was to understand the implementation of ATLS in Mongolia and aid in its sustainability. More broadly, this study demonstrates that initial investment in infrastructure leads to long-term savings—a recurrent concept in the global setting that should be highlighted and shared when possible. Our findings unequivocally show that a *train-the-trainers* approach, rather than a paternalistic model, results in long-term cost savings.

The minimum budget provides a baseline for expenses on an annual and per-course basis for an ATLS program in Mongolia. It should be noted that these projections represent a model, and permutations will be necessary for other LMICs to apply this model. For example, the number of ATLS courses offered per year is flexible depending on the resources available within a country. Furthermore, it will be important to explore the contingency budget and research the cost of enacting each individual contingency. The contingencies, especially ATLS edition updates, will be crucial for improving the course and ensuring its long-term effectiveness.

Table 3 Comparison of annual cost for Mongolian versus foreign instructors

	Annual costs: Mongolian versus foreign instructors	
	Mongolian instructors	Foreign instructors
Courses/year	3 Student courses 1 Instructor course	3 Student courses 0 Instructor courses
Foreign instructor/educator (travel and board)	\$1700	\$57,600
Translators	\$522	\$4696
Copyright fee	\$240	\$240
Manual printing cost	\$852	\$852
Equipment costs	\$3735	\$3600
Instructor pay	\$2310	n/a
Coordinator pay	\$1350	\$1050
Total	\$10,709	\$68,038

As the program becomes more established, rural ATLS or RTTDC courses may be considered. These would expand the program’s reach and offer the advantage of training physicians in their own hospital environment. Critical for rural providers with infrequent exposure to these types of patients, organizational and prioritization skills persist for years after the course [16, 31–33]. Also, it is possible that costs could be reduced with off-site training. However, this approach will need to be explored further as well as any possible impact of the new web-based training components of the ATLS 10th edition. Other contingencies such as the ATLS website and establishing the emergency fund will become necessary once the course is more established and has available funds.

The burden of trauma in Mongolia has risen as the country transitions from an agrarian to a commodities-based economy [1, 2]. Thus, the need for an organized trauma system and standardized care will become increasingly important. Among the many potential stakeholders in advancing trauma care training in Mongolia, the mining industry represents a strong potential supporter. As

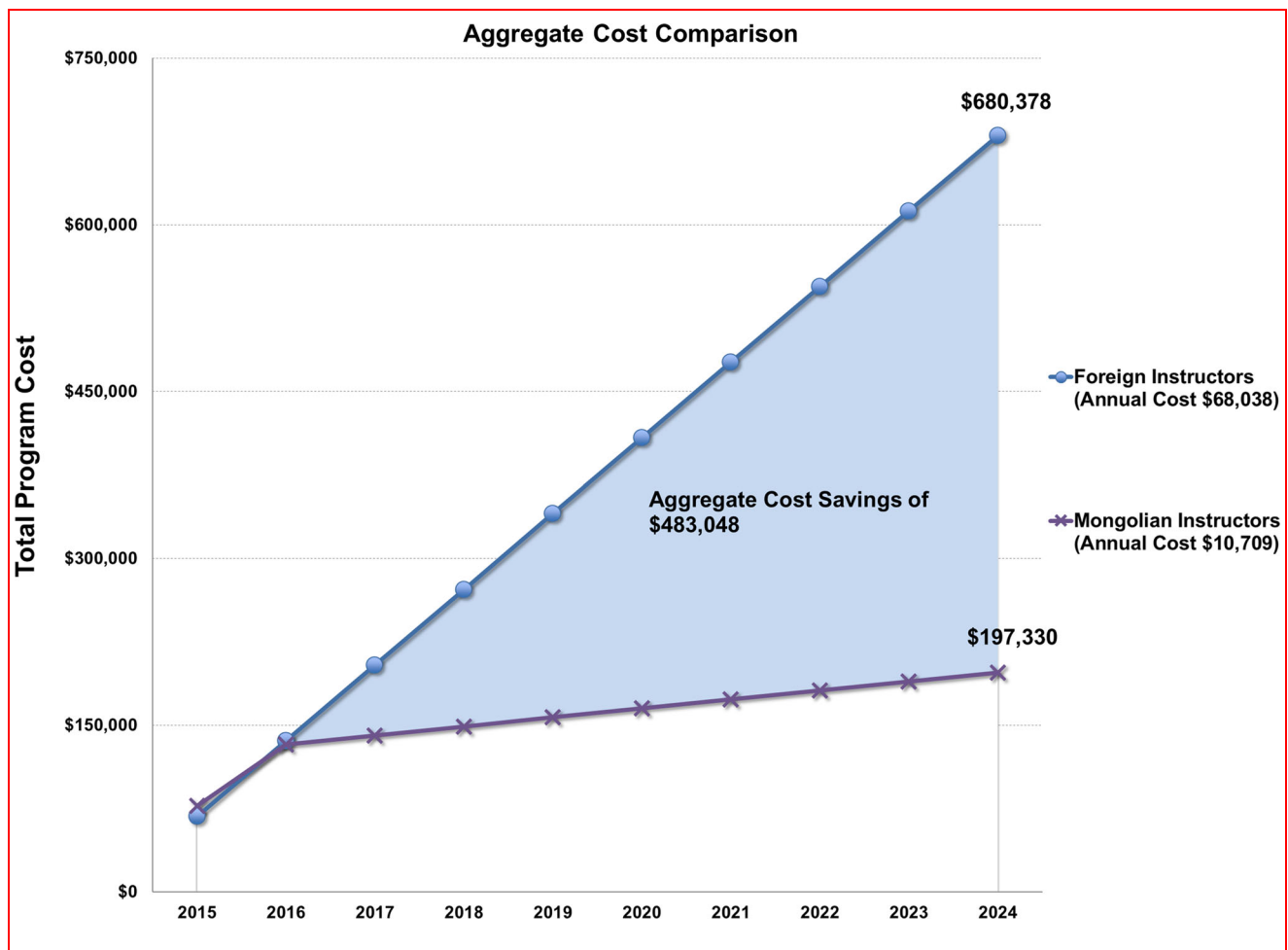


Fig. 1 Aggregate cost of foreign instructor and Mongolian instructor scenarios and subsequent savings

Table 4 Comparison of possible funding sources for the Mongolian ATLS course

	Comparison of possible sources of ATLS course funding						
	Student fees	% of annual physician salary	Ministry of health contribution (MoH)	% of annual public health expenditure	Third-party stakeholder contribution	% of annual mining revenues	Total yearly cost of student courses
Scenario A	\$0	n/a	\$10,709	0.04%	n/a	n/a	\$10,709
Scenario B	\$2007	0.85%	\$8702	0.03%	n/a	n/a	\$10,709
Scenario C	\$2007	0.85%	n/a	n/a	\$8702	<0.01%	\$10,709

of 2016, Mongolia's mining sector represented 21% of the GDP and over 70% of the country's foreign direct investment [34]. Partnerships should be explored in supporting the development of a robust trauma care program, not only in Ulaanbaatar but also in the provinces where many of these mining sites are located.

Three scenarios for funding the ATLS program were identified. Scenario A shows a contribution of 0.04% of annual Mongolian public health expenditures can fund the ATLS program. Scenario B combines student fees and a contribution of 0.03% of annual public health expenditures to fund the ATLS program. In Scenario C, explores ATLS student courses being supported by student fees and subsidized by donations from the mining industry, which would account for less than 0.01% of annual mining revenues (Table 4). Likewise, a government contribution comprised of a small fraction of a percent of total public health expenditures would help sustain the ATLS program. Training Mongolian physicians to adequately deliver trauma care will benefit the government, mining companies and the Mongolian people. This study provides a framework for stakeholders, new and old, to support trauma care and the health of the Mongolian people.

This analysis is limited by a few assumptions. It assumes that all courses are operated at full capacity, and students successfully complete the student and instructor courses on their first attempt. Due to the leadership's dedication to quality control the initial student pass rate was quite low at 37%. It has increased to 50% in part due to more Mongolian instructors. This is particularly important in the early stages of the program because there needs to be an ample number of students to take the instructor course and, subsequently, enough instructors to teach student courses. Otherwise, the initial investment in instructor training would become less cost-effective. The program would require foreign instructors for a longer period of time before the student course becomes self-sufficient, thus driving costs up. Here, we assume that the Mongolian ATLS program will require only 1 foreign educator and no

foreign instructors beginning in 2018. For the foreign instructor scenario, it is not currently possible to run 3 student courses back to back. Although doing so would cut down on travel expenses, most foreign instructors take time off clinical duty to teach, limiting the time available for each training course. Therefore, the training would require multiple visits. Also, the calculations do not take inflation into account, nor relatively big-ticket assets belonging to the program, such as the skills training mannequins, and the depreciation associated with them. Some countries might choose to use animal models or seek funding from organizations like People for The Equal Treatment of Animals, in which case these costs would be lower. Therefore, like the other assumptions made in our study, these were made for the sake of simplicity and generalization.

The cost analysis shows that by training Mongolian instructors, nearly \$500,000 can be saved over the course of a decade. By training a Mongolian educator, an additional \$17,000 can be saved over that period. These initial investments further enhance the sustainability of the program by placing the ownership in the hands of the Mongolian physicians, thus transitioning away from a paternalistic model. The need for translators—a potential source of teaching error as well as additional expense—is eliminated. In the future, it will be important to study the effectiveness of Mongolian instructors relative to foreign instructors. At this point, not enough exclusively Mongolian-run student courses have occurred to power an effectiveness study. This cost analysis can serve as a tool for continued support of the ATLS course from the Mongolian government and may garner support from third parties. Furthermore, barring cultural, socioeconomic and geopolitical differences, this study may provide a conceptual framework to provide guidance for implementing the ACS ATLS course into other LMICs.

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Compliance with ethical standards

Conflict of interest The authors report no conflict of interest in the publication of this manuscript.

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