




BMJ Open Establishing a baseline for surgical care in Mongolia: a situational analysis using the six indicators from the Lancet Commission on Global Surgery

Jade M Nunez ¹, Jonathan Nellermeoe,¹ Andrea Davis,² Simon Ruhnke,³ Battsetseg Gonchigjav,⁴ Nomindari Bat-Erdene,⁵ Anudari Zorigtbaatar ⁶, Ali Jalali ⁷, Kevin Bagley,⁸ Micah Katz,⁹ Hannah Pioli,¹⁰ Batsaikhan Bat-Erdene,⁵ Sarnai Erdene,⁵ Sergelen Orgoi,⁵ Raymond R Price,^{1,11} Ganbold Lundeg¹²

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JMN and JN contributed equally.

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For numbered affiliations see end of article.

Correspondence to

Dr Jade M Nunez;
jade.nunez@hsc.utah.edu

ABSTRACT

Objectives To inform national planning, six indicators posed by the *Lancet* Commission on Global Surgery were collected for the Mongolian surgical system. This situational analysis shows one lower middle-income country's ability to collect the indicators aided by a well-developed health information system.

Design An 11-year retrospective analysis of the Mongolian surgical system using data from the Health Development Center, National Statistics Office and Household Socio-Economic Survey. Access estimates were based on travel time to capable hospitals. Provider density, surgical volume and postoperative mortality were calculated at national and regional levels. Protection against impoverishing and catastrophic expenditures was assessed against standard out-of-pocket expenditure at government hospitals for individual operations.

Setting Mongolia's 81 public hospitals with surgical capability, including tertiary, secondary and primary/secondary facilities.

Participants All operative patients in Mongolia's public hospitals, 2006–2016.

Primary and secondary outcome measures Primary outcomes were national-level results of the indicators. Secondary outcomes include regional access; surgeons, anaesthesiologists and obstetricians (SAO) density; surgical volume; and perioperative mortality.

Results In 2016, 80.1% of the population had 2-hour access to essential surgery, including 60% of those outside the capital. SAO density was 47.4/100 000 population. A coding change increased surgical volume to 5784/100 000 population, and in-hospital mortality decreased from 0.27% to 0.14%. All households were financially protected from caesarean section. Appendectomy carried 99.4% and 98.4% protection, external femur fixation carried 75.4% and 50.7% protection from impoverishing and catastrophic expenditures, respectively. Laparoscopic cholecystectomy carried 42.9% protection from both.

Conclusions Mongolia meets national benchmarks for access, provider density, surgical volume and postoperative mortality with notable limitations. Significant disparities exist between regions. Unequal access may be efficiently addressed by strengthening or building key

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This retrospective analysis is based on facility-level data from a mature health information system in a lower middle-income country.
- ⇒ Impoverishing and catastrophic expenditures were calculated using a national household survey, avoiding modelling techniques developed for high-income countries.
- ⇒ Analysis of impoverishing and catastrophic expenditures is limited by the prevalence of informal payments in healthcare, common in post-Soviet nations.
- ⇒ Surgical data from Mongolia's mostly urban private sector were unavailable, which account for 18% of inpatient admissions.

district hospitals in population-dense areas. Increased financial protections are needed for operations involving hardware or technology. Ongoing monitoring and evaluation will support the development of context-specific interventions to improve surgical care in Mongolia.

INTRODUCTION

Recent health systems research emphasises the immense unmet burden of surgically treatable disease within low and lower middle-income countries (LMICs). The publication of a special *Lancet* Commission on Global Surgery (LCoGS) galvanised calls to coordinate a new research agenda around surgical access themes.¹ To inform national planning, this commission proposed a core set of indicators to assess a country's surgical systems (table 1). The LCoGS recommended collection and tracking of six indicators measuring preparedness, service delivery and cost protection as part of normative reporting processes owned by Ministries of Health and National Statistical Offices.

**Table 1** *Lancet* Commission on Global Surgery surgical indicators

	Definition	Target
Preparedness		
Access to timely essential surgery	The proportion of the population that can access caesarean delivery, laparotomy and treatment of open fracture (the bellwether procedures) within 2 hours.	A minimum of 80% coverage of essential surgical and anaesthesia services per country by 2030.
Specialist surgical workforce density	Number of specialist surgical, anaesthetic and obstetric physicians who are working, per 100 000 population per year.	100% of countries with at least 20 surgical, anaesthetic and obstetric physicians per 100 000 population by 2030.
Service delivery		
Surgical volume	Procedures are done in an operating theatre, per 100 000 population per year.	80% of countries by 2020 and 100% of countries by 2030 tracking surgical volume; a minimum of 5000 per 100 000 population by 2030.
Perioperative mortality	All-cause death rate before discharge in patients who have undergone a procedure in an operating theatre, divided by the total number of procedures, presented as a percentage.	80% of countries by 2020 and 100% of countries by 2030 tracking perioperative mortality; in 2020, assess global data and set national targets for 2030.
Cost protection		
Protection against impoverishing expenditure	The proportion of households protected against impoverishment from direct out-of-pocket payments for surgical and anaesthesia care.	100% protection against impoverishment from out-of-pocket payments for surgical and anaesthesia care by 2030.
Protection against catastrophic expenditure	The proportion of households protected against catastrophic expenditure from direct out-of-pocket payments for surgical and anaesthesia care.	100% protection against catastrophic expenditure from out-of-pocket payments for surgical and anaesthesia care by 2030.

Adapted from Meara *et al.*¹

Mongolia is an LMIC with a population of 3 million and a national poverty rate of 28.4%. Poverty is more prevalent in rural areas (31%) where a quarter of the country's population are nomadic herders.² Due to a long trend of urban migration, half of the population is concentrated in the capital, Ulaanbaatar (UB). Many migrants chose UB over other cities for better access to healthcare. This urbanisation has produced significant disparities in health systems access and strains on resource allocation.³

After the dissolution of the Soviet Union,⁴ Mongolia inherited a large public hospital system organised in four tiers (online supplemental file 1). Surgical infrastructure is present at the secondary (*aimag* and *rural general*) and tertiary levels. The intermediate district hospitals, or *intersoums*, often staff a surgeon as well.⁵ Health services are considered a right, but concerns exist over poor quality, inefficiency and increasing inequity in health services delivery.^{4 6 7} Mongolia now has a growing private health sector consisting largely of outpatient clinics. Private inpatient facilities, however, are concentrated in urban areas and tend to duplicate rather than complement public services.⁸

Mongolia has the advantage of a highly developed health information system with statisticians at every district-level hospital. It has been highlighted as a model for surgical scale-up⁹ and to demonstrate the feasibility of access calculations within LMICs.^{10 11} The development of a country-wide data set around surgical capacity has been a crucial next step in guiding and tracking progress towards surgical capacity expansion in Mongolia.

This is a situational analysis of an LMIC surgical system based on actual facility-level data and national household survey data sets.^{12–16} We aim to (1) set an 11-year

retrospective baseline using the LCoGS indicators to guide National Surgical, Obstetric, and Anesthesia Planning (NSOAP); (2) raise procedural questions about surgical systems indicators monitoring and best practices; (3) set future directions of research; and (4) recommend improvements for increased access to surgical systems in Mongolia.

METHODS

National data for public sector hospitals were obtained through the Mongolian Health Development Center (HDC) and demographic/population survey data through the National Statistics Office of Mongolia (NSO), via open access records. Disaggregated data of facilities outside the administrative boundaries of the capital city, UB, were obtained through contact with each of Mongolia's hospitals at the *aimag* (provincial), *rural general* and *intersoum* levels (online supplemental file 1) by letter and email correspondence with in-hospital statisticians in 2018 (100% response rate). HDC provided hospital strata classification details to develop further previously published information¹⁷ and personal correspondence (online supplemental file 1). UB-specific hospital stratum 'Tertiary'/'Specialty' is represented within HDC data in aggregate and is included within all characterisations of national capacity in this paper. All data were collected for the years between 2006 and 2016.

Indicator 1: 2-hour access to essential surgery

Hospital statisticians reported their hospital's capacity to perform caesarean sections (c-section), laparotomies and treatment of open fractures, within relevant hospital

types ('Intersoum' and 'Rural General') not previously described within the literature.¹¹ Distance was measured using publicly available road data from the National Aeronautics and Space Administration, Socioeconomic Data and Applications Center and the Global Roads Open Access Data Set version 1 (1980–2010),¹⁸ and checked against publicly available satellite data, administrative boundaries, 30 m digital elevation model (DEM), 30 m hill shade and lake and river shapefiles publicly available on Christopher M Free.¹⁹ Population density data for 2016 were available from WorldPop.²⁰

Two-hour access estimates for the entire country were created using a path distance algorithm in ArcGIS Pro (V.2.5), based on travel time to locations providing all three bellwether procedures. Travel speed on major roads was calculated using an average 65 km/hour speed, with off-road speeds calculated as an average 30 km/hour to represent likely modes of emergency travel (four-wheel drive vehicle, motorbike). DEM and hill shade data were included to improve path distance estimates for the country. Zonal statistics in ArcGIS Pro were used to determine the sum of the population within each given boundary, including current access to bellwether procedures, the sum of the population not covered within 2 hours of a bellwether facility and an estimation of the population for the recommended locations. We determined which interventions could increase access by improving surgical capacity at the district level. Intersoum hospitals covering the highest percentage of the population were noted for candidates where surgical capacity may be reasonably strengthened (five intersoums). Recommendations of new sites of surgical infrastructure access were based on population density information derived using WorldPop (five new sites).

Indicator 2: specialist surgical workforce density

Annual counts for surgeons, anaesthesiologists and obstetricians (SAO) were obtained from official HDC 'Health Indicators' publications.²¹ The count of surgeons includes general surgeons, traumatologists, urologists, ophthalmologists and otolaryngologists. The HDC number of SAO at the aimag level closely resembled aggregations of available facility-level counts. The density ratio is the total number of the SAO physicians per 100 000 people factored by the total population for the country cited in HDC publications for years 2006–2016.

Indicator 3: surgical volume

Surgical volume data were obtained from the HDC 'Health Indicators' publications. All inpatient and outpatient procedures performed in an operating room were included. Volume was calculated as a ratio of operations per 100 000 people factored by the total population at country-wide level as cited in HDC publications for years 2006–2016.

Indicator 4: perioperative mortality rate

All-cause mortalities before discharge were calculated by taking aggregated numbers of postsurgical, in-hospital deaths divided by the total number of operations

performed. These numbers were supplied by the HDC, then confirmed by disaggregated data from each hospital. This calculation was performed at a country-wide level for years 2006–2016.

Indicators 5 and 6: protection against impoverishing and catastrophic expenditures

Estimated monthly household consumption expenditures were calculated for years 2009–2016 using data from the Mongolian Household Socio-Economic Survey.²² Following the WHO methodology for estimating the per cent of households at risk of catastrophic and impoverishing health expenditures,²³ findings were related to costs associated with specific surgeries. We differentiated the share of total consumption expenditure going towards the purchase of food (excluding tobacco, alcohol and dining services). A nationally representative poverty line was established using sample weights provided by the NSO, equal to the weighted average food expenditures per individual (adjusted for household size and inflation) between the 45th and 55th percentiles of the food expenditure shares (in 2017 Mongolian tugriks). The non-subsistence effective income available for each household, that is, a household's capacity to pay (CTP), was then determined as being any adjusted expenditures beyond the poverty line. For those households with estimated food expenditure below subsistence level, CTP was estimated as any expenditures beyond a household's own food expenditures.

The per cent of households facing catastrophic health expenditures were then determined using the out-of-pocket (OOP) expenditures at government-operated hospitals for five emergency surgical procedures: c-section, appendectomy, laparoscopic cholecystectomy, exploratory laparotomy and external fixation of the femur. A household is defined as 'at risk for catastrophic expenditure from the respective surgical expenditure' if the expected OOP expenditure for surgery exceeds 40% of the household's CTP.²³ Households are defined as 'at risk of impoverishment due to surgery' if the OOP expenditure associated with a surgery would move a household below the defined poverty line.

Patient and public involvement

There was no patient or public involvement in this report of deidentified retrospective, open-source data.

RESULTS

Indicator 1: 2-hour access to essential surgery

Overall 2-hour access to essential surgery in Mongolia is 80%. Half of the population lives in UB (online supplemental file 2), of which 99.7% have timely access. However, only 60% of those outside of the capital have timely access. **Figure 1A** shows the current facilities performing the bellwether procedures across the country, displayed with travel time and population coverage. Capable facilities include aimag (22 and capital UB), rural general (6) and intersoum (1) levels. If all intersoum-level hospitals (37) were capable of the three bellwether procedures, 3.0% of

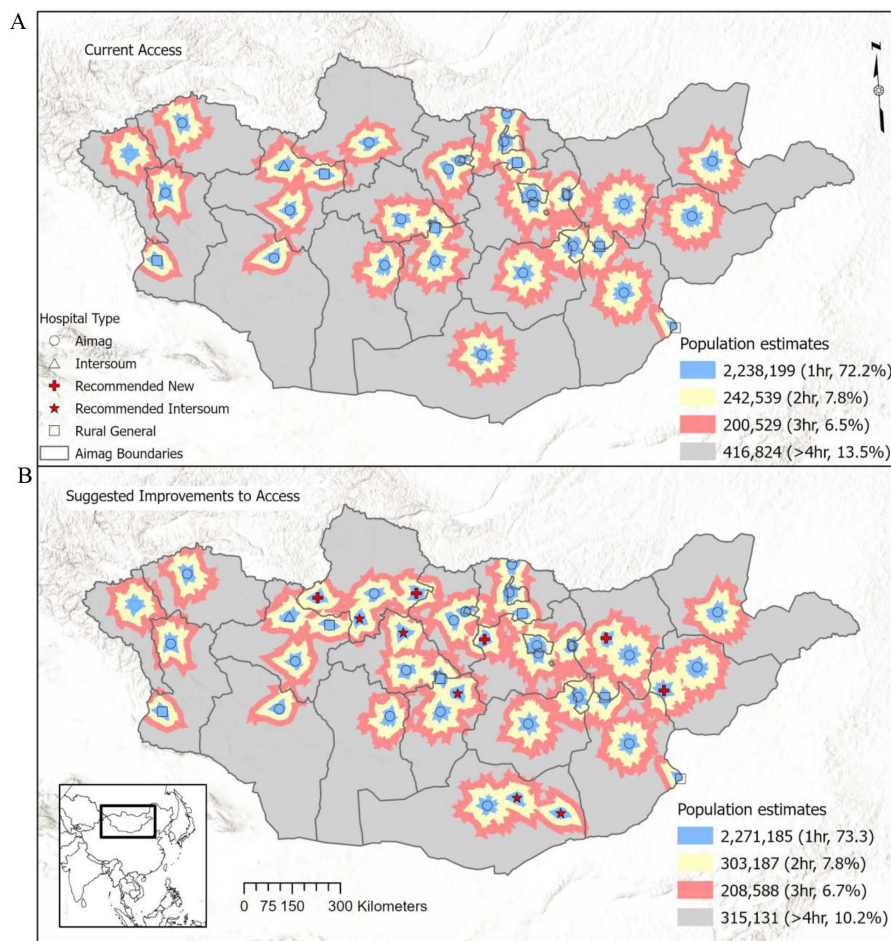


Figure 1 Current (A) and improved (B) access to bellwether procedures by population, 2016.

the national population would gain 2-hour access (online supplemental file 3). Because all intersoum hospitals are outside of UB, 6% of the rural population would gain access. Spatial analysis, sensitive to population density and existing access patterns, highlights five intersoums where expanding surgical capacity could add coverage to 1.6% of the total population. Also, adding five hospitals capable of performing bellwether procedures would give access to another 1.4% of the total population. These recommendations build into a set of 10 total facilities rather than make improvements to all 37 intersoums and would improve access to 3% of the total population (6% of the rural population), or approximately 93 634 people (figure 1B).

Indicator 2: specialist surgical workforce density

The overall surgical workforce density in 2016 was 47.4 SAO per 100 000 population, which has increased from 42.9 per 100 000 in 2006 (online supplemental file 4). Of the 1479 SAO in 2016, 442 (29.9%) were surgeons, 278 (18.8%) anaesthesiologists and 759 (51.3%) obstetricians. By province, the SAO ranges from 22.5 per 100 000 in Selenge to 66.6 per 100 000 in UB. There was no statistically detectable difference in the professional mix of SAO over the 11-year period (online supplemental file 5).

Indicator 3: surgical volume

The number of surgical procedures per 100 000 population in the country increased from 2601 in 2006 to 5784 in 2016 (online supplemental file 6). The coding system reverted to International Classification of Diseases, Ninth Revision (ICD-9) from ICD-10 in 2014, affecting the comparability of data before and after. Years 2006–2013 showed a rate of 6.57% average annualised growth in surgical volume. Volumes in 2016 ranged from 825 in Selenge to 148 077 in UB. Of the 21 provinces and capital, only UB met the key threshold LCoGS target rate of 5000 procedures per 100 000 population.

Indicator 4: perioperative mortality rate

In 2016, the all-cause in-hospital mortality in Mongolia was 0.14% (online supplemental file 7). This ranged from no reported in-hospital mortalities (0/17 921) in 11 provinces to a 0.31% mortality rate (7/2279) in Uvurkhangai (online supplemental file 8). From 2006 to 2016, the in-hospital mortality decreased from 0.31% to 0.14%, with a peak of 0.32% in 2008. With the exceptions of Dornod and Uvurkhangai, most provinces reported zero mortality over multiple years.

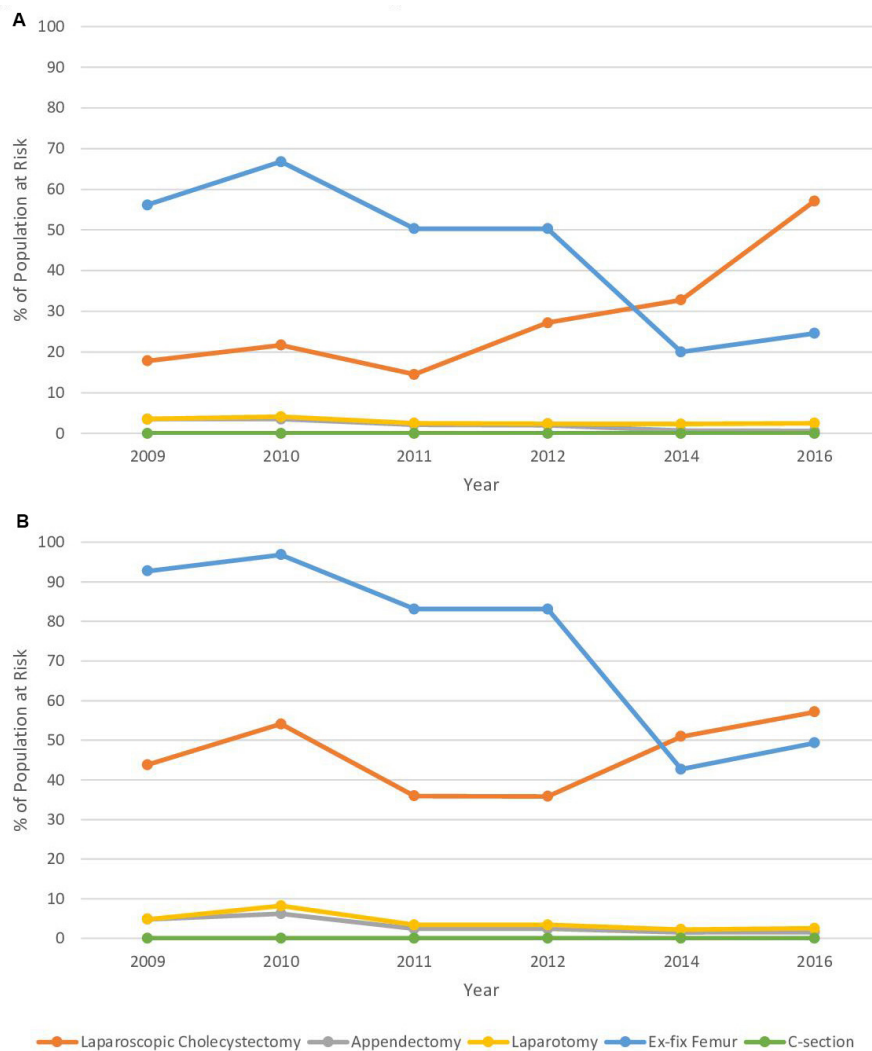


Figure 2 Percentage of Mongolian population at risk of impoverishment (A) and catastrophe (B) due to five operations between 2009 and 2016.

Indicators 5 and 6: protection against impoverishing and catastrophic expenditures

Between 11 200 and 12 811 unique Mongolian households per year were surveyed for years 2009–2016 representing populations of 2 735 800 and 3 119 900 in Mongolia over the same years.

Impoverishing expenditure

For all years examined, 100% of households were protected from impoverishment due to c-section. In 2009, 96.5% of households were protected from impoverishment due to appendectomy, 82.2% due to laparoscopic cholecystectomy and 43.8% due to external femur fixation. In 2016, 99.4% of households were protected from impoverishment due to appendectomy, 42.9% due to laparoscopic cholecystectomy and 75.4% due to external femur fixation (figure 2A).

Catastrophic expenditure

For all years examined, 100% of households were protected from catastrophe due to c-section. In 2009, 95.2% of households were protected from catastrophe

due to appendectomy, 56.2% due to laparoscopic cholecystectomy and 7.3% due to external femur fixation. In 2016, 98.4% of households were protected from catastrophe due to appendectomy, 42.9% due to laparoscopic cholecystectomy and 50.7% due to external femur fixation (figure 2B).

DISCUSSION

This is the first situational analysis of Mongolia's surgical system using all six indicators of access to safe and affordable surgical care recommended by the LCoGS.¹ Mongolia has crucial elements that are often lacking among LMICs, such as a large public healthcare infrastructure and a highly developed health information reporting system, which allowed for a detailed analysis. We found that Mongolia meets national-level benchmarks for preparedness with 80.1% of the population having timely access to essential surgery and more than double the target provider density (47.4 per 100 000 population). Service delivery also seems adequate with a surgical volume of

5825 cases per 100 000 population annually and a post-operative mortality of 0.14%. However, closer inspection shows these numbers are buoyed by the service-rich capital. Surgical capability in Mongolia is clearly over-represented by UB, where over 80% of surgeries are performed. While provider density is adequate in rural areas, specialist distribution is a concern. Finally, Mongolia fails to meet the target of universal financial protection, as risk varies by type of procedure.

An earlier feasibility study reported 83% of Mongolians have timely access.¹¹ Our findings revise this number, fine-tuned by accounting for the impact of terrain (slope), road condition (main/off-road) and satellite image-guided population density variation. Access numbers are also influenced by mass migration to the capital over the last 30 years. Around half of the population now lives in and around UB, up from 26.8% in 1989.³ Of patients living within the capital, 99.7% have 2-hour access. This is true of only 60% of those living in the rest of the country.

Mongolia has the world's second-lowest population density²⁴ and its people are historically nomadic. Timely access for the entire rural population may be impractical, but some of the disparity can be corrected by strengthening the intersum hospital. However, only regional referral centres in Mongolia have sufficient populations to support surgical procedures consistently. Our recommendations are therefore guided by a strategy of optimisation. Rather than seek a 6% increase in rural access by strengthening all 37 intersum hospitals, it may be achieved by strengthening just five intersum hospitals and placing five new hospitals in population-dense areas. Access to essential surgery outside of UB would increase to 66%, or an additional 936 364 people.

Factors typical to Mongolia limit this analysis for timely access to surgical care: variable road quality, harsh winters and disparate access to transportation. Private hospitals were not included in the analysis, but are concentrated in urban areas⁸ and would not significantly change access. The realities of 2-hour access in UB's gridlock traffic conditions were left for future research. Among next steps for national surgical planning is to understand and anticipate disruption of surgical access as a result of these seasonal and traffic factors.

The number of SAO providers in Mongolia exceeds the recommended threshold of 20 providers per 100 000 persons, as well as the steeper goal of 40 providers per 100 000 described to maximise surgical output.¹² In fact, every region is independently above the recommended threshold. The proportion of anaesthesiologists also exceeds recommendations of 4 and 5 per 100 000 persons.^{25 26} However, high SAO figures are not necessarily a reliable proxy for effective investments in surgical infrastructure. Countries categorise their surgical workforce differently, and it is not clear who should count towards a total SAO figure.¹ Mongolia designates five different types of surgeons: general surgeons, traumatologists, urologists, ophthalmologists and otolaryngologists. A report from Brazil counts 14 types, including subspecialists.¹³

Additionally, obstetricians account for over one-half of all SAO providers in Mongolia, but according to correspondence with the Mongolian Federation of Obstetrics and Gynecology, fewer than half perform c-sections. The problem of SAO distribution must be considered as well. Obstetricians dominate the composition of the surgical workforce at the province level (online supplemental file 5). However, smaller surgically equipped facilities often lack an obstetrician or anaesthesiologist altogether. Taken as a whole, it is clear that Mongolia's SAO density grossly overestimates the adequacy of its surgical staffing. When applied as a metric moving forward, SAO density should consider provider distribution, proportion and skill set to better inform national surgical planning.

In the last 3 years observed, surgical volume in Mongolia rose above the threshold of 5000 cases per 100 000 population annually, correlating with a switch in coding operations from the ICD-10 to ICD-9. This counterintuitive selection of older coding paradigms reflects a preference among coders at the HDC for the more intuitive ICD-9, enabling them to better capture outpatient procedures. This affected the denominator for calculating perioperative mortality, and underscores the interdependence of the indicators. It is notable that even with adequate SAO density, no province outside of the capital reached the surgical volume target recommended by LCoGS. In fact, only 18% of surgeries were performed outside of UB in 2016 (32 386/180 463),²⁷ underscoring the capital's role as the ultimate referral centre for the country's rural population. Seriously injured patients, for example, are transferred to the capital's military trauma hospital and most cancer surgery is performed at the national cancer hospital. Building capacity for more complex cases at aimag hospitals may decrease reliance on tertiary hospitals in the capital.

Despite its role, UB barely meets the threshold for surgical volume. One explanation for unexpectedly low operative volume is medical tourism to surrounding countries, including South Korea, Japan and China, where surgical capacity is more robust.⁶ As many as 40 000 Mongolians engage in medical tourism each year,⁶ representing a well-known phenomenon that can affect national surgical volumes.¹ Mongolia's leaders are seeking to address the issue with improved training in country and abroad.^{28 29} For instance, having the highest prevalence of hepatocellular carcinoma in the world,³⁰ Mongolia contributed the largest share of foreign visitors travelling to South Korea seeking liver transplantation.³¹ This declined sharply after a liver transplant programme was initiated in 2011 in cooperation with South Korean surgeons.^{31 32} Mongolia now has the third highest rate of living-donor liver transplant.³³

In-hospital mortality following surgery continuously fell over the observed course, down to a low of 0.14%. Though very low for an LMIC, it is consistent with previously reported data from middle-income countries.¹ Mongolia experienced a drop in perioperative mortality from 2013 to 2014, best explained by inclusion of low-risk outpatient procedures.

Table 2 Recommendations for surgical system strengthening in Mongolia and general comments on the Lancet surgical indicators

Indicator	2030 target	Mongolia 2016	Recommendations for surgical system strengthening in Mongolia	General comments on the Lancet surgical indicators
1. Access to timely essential surgery	80% coverage	80.1% coverage 60% coverage of population outside of capital	Increase the capacity of five key intersoum hospitals and consider five new hospitals in populated areas. Characterise access delays due to weather and traffic.	Understanding transportation challenges particular to each country is essential to determine accurate surgical access. Account for volume of bellwether procedures at a hospital when interpreting access.
2. Specialist surgical workforce density	20 SAO per 100 000 population	47.4 SAO per 100 000 population	Ensure appropriate SAO skill set and distribution, especially to smaller surgical facilities. Quantify obstetricians able to perform procedures such as caesarean delivery.	Assess provider skill set and distribution along with SAO density. Only obstetricians able to perform caesarean delivery should count towards SAO.
3. Surgical volume	5000 per 100 000 population	5784 per 100 000 population	Continue efforts to improve the scope of care and public perception in rural provinces. Engender trust in the health system to reduce surgical tourism through improved training, research and international outreach. Capture private surgical cases.	Monitor distribution of procedures to understand the scope of access to elective surgery.
4. Perioperative mortality	Track and set national targets	0.14%	Consider ways to track 30-day postoperative mortality. Explore the potential for error or under-reporting of postoperative mortality. Promote processes for quality improvement at the regional level.	While impractical in many LMICs, 30-day postoperative mortality may be important for overcoming cultural barriers. Consider stratifying mortality by procedure and emergent versus elective.
5. Protection against impoverishing expenditure 6. Protection against catastrophic expenditure	100% protection	C-section: 100% protection from impoverishing and catastrophic expenditures. Appendectomy: 99.4% protection from impoverishing expenditure, 98.4% protection from catastrophic expenditure. Laparoscopic cholecystectomy: 42.9% protection from impoverishing and catastrophic expenditures. Ex-fix femur: 75.4% protection from impoverishing expenditure, 50.7% protection from catastrophic expenditure.	Enact legislation to decrease formal out-of-pocket costs, especially for those procedures involving implants or technology. Decrease systemic dependence on informal out-of-pocket payments. Build trust and quality in the public healthcare system to decrease surgical tourism.	Assessment at the level of individual procedures may better characterise financial protection. Factor local customs and concerns into the cost of surgical care, including informal out-of-pocket payments.

SAO, surgeons, anaesthesiologists and obstetricians.

Regardless, postoperative mortality has been on a downward trend since 2006. Two reasons for low postsurgical in-hospital mortality stand out. First, rural hospitals refer complex procedures to tertiary centres in the capital. Second, Mongolian cultural preferences make discharge to home likely if death is imminent. Yet these factors alone do not explain a mortality of zero in many districts. The potential for under-reporting should be carefully explored. Surgical complications can carry professional and legal ramifications and significant stigma. For these reasons, trends of in-hospital mortality may not be the best indicator to guide quality improvement in Mongolia. Monitoring 30-day postoperative mortality, though difficult, would provide more accurate information on postsurgical mortality to guide nationwide initiatives.³⁴

Limiting collection to emergency laparotomy or a select group of inpatient procedures would eliminate the impact of lower risk outpatient procedures on postoperative mortality rates and allow for better comparability between regions.³⁴⁻³⁶

While Mongolia does have mandatory national health insurance, decline in public health financing has increased OOP payments to over a third of health expenditure.^{37 38} Costs of c-sections have been used as a surrogate to model financial burdens of surgical cost in LMICs.³⁹ This fails in Mongolia, where the procedure still incurs no formal OOP payment. Instead, financial protection was assessed with five common operations selected due to their association with bellwether procedures and the high incidence of gallbladder pathology.^{28 40} Laparotomy and appendectomy were found

to involve relatively low financial risk. Laparoscopic cholecystectomy and external fixation of the femur bring much higher risk because the cost of new technology and hardware is passed along to patients. The Ministry of Health has enacted decrees to reduce the cost of some high-cost operations using newer technology, decreasing the financial risk for external femur fixation substantially between 2012 and 2014. However, the financial risk for laparoscopic cholecystectomy has continued to rise.

The growing cost of surgery will require a coordinated effort between all entities of healthcare delivery. Legislation to decrease OOP cost should be prioritised, especially for minimally invasive approaches which can allow faster return to work. Innovation from within Mongolia may reduce dependence on imported medical devices and equipment. Counterintuitively, the wealthiest households are at greatest risk of catastrophic health payments in Mongolia. This is credited to preferences for tertiary and private facilities with higher OOP payments and seeking care overseas.⁴¹ In fact, as much as US\$14 million is lost to medical tourism from Mongolia annually, or 7% of the state healthcare budget.⁶ Efforts to engender trust in the healthcare system may reduce medical tourism and redirect financial flows back towards the country.

Our approach to impoverishing and catastrophic expenditures should be considered in light of two important precedents within the literature.^{13 14} Recent reports from Brazil and Colombia, upper middle-income countries, illustrate two contrasting approaches to assessing protection against impoverishing and catastrophic expenditures. In Brazil, Massenburg *et al* used a method of modelling based on commonly available variables, Gini coefficient and gross domestic product. It relies on the simplifying assumption that the income distribution follows a similar functional form (γ) observed in high-income countries. In Colombia, Hanna *et al* avoided modelling by using a national health survey specifically designed to capture individual healthcare costs. While this yields a very accurate estimation of expenditure, such a detailed collection is more difficult in an LMIC setting. The method used in Mongolia falls between these extremes and uses a more general household expenditure survey to quantify these indicators objectively and in a manner that is more easily scaled to other countries compared with health-specific data collection.

Analysis of catastrophic and impoverishing expenditures is limited by the prevalence of informal payments in healthcare, common in post-Soviet nations.^{42 43} In Mongolia, these under-the-table payments comprise around 60% of OOP expenditure, typically for surgery, cancer and obstetrics.⁴¹ This has been associated with decreased utilisation of healthcare^{44 45} and represents catastrophic expenditure for poorer households.^{46 47} We did not measure the effect of informal payments, so our findings likely underestimate the financial impact of accessing surgical care.

Surgical data from Mongolia's growing private sector were unavailable, limiting our study's scope. Private

inpatient facilities care for 18% of all admissions.⁸ They have little effect on access, however, as almost all of their admissions outside of UB occur in provincial capitals. Efforts should be made to characterise surgical care at these facilities and policy makers should better engage them in health system planning.⁴⁸

Mongolia faces challenges common to other LMICs. Accordingly, this study has given us a better understanding of the surgical indicators for wider application. Geospatial analysis, for instance, is a powerful tool for measuring access. Accurate estimates, however, depend on knowledge of dynamic local conditions. Travel times should be interpreted conservatively where infrastructure is lacking and caution is encouraged when comparing results between countries.⁴⁹ Geographical disparities can undermine measurements of preparedness and service delivery, so physician and procedure distribution should be weighed alongside national totals. Local customs can affect mortality reporting, referral patterns for complex cases and unmeasured OOP costs. Monitoring 30-day postoperative mortality, stratifying cases by type and acuity and characterising informal payment practices may overcome the pitfalls of these broad-natured indicators. Recommendations for both Mongolia and more general use are summarised in [table 2](#).

CONCLUSION

While Mongolia meets global benchmarks for access, provider density, surgical volume and postoperative mortality, these results must be considered alongside important limitations. Closer inspection at the regional level reveals important opportunities for system strengthening. Physical distances between equipped facilities and high-estimated burdens of OOP payments are the biggest hurdles to improving surgical care. Policy changes should focus on improving access for rural populations and address risks of OOP costs, both formal and informal. This situational analysis provides critical information that can be used to inform Mongolia's NSOAP. Integration of indicator monitoring within existing national health information systems will be essential to evaluate interventions moving forward, enabling healthcare leaders to raise the standard of care for all patients.

This study demonstrates one LMIC's capacity to collect all six indicators recommended by the LCoGS. As the great majority of costs to global economies will be shouldered by such countries,¹ their own comprehensive assessments will be of particular importance to develop context-specific interventions to improve surgical care.

Author affiliations

¹Department of Surgery, University of Utah Health, Salt Lake City, Utah, USA

²Department of Geography, University of Utah, Salt Lake City, Utah, USA

³Berliner Institut für Empirische Integrations- und Migrationsforschung/BIM, Berlin, Germany

⁴Mongolian Health Development Center, Ulaanbaatar, Mongolia

⁵Department of Surgery, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia

⁶Faculty of Medicine, McGill University, Montreal, Québec, Canada
⁷Cornell University Joan and Sanford I Weill Medical College, New York City, New York, USA
⁸Southwest Memorial Hospital, Cortez, Colorado, USA
⁹Cayuga Medical Center, Ithaca, New York, USA
¹⁰University of Utah School of Medicine, Salt Lake City, Utah, USA
¹¹Intermountain Healthcare, Salt Lake City, Utah, USA
¹²Department of Critical Care and Anaesthesia, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia

Twitter Jade M Nunez @jadununez, Jonathan Nellermeoe @jnellermeoe, Anudari Zorigtbaatar @AnudariZorigtb and Ali Jalali @ali_jalali_

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ORCID iDs

Jade M Nunez <http://orcid.org/0000-0002-5642-5767>
 Anudari Zorigtbaatar <http://orcid.org/0000-0002-5050-8967>
 Ali Jalali <http://orcid.org/0000-0003-4349-1519>

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