

## Assessing unmet anaesthesia need in Sierra Leone: a secondary analysis of a cluster-randomized, cross-sectional, countrywide survey.

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### Abstract

**Objectives:** To determine the unmet anaesthesia need in a low resource region.

**Introduction:** Surgery and anaesthesia services in low- and middle-income countries (LMICs) are under-equipped, under-staffed, and unable to meet current surgical need. There is little objective measure as to the true extent and nature of unmet need. Without such an understanding it is impossible to formulate solutions. Therefore, we re-examined Surgeons OverSeas (SOSAS) unmet surgical need data to extrapolate unmet anaesthesia need.

**Methods:** For the untreated surgical conditions identified by SOSAS, we assigned anaesthetic technique required to carry out the procedure. The chosen anaesthetic was based on common practice in the region. Procedures were categorized into minimal anaesthesia, spinal anaesthesia, regional anaesthesia, ketamine/monitored anaesthesia care (MAC), and general endotracheal anaesthesia (GETA).

**Discussions:** Ninety-two per cent (687 of 745) of untreated surgical conditions in Sierra Leone would require some form of anaesthesia. Seventeen per cent (125 of 745) would require MAC, 22% (167 of 745) would require spinal anaesthesia, and 53% (395 of 745) would require GETA.

**Conclusion:** Analyses such as this can provide guidance as to the rational and efficient production and distribution of personnel, drugs and equipment.

**Keywords:** unmet anaesthesia, cluster-randomized, cross-sectional, countrywide survey.

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### Introduction:

The World Bank classifies countries into low-, middle- and high-income based on the gross national income per capita in U.S. dollars. The divisions are: low-income, \$1,035 or less; middle-income, \$1,036 - \$12,615; and high-income, \$12,616 or more.<sup>1</sup>

It is recognized that surgery and anaesthesia services in low- and middle-income countries (LMICs) are un-

der-equipped and under-staffed.<sup>2-21</sup> Most of this data comes from assessments of personnel, supplies and workload at institutions throughout the low resource world. It clearly demonstrates that surgical and anaesthesia services are unable to meet the current need, but gives no sense as to the true extent and nature of unmet need. Without such an understanding it is almost impossible to formulate strategies to resolve the shortfall. To address the knowledge deficit regarding surgical need, Surgeons OverSeas<sup>22</sup> developed and tested a survey tool, the Surgeons OverSeas Assessment of Surgical Need (SOSAS).<sup>23</sup> In 2012 this tool was used to assess the prevalence of surgically treatable conditions in Sierra Leone, and revealed that one quarter of the population had a surgical condition needing attention.<sup>24</sup> In an attempt to determine the corresponding unmet anaesthesia need, we re-examined this data to infer the types and numbers of anaesthetics that would be required to satisfy this unmet surgical need.

### Methods

The original SOSAS survey of Sierra Leone targeted 1875 households randomly selected from study clus-

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ters based on enumeration areas in Sierra Leone. Two randomly selected household members underwent head-to-toe verbal examinations to identify existing untreated surgical conditions. Conditions were defined with multiple modifiers: anatomic location, aetiology (injury, congenital, mass, etc.), severity of consequent disability, and reason for not receiving care.<sup>24</sup>

After obtaining University of Utah Institutional Review Board approval to assess this dataset (IRB # 00062903) we assigned types of anaesthetic techniques required to carry out the procedure for the untreated surgical conditions identified in the SOSAS dataset. The chosen anaesthetic technique was based on common practice in the region. If there was ambiguity about the necessary

intensity of anaesthetic care, the less complex anaesthetic (fewer resources) was chosen. Procedures were categorized into minimal anaesthesia, spinal anaesthesia, regional anaesthesia, ketamine/monitored anaesthesia care (MAC), and general endotracheal anaesthesia (GETA) (see Table 1).

As noted by Groen et al<sup>24</sup> “respondents could report having more than one surgical condition”. Therefore, in the SOSAS paper they reported ‘respondents in need of surgical care’ rather than the absolute number of surgical conditions. To address this issue in our analysis, we selected the highest-level anaesthetic technique required for at least one of the respondents’ surgical conditions.

**Table 1 Anaesthetic requirement by surgical procedure / condition ordered by increasing complexity, costlier equipment and supplies, and higher training level of personnel.**

Type of anaesthetic	Description	Criteria (Examples)
<b>Minimal anaesthesia</b>	Topical or sub-cutaneous local anaesthetic infiltration by non-anaesthesia personnel.	<input type="checkbox"/> All procedures for dental and ophthalmic conditions not resulting from injury
<b>MAC</b>	Sedation with ketamine and/or benzodiazepines.	<input type="checkbox"/> All procedures for non-disabling back, neck, head, chest and breast conditions. <input type="checkbox"/> All non-injury related abdominal wounds, and soft reducible masses.
<b>Spinal anaesthesia</b>	Local anaesthetic injected into the intrathecal space (may include sedation as in MAC).	<input type="checkbox"/> All lower extremity and groin procedures (including inguinal hernia). <input type="checkbox"/> Procedures for obstructed labour or ‘inability to urinate’.
<b>GETA</b>	General anaesthesia with endotracheal intubation, maintained with inhaled agents.	<input type="checkbox"/> All procedures for eye, head and neck injuries, and ENT, upper extremity and abdominal conditions not suitable for above anaesthetic types. <input type="checkbox"/> All significantly disabling conditions.

### Findings

Our analysis of the SOSAS dataset revealed that 92% (687 of 745) of untreated surgical conditions in Sierra Leone would require some form of anaesthesia. Seventeen per cent (125 of 745) would require MAC, 22% (167 of 745) would require spinal anaesthesia, and 53%

(395 of 745) would require GETA (Table 2).

Using the extrapolated numbers from Groen et al,<sup>24</sup> if 1.5 million Sierra Leoneans potentially need surgery today, then up to 795 000 (53%) will need a GETA, 330 000 (22%) will need spinal anaesthesia, and 255 000 (17%) will need MAC.

**Table 2 Distribution of anaesthetic types needed for untreated surgical conditions.**

Anatomic Site	# Needing surgery	Categories	Minimal anaesthesia	MAC	Spinal	GETA
Eye	52	Injury				13
		Non-injury	39			
ENT	19					19
Dental / mouth / lips	22	Injury				3
		Non-injury	19			
Neck	27	NO disability (0 injuries)		9		
		Significant disability				18
Head	36	NO disability	Injury			1
			Non-injury		17	
		Significant disability				18
Chest / breast	60	NO disability		34		
		Significant disability				26
Back	58	NO disability		19		
		Significant disability				39
Abdominal	299	Injury				20
		Wounds (non-injury)		6		
		Solid masses				15
		Soft, reducible mass		40		
		Deformity (congenital or acquired)				5
		Rectal bleeding				18
		Abdominal pain / distension				165
		Obstructed labour				15
		Inability to urinate				15
Groin	69	Burn / injury			2	
		Solid masses (testicular)			7	
		Inguinal herniæ			34	
		Deformity (congenital or acquired)			15	
		Fistula			2	
		Hæmaturia				9
Extremities	103	Upper				26
		Lower			77	
Total	745		58	125	167	395
			7.79%	16.78%	22.42%	53.02%

## Discussion

Sierra Leone has a large unmet surgical need, most of which (92%) would require some form of anaesthesia. The factors limiting provision of this anaesthesia care are myriad and common throughout LMICs.<sup>2-18</sup> The re-

cent Ebola epidemic, with the tragic loss of many vital providers has exacerbated these problems.

In some LMICs<sup>25</sup> there are disproportionately fewer anaesthesia-providers than surgeons, making anaesthesia manpower the 'rate-limiting factor' in unmet surgi-

cal need. Before the Ebola epidemic, Sierra Leone had 30 surgical providers and 32 anaesthesia providers for a country of six million.<sup>21</sup> Now, sadly, there are many fewer. Most of these providers are located in the larger urban centres which have only 39% of the population.<sup>26</sup> This leaves the district hospitals short-staffed, although proportionately so. There is little doubt that both surgical and anaesthesia manpower must be increased in parallel if the unmet surgical need is to be addressed.

As of 2009 there were three anaesthesia machines<sup>19</sup> and few vital signs monitors<sup>21</sup> scattered over nine general hospitals in Sierra Leone. Oxygen is mostly supplied by concentrators, which malfunction frequently.<sup>19</sup> Municipal electricity and water supplies are unreliable. Surgical patients' families often must provide funds for fuel for the hospital's electricity generator during their relative's surgery.<sup>19,21</sup>

This analysis provides guidance as to rational and efficient training of personnel, and equipment purchase and distribution. Fifty-three per cent of unmet surgical need in Sierra Leone would require GETA, and a significant proportion (39%) of procedures could be conducted with a spinal anaesthesia or MAC. This two-tier construct reflects practicalities, and highlights the large gap between de facto practice and ideal systems of care. The World Federation of Societies of Anaesthesiologists<sup>27</sup> and the World Health Organization<sup>28</sup> clearly delimit personnel able to provide different levels of anaesthesia care. It is considerably more expensive and time-consuming to train a physician than a nurse or anaesthesia officer,<sup>9</sup> and these mid-level professionals could provide much of the unmet anaesthetic need with lower level anaesthetics. As numbers of credentialed providers are recovered, there may be an opportunity to judiciously recruit and train distinct personnel to provide different levels of anaesthetic services at appropriate surgical sites.

Medication and equipment acquisition could be prioritized to procedurally appropriate facilities. Although there are recognised minimum drug and equipment standards for any anesthetizing location,<sup>27,28</sup> there is an opportunity to focus drugs and equipment required for higher level anaesthesia in those centres with the appropriate patients, and surgical and anaesthesia personnel. A successful surgical procedure requires a multiplicity of personnel and processes functioning in synchrony. To address surgical deficit one must encompass all of

these variables. An analysis of this type, in which we examine the anesthetic counterpart of unmet surgical need, is a key part of planning for increasing surgical capacity.

### Limitations

As noted by Groen et al<sup>24</sup> this data relies on respondent self-reportage, both of the existence of a condition, and its amenability to surgical correction. In the SOSAS study this limitation is offset by the fact that the reported condition must still be assessed by a surgical health-care professional to consider operative intervention. In our analysis we assume that surgical intervention would be carried out for conditions reported by the respondents. This could lead to an overestimation of surgical and therefore anaesthetic need.

Categorization of surgical procedures into specific anaesthesia types is based on subjective judgment and is inherently debatable. Our approach to categorization was to suggest techniques currently implemented by practitioners in Sierra Leone, and indeed most of West Africa. For ambiguous situations, we chose the simplest anaesthetic technique that would be safe and effective for the condition and procedure described. This rationale provides a practical template most likely to reflect clinical practice influenced by drug availability, personnel training and availability, and tolerability of specific surgical procedures. It assumes different standards of safety and monitoring than exists in other systems,<sup>5</sup> and this may over-estimate the number of patients willing to undergo a surgical procedure. Cultural acceptance of surgical need or anaesthetic services may vary widely, and therefore the chosen anaesthetic technique for a particular procedure will ultimately be determined by patient preference.

The SOSAS tool has been validated for surgical disease burden,<sup>23</sup> but not anaesthesia burden, and was not constructed with an anaesthesia analysis in mind. Many questions that would have eased prediction of anaesthesia type were omitted. Therefore, extrapolation from this data to infer anaesthesia techniques requires many 'leaps'. Moreover, we are extrapolating from Sierra Leonean practitioners' current standards, to predict care that they are not currently providing.

In many ways Sierra Leone is representative of LMICs, with limited access to healthcare, low life expectancy at

birth, and a high maternal mortality.<sup>26</sup> At number 183, however, it currently ranks as one of the lowest of the 187 nations on the UN Development Index.<sup>29</sup> Therefore, the ability to extrapolate Sierra Leone's anaesthesia need data to other LMICs is somewhat limited. However, the process of generating and analysing such data may prove very useful to other LMICs seeking to rationally build capacity and satisfy their own unmet surgical and anaesthesia need.

### Summary

Specific assessment of anaesthesia needs is warranted in LMICs to address this important component of global health. Such assessments can ensure that the training and distribution of local personnel, and the acquisition and distribution of anaesthesia equipment and drugs are tailored to the specific anaesthesia needs of a community.

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