Title

Essential equipment and services for otolaryngology care: a proposal by the Global Otolaryngology-Head and Neck Surgery Initiative.

Journal

Current Opinion in Otolaryngology & Head and Neck Surgery, 31(3)

Authors

Srinivasan, Tarika
Cherches, Alexander
Seguya, Amina
et al.

Publication Date

2023-06-01

DOI

10.1097/MOO.0000000000000885

Peer reviewed

OPEN

Essential equipment and services for otolaryngology care: a proposal by the Global Otolaryngology-Head and Neck Surgery Initiative

Tarika Srinivasan[a,b], *Alexander Cherches*[a,c], *Amina Seguya*[a,d], *Valerie Salano*[a,e], *Rolvix H. Patterson*[a,f], *Mary Jue Xu*[a,g], *Blake C. Alkire*[a,h,i], *Samuel N. Okerosi*[a,j] *and Sharon Ovnat Tamir*[a,k]

Purpose of review
To highlight the need for comprehensive resource lists to provide baseline care of otolaryngologic conditions; to present a proposed list of essential equipment and services that may be applied toward surgical systems research, policymaking, and charitable efforts in global otolaryngology-head and neck surgery.

Recent findings
To provide effective and high-quality surgical care across care settings, there must be a global standard for equipment and ancillary services necessary to provide baseline care. Though there have been efforts to devise resource standards via equipment lists and appraisal tools, these have been limited in scope to general surgery, emergency care, and a few other subspecialty surgical contexts. Recent efforts have brought attention to the significant burden imposed by otolaryngologic conditions such as hearing loss, otitis media, head and neck cancer, head and neck trauma, and upper airway foreign bodies. Yet, there has not been a comprehensive list of resources necessary to provide baseline care for common otolaryngologic conditions.

Summary
Through an internal survey of its members, the Global Otolaryngology-Head and Neck Surgery Initiative has compiled a list of essential equipment and services to provide baseline care of otolaryngologic conditions. Our efforts aimed to address common otolaryngologic conditions that have been previously identified as high-priority with respect to prevalence and burden of disease. This expert-driven list of essential resources functions as an initial framework to be adapted for internal quality assessment, implementation research, health policy development, and economic priority-setting.

Keywords
equipment, global surgery, otolaryngology, policy

INTRODUCTION

Safe surgical and procedural care is a critical component of ensuring high-quality healthcare delivery in global settings [1]. Effective surgical care requires costly infrastructure for the acquisition, sterilization, and maintenance of essential equipment and robust support services such as imaging, laboratory testing, histopathology, and blood banking. The field of otolaryngology–head and neck surgery (OHNS) encompasses a breadth of conditions and operative techniques necessitating a wide variety of equipment to provide essential care. Given variations in resource access and health system infrastructures, availability of equipment varies regionally and by practice setting.

Surgical subspecialties, such as pediatric surgery, have created essential equipment and health service frameworks to promote the quality of surgical infrastructure, advocate for resources, and enable surgeons to deliver standard surgical care in diverse

[a]The Global Otolaryngology-Head and Neck Surgery Initiative, [b]Harvard Medical School, Boston, Massachusetts, [c]Duke University School of Medicine, Durham, North Carolina, USA, [d]Mulago National Referral Hospital, Kampala, Uganda, [e]Nyahururu County Hospital, Laikipia County, Kenya, [f]Department of Head and Neck Surgery & Communication Sciences, Duke University School of Medicine, Durham, North Carolina, [g]Department of Otolaryngology-Head and Neck Surgery, University of California San Francisco, San Francisco, California, [h]Department of Otolaryngology-Head and Neck Surgery, Harvard Medical Schoo, [i]Center for Global Surgery Evaluation, Massachusetts Eye and Ear, Boston, Massachusetts, USA, [j]Kenyatta National Hospital, Nairobi, Kenya and [k]Department of Otolaryngology/Head and Neck Surgery, Samson Assuta Ashdod University Hospital, Faculty of Health Sciences, Ben Gurion University of the Negev, Beersheba, Israel

Correspondence to Tarika Srinivasan, Harvard Medical School, 25 Shattuck St, Boston, MA 02115, USA.
E-mail: tarikasrinivasan@hms.harvard.edu

Curr Opin Otolaryngol Head Neck Surg 2023, 31:194–201

DOI:10.1097/MOO.0000000000000885

KEY POINTS

- Equipment and ancillary services remain a significant barrier to effective, high-quality surgical care in health systems throughout the world.
- Essential resource checklists serve to prioritize infrastructural investment and guide targets for capacity assessment across global settings.
- This list of essential equipment and ancillary services may serve as a framework for quality assessment, implementation research, policy development, and economic priority-setting in otolaryngology–head and neck surgery.
- Stratification of equipment and services by relative priority at various institutional levels helps to make recommendations appropriate to specific contexts of otolaryngologic care.

settings. To date, no inventory of essential equipment and services has been developed for OHNS on a global scale. Our review aims to highlight guidelines for prioritization of resources and to provide a list of essential equipment for OHNS surgical care, based on international input from experienced OHNS providers.

PRIORITIZING EQUIPMENT AND ANCILLARY SERVICES IN SURGERY

Surgical, anesthetic, and ancillary medical services are essential for the treatment of operable conditions, which are estimated to comprise 28–32% of the total global burden of disability and mortality [2,3]. Surgery has been under-prioritized within global health efforts for reasons including the perceived high cost of surgical infrastructure and complexity of surgical care delivery [4]. Although the moral imperative to provide high-quality healthcare is reason enough to expand access to surgical care, surgery has also been proven to be a cost-effective intervention. For example, a 2014 systematic review of cost-effectiveness studies in low- and middle-income countries (LMICs) determined that surgical intervention can be cost-effective or very cost-effective based on World Health Organization (WHO) criteria and compares favorably to currently accepted public health interventions [5]. Without considering the prioritization of surgical equipment in certain subspecialties, such as OHNS, surgical care cannot be given in a satisfactory manner.

A core component of the delivery of surgical care is specialized equipment and infrastructure. In 2005, the WHO launched its Global Initiative for Emergency and Essential Surgical Care which published standards for public district hospitals to promote adequately equipped operating theaters, basic intensive care units, and the ability to treat several life- threatening and highly-disabling surgical conditions [6,7]. To this end, the WHO drew on government, clinical, biomedical engineering, and medical device stakeholders to increase the availability of essential surgical equipment in LMICs [7–9]. Several inventories have since been developed to appraise surgical capacity, including the WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care (SAT) [10]; the Personnel, Infrastructure, Procedures, Equipment, and Supplies (PIPES) tool [11]; and the International Assessment of Capacity for Trauma (INTACT) index [12]. These inventories have demonstrated stark surgical equipment shortages in various countries in sub-Saharan Africa [13–17], Asia [18–21], and Central/South America [22–24], highlighting the need for government involvement in surgical capacity building for both infrastructure and personnel.

The next generation of surgical equipment appraisal has been marked by the delineation of surgical equipment lists beyond the context of general and trauma surgery. The WHO and the World Federation of Societies of Anesthesiologists produced the International Standards for a Safe Practice of Anesthesia, which introduced concrete recommendations for anesthetic equipment and support personnel at various care levels [25]. The Global Initiative for Children's Surgery, an independent consortium of pediatric surgical providers, created consensus guidelines on optimal supplies and equipment for the care of pediatric surgical conditions in LMICs [26,27▪]. Surgical subspecialty groups have also adapted the existing PIPES tool to enable the evaluation of neurosurgical and pediatric surgical capacity, thereby broadening the scope of existing assessment tools [28,29]. Such surgical equipment lists are used not only for infrastructure assessment but also for internal quality improvement, surgical policy development by health ministries, and investment priority-setting for advocacy and charitable efforts.

ESSENTIAL EQUIPMENT AND SERVICES FOR OHNS CARE

OHNS conditions remain relatively understudied with respect to global surgical care delivery, despite OHNS conditions representing a significant burden of disease [30]. The Institute for Health Metrics and Evaluation's Global Burden of Disease study identified that hearing loss (with a $\geq$20-dB threshold for mild hearing loss) affects 1.57 billion people

globally and is the third largest cause of disability in the global burden of disease [31▪]. Otitis media, one of the most common and preventable causes of hearing loss in children, has an estimated incidence of 471–709 million cases per year [32]. Head and neck cancers account for 5.7% of global cancer-related mortality, with a significantly higher mortality burden and subsequent economic loss in LMICs compared to high-income countries (HICs) [33▪]. Other OHNS conditions with high global burden of disease include upper respiratory infections, cleft lip/palate, head and neck trauma, pediatric foreign body, and deep neck space infections [34▪, 35,36▪▪].

The cost of acquiring and maintaining subspecialty-specific equipment has been identified as a pronounced barrier to care for OHNS conditions [30,37]. Recent work conducted during the COVID-19 pandemic further highlighted challenges faced by otolaryngologists working in LMICs, who faced obstacles such as insufficient personal protective and surgical equipment to maintain surgical output [38]. Despite the high global burden of OHNS conditions, there is not yet a description of essential surgical equipment necessary for the delivery of high- quality OHNS care worldwide. To fill this gap, the Global OHNS Initiative developed an expert-driven list of essential equipment and services for the delivery of high-quality OHNS surgical care.

THE GLOBAL OTOLARYNGOLOGY–HEAD AND NECK SURGERY INITIATIVE: ESSENTIAL EQUIPMENT AND SERVICES

The Global OHNS Initiative is a global consortium of OHNS clinical providers, trainees, and researchers with a vision for ''*universal access to high-quality, safe, timely, and affordable care for those with OHNS conditions*''. To begin defining the role of OHNS care within comprehensive health systems, the group previously used the Delphi methodology to identify a consensus of priority OHNS conditions and procedures which all national health systems should be capable of managing [35]. The initiative then used these findings to develop an expert-driven list of the minimal equipment necessary for the medical and surgical care of the priority conditions. This list was created under the assumption that a facility providing OHNS care would already have the resources required for general surgery care; as such, equipment was excluded if they were included in most general surgery equipment checklists [10–12]. OHNS providers across a variety of practice settings were consulted to add additional equipment or services regularly employed in their clinical practice.

Once a preliminary list was compiled, an internal survey was disseminated to OHNS providers and advanced-level trainees within the initiative. Respondents to the survey included respondents who practice in eleven countries, including the United States, Uganda, Israel, Pakistan, Kenya, Lebanon, Chile, Myanmar (Burma), the United Kingdom, India, and Austria. The equipment included in the survey spanned the following OHNS subspecialties: general otolaryngology, otology, head and neck surgery, rhinology, skull base surgery, and pediatric otolaryngology. Providers were asked to rate the utility of each type of equipment and service at the primary and tertiary care levels, which were defined as follows:

(1) Primary = ear, nose and throat (ENT) care provided at a community-level hospital or clinic
(2) Tertiary = a referral-based center for specialist or sub-specialist ENT care not regularly managed at the community level

Equipment and ancillary service utility was categorized under three designations:

(1) ''Essential'' – This equipment/service must be accessible in-house and is critical to the care of the ENT conditions encountered at the respective care level.
(2) ''Aspirational'' – This equipment may not be necessary to provide care at this respective healthcare level but could be useful for ENT needs. If it were available, it would be regularly used.
(3) ''Nonessential'' – This equipment/service is not necessary to manage the ENT conditions managed at the respective care level. There may be sufficient substitutes that perform the same function as this equipment or service.

The internal survey results were compiled and reviewed through multiple group consensus meetings. A final list of essential equipment and ancillary services for baseline OHNS care was generated (Tables 1 and 2). This list of essential OHNS equipment and services may serve as a resource to support the development of high-quality OHNS care in various healthcare settings and to permit a high standard of care for all patients with OHNS conditions.

Stratification of equipment and services by primary and tertiary facility levels permits a more nuanced understanding of the resources needed for appropriate OHNS care. We also categorized equipment as ''essential'' or ''aspirational'' to

Table 1. A list of essential equipment for baseline care in otolaryngology-head and neck surgery as compiled by the Global OHNS Initiative

General care		
	Primary	**Tertiary**
Essential	Headlights 512 Hz turning fork Laryngeal mirror Otoscope and ear speculum Suction aspirator Ear forceps Ear curettes Nasal speculum Flexible endoscopy Bipolar/diathermy Bone-cutting drill Operating microscope (suitable for OHNS procedures)	Headlights 512 Hz turning fork Laryngeal mirror Otoscope and ear speculum Suction aspirator Ear forceps Ear curettes Nasal speculum Flexible endoscopy Bipolar/diathermy Bone-cutting drill Operating microscope (suitable for OHNS procedures) Loupes Bedside/POC ultrasound Facial nerve monitoring
Aspirational	Loupes Bedside/POC ultrasound Facial nerve monitoring	
Non-essential		

Endoscopy		
	Primary	**Tertiary**
Essential	Endoscopy tower (light source and video processor) Hopkin's rod (rigid telescope) Rigid bronchoscope Rigid bronchoscope accessory instruments Direct laryngoscopy and biopsy set Esophagoscope	Endoscopy tower (light source and video processor) Hopkin's rod (rigid telescope) Rigid bronchoscope Rigid bronchoscope accessory instruments Direct laryngoscopy and biopsy set Esophagoscope Flexible bronchoscope
Aspirational	Flexible bronchoscope	
Non-essential		

Otology		
	Primary	**Tertiary**
Essential	Otologic drill Hammer and gauge Otology set (or equivalent supplies) Myringotome (surgical knife for paracentesis of eardrum) Tympanostomy set (or equivalent supplies) Cutting diamond-head drill burrs Alligator ear forceps	Otologic drill Hammer and gauge Otology set (or equivalent supplies) Myringotome (surgical knife for paracentesis of eardrum) Tympanostomy set (or equivalent supplies) Cutting diamond-head drill burrs Alligator ear forceps Otoendoscope Bone pate Cochlear implant Jeweler forceps
Aspirational	Otoendoscope Bone pate	
Non-essential	Cochlear implant Jeweler forceps	

Head and neck surgery		
	Primary	**Tertiary**
Essential	Neck dissection set (or equivalent supplies) Tracheotomy tubes of different sizes	Neck dissection set (or equivalent supplies) Tracheotomy tubes of different sizes Endovascular microscope and loupes Maxillofacial plating set Microsurgical/microdissection set (or equivalent supplies) Tracheoesophageal voice prosthesis
Aspirational	Endovascular microscope and loupes Maxillofacial plating set	
Non-Essential	Microsurgical/microdissection set (or equivalent supplies) Tracheoesophageal voice prosthesis	

Table 1. (*Continued*)

Rhinology and sinus surgery		
	Primary	**Tertiary**
Essential	Straight (0-degree) nasal endoscope Angled (30-degree) nasal endoscope Sinus surgery set (or equivalent supplies) Rhinology, rhinoplasty, septoplasty set (or equivalent supplies)	Straight (0-degree) nasal endoscope Angled (30-degree) nasal endoscope Angled (45-degree) nasal endoscope Angled (70-degree) nasal endoscope Sinus surgery set (or equivalent supplies) Rhinology, rhinoplasty, septoplasty set (or equivalent supplies) Rotation (suction) microdebrider Endoscopic dissection tools (miniature forceps, dissectors, etc.) Anterior skull base dissection set
Aspirational	Angled (45-degree) nasal endoscope Angled (70-degree) nasal endoscope Rotation (suction) microdebrider Endoscopic dissection tools (miniature forceps, dissectors, etc.)	Computer-assisted navigation for skull base surgery
Non-essential	Anterior Skull Base Dissection Set Computer Assisted Navigation for Skull Base Surgery	
Pediatric otolaryngology		
	Primary	**Tertiary**
Essential	Mouth gag Suction electrocautery Tonsillectomy set (or equivalent supplies) Adenoidectomy set with adenotomes Pediatric airway set (with airway dilators, balloons, choanal atresia perforators)	Mouth gag Suction electrocautery Tonsillectomy set (or equivalent supplies) Adenoidectomy set with adenotomes Pediatric airway set (with airway dilators, balloons, choanal atresia perforators) Coblation (cold ablation)
Aspirational	Coblation (Cold Ablation)	
Non-Essential		

Equipment groupings occur by subspecialty of use. Equipment are categorized separately at the primary and tertiary care levels, denoted by each column. Equipment categorizations include essential, aspirational, or nonessential with respect to each care level.

Table 2. A list of essential services for baseline care in otolaryngology-head and neck surgery as compiled by the Global OHNS Initiative

	Primary	**Tertiary**
Essential	Audiology Histopathology and cytology Microbiology Blood serology Blood bank Equipment sterilization Biomedical equipment maintenance X-ray radiography Computerized tomography (CT) Ultrasonography (with specialist ultrasonographer and radiologist interpretation)	Audiology Histopathology and cytology Microbiology Blood serology Blood bank Equipment sterilization Biomedical equipment maintenance X-ray radiography Computerized tomography (CT) Ultrasonography (with specialist ultrasonographer and radiologist interpretation) Magnetic resonance imaging (MRI) Positron emission tomography (PET) Speech-language pathology Medical oncology consult Radiation oncology consult
Aspirational	Magnetic resonance imaging (MRI) Positron emission tomography (PET) Speech-language pathology Medical oncology consult Radiation oncology consult	
Non-essential		

Services are categorized separately at the primary and tertiary care levels, denoted by each column. Service categorizations include essential, aspirational, or nonessential with respect to each care level.

indicate relative prioritization. Aspirational equipment often included items that are not absolutely necessary for the provision of OHNS care, but have grown increasingly popular within high-resource settings to improve patient safety and overall quality of care. For the ''essential'' categorization, survey respondents prioritized global standards of care over newer technologies to create a more equitable benchmark that could be reached by a greater proportion of OHNS providers, facilities, or hospital systems.

These categorizations are subject to change with the evolution of disease burden, training standards, and equipment availability.

Survey responses highlighted variations in equipment use as a result of resource constraints and training standards. At the primary level, in the general otolaryngology care section, laryngeal mirrors for indirect laryngoscopy were deemed essential (Table 1). However, clinicians in HICs have trended away from using laryngeal mirrors, instead utilizing fiberoptic laryngoscopy (FOL) or rigid laryngeal endoscopy for visualization of the supraglottic and glottic regions due to patient comfort and completeness of laryngeal examination [39,40]. Thus, both FOL and laryngeal mirrors were considered essential to encompass the spectrum of infrastructure availability and evolving training standards across economic strata.

For endoscopy at the primary level, respondents categorized a rigid bronchoscope as essential and a flexible bronchoscope as aspirational (Table 1). In subsequent discussion, respondents indicated that almost any tracheal foreign body, lesion, or tumor can be treated using a rigid bronchoscope. However, current literature demonstrates that flexible bronchoscopy may help to definitively exclude foreign body aspiration when rigid bronchoscopic examination is equivocal or unable to reach more distal locations in the airway [41,42]. Although typically a tool in the arsenal of pulmonologists and thoracic surgeons, the use of this equipment by OHNS providers continues to expand [43,44], indicating the potential for recategorization of equipment as essential in future iterations of these lists.

In open-ended responses, a few survey respondents reported various applications of equipment to provide care beyond the original intended use. For example, two respondents commented that nasal endoscopes were frequently repurposed for otologic procedures and pediatric airway foreign body removal. Another respondent remarked that their facility used otologic instruments for pediatric anterior skull base surgery. Born out of equipment shortages during the COVID-19 pandemic, there has been an interest in developing cost-effective strategies for surgical capacity – including the reuse and repurposing of equipment [45,46]. A recent study on the benefits of equipment repurposing reported that endoscopic approaches to the middle ear show improved anatomic visualization with similar audiometric and surgical outcomes seen with binocular approaches [47]. What is more, the endoscopic surgical setup has far fewer logistical and cost-related barriers compared to the otologic microscopic surgical setup, making the endoscope a feasible option for otologic surgical teaching in LMICs [47]. Thus, the range of applications for certain equipment items was taken into consideration when categorizing equipment priority for the lists.

Loupes were categorized by survey respondents as aspirational at the primary level compared to an operating microscope for microsurgical work in head and neck operations, which was deemed essential at the primary level (Table 1). Loupes-only magnification has been utilized for microsurgical anastomosis in a variety of applications [48,49]; however, the categorization of ''aspirational'' may reflect the fact that loupes must be fitted to an individual surgeon as opposed to microscopes being accessible to any operating surgeon who is able to adjust magnification.

Operating microscopes may also be shared with other surgical services that require an operating microscope. Otoendoscopes were also deemed aspirational at the primary level (Table 1), despite evidence demonstrating ergonomic benefits [50] and similar outcomes compared to traditional microscopic ear surgery [51,52]. This is perhaps due to its relatively recent arrival to the otology armamentarium and its steep learning curve for those trained only with operative microscopes to reliably benefit from the use of otology equipment [53]. It should be noted that at the tertiary level, only computer-assisted navigation for skull base surgery was deemed aspirational (Table 1). This system, which provides real-time computed tomography-based guidance in surgery, may have been considered aspirational due to its prohibitive cost, lack of definitive evidence supporting improved outcomes, and the need for trained personnel for its use [54].

This survey included perspectives of OHNS providers from both HICs and LMICs to describe the need for OHNS equipment and services across economic strata. There are broad uses for this set of essential equipment and services. First, this list might be deployed to measure resource availability, expanding the potential for current surgical capacity assessments to include OHNS care. Accurate capacity assessments are critical

for internal appraisals of health systems and broader goals in academic global surgery. Second, this list can be used to guide investment in OHNS equipment by ministries of health, health systems, and facilities. OHNS conditions have been underemphasized in national surgical plans; however, the list of essential equipment and services may inform policy development to improve OHNS care. Third, this list may be used to advocate for the charitable provision of essential equipment in countries that lack access to equipment needed for high-quality OHNS care. Similar lists have been used to leverage HIC academic centers, medical equipment companies, and nongovernmental entities to donate ''essential equipment kits'' to resource-limited clinical centers [38]. Together, these lists can be used to optimize resource allocation and support a higher standard of OHNS care for patients around the world

CONCLUSION

The lack of equipment and ancillary support services continues to be a significant barrier to OHNS care in health systems around the world. Surgical providers have developed essential resource checklists to fulfill the need for infrastructure capacity assessment and targeted resource investment. This expert-driven list of essential OHNS equipment and services functions as an initial framework to be adapted for internal quality assessment, implementation research, health policy development, and economic priority-setting. Ultimately, we hope that these lists of essential equipment and services for care delivery will contribute to improved health outcomes globally and shape benchmarks of quality for OHNS care delivery.

Acknowledgements

The authors would like to express their gratitude to the fellow members of the Global Otolaryngology-Head and Neck Surgery Initiative for contributing to this internal survey and providing valuable feedback throughout the project development. Special thanks to Dr Mahmood Bhutta and Dr Johannes J. Fagan for their guidance during the survey dissemination, and to Dr Estephania Candelo, Keshav Shah, and Sarah Nuss for their valuable feedback during manuscript preparation.

Financial support and sponsorship

None.

Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- ■ of special interest
- ■■ of outstanding interest

1. Meara JG, Leather AJM, Hagander L, *et al.* Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. Lancet 2015; 386:569–624.
2. Alkire BC, Raykar NP, Shrime MG, *et al.* Global access to surgical care: a modelling study. Lancet Glob Health 2015; 3:e316–e323.
3. Shrime MG, Bickler SW, Alkire BC, Mock C. Global burden of surgical disease: an estimation from the provider perspective. Lancet Glob Health 2015; 3:S8–S9.
4. Farmer PE, Kim JY. Surgery and global health: a view from beyond the OR. World J Surg 2008; 32:533–536.
5. Chao TE, Sharma K, Mandigo M, *et al.* Cost-effectiveness of surgery and its policy implications for global health: a systematic review and analysis. Lancet Glob Health 2014; 2:e334–e345.
6. Bickler SW, Spiegel D. Improving surgical care in low- and middle-income countries: a pivotal role for the World Health Organization. World J Surg 2010; 34:386–390.
7. Spiegel DA, Abdullah F, Price RR, *et al.* World Health Organization Global Initiative for emergency and essential surgical care: 2011 and beyond. World J Surg 2013; 37:1462–1469.
8. Malkin RA. Barriers for medical devices for the developing world. Expert Rev Med Devices 2007; 4:759–763.
9. Sonderman KA, Citron I, Meara JG. National surgical, obstetric, and anesthesia planning in the context of global surgery: the way forward. JAMA Surg 2018; 153:959–960.
10. Osen H, Chang D, Choo S, *et al.* Validation of the World Health Organization tool for situational analysis to assess emergency and essential surgical care at district hospitals in Ghana. World J Surg 2011; 35:500–504.
11. Markin A, Barbero R, Leow JJ, *et al.* Inter-rater reliability of the PIPES Tool: validation of a surgical capacity index for use in resource-limited settings. World J Surg 2014; 38:2195–2199.
12. Wong EG, Gupta S, Deckelbaum DL, *et al.* The International Assessment of Capacity for Trauma (INTACT): an index for trauma capacity in low-income countries. J Surg Res 2014; 190:522–527.
13. Kouo-Ngamby M, Dissak-Delon FN, Feldhaus I, *et al.* A cross-sectional survey of emergency and essential surgical care capacity among hospitals with high trauma burden in a Central African country. BMC Health Serv Res 2015; 15:478.
14. Chao TE, Burdic M, Ganjawalla K, *et al.* Survey of surgery and anesthesia infrastructure in Ethiopia. World J Surg 2012; 36:2545–2553.
15. Henry JA, Frenkel E, Borgstein E, *et al.* Surgical and anaesthetic capacity of hospitals in Malawi: key insights. Health Policy Plan 2014; 30:985–994.
16. Henry JA, Windapo O, Kushner AL, *et al.* A survey of surgical capacity in rural southern Nigeria: opportunities for change. World J Surg 2012; 36:2811–2818.
17. Elkheir N, Sharma A, Cherian M, *et al.* A cross-sectional survey of essential surgical capacity in Somalia. BMJ Open 2014; 4:e004360.
18. Bhatia MB, Mohan SC, Blair KJ, *et al.* Surgical and trauma capacity assessment in rural Haryana, India. Ann Glob Health 2021; 87:15.
19. Loveday J, Sachdev SP, Cherian MN, *et al.* Survey of emergency and essential surgical, obstetric and anaesthetic services available in Bangladeshi government health facilities. World J Surg 2017; 41:1743–1751.
20. Kalhor R, Keshavarz Mohamadi N, Khalesi N, Jafari M. Situational analysis of essential surgical care management in Iran using the WHO tool. Iran Red Crescent Med J 2016; 18:e23075.
21. Contini S, Taqdeer A, Cherian M, *et al.* Emergency and essential surgical services in Afghanistan: still a missing challenge. World J Surg 2010; 34:473–479.
22. Solis C, León P, Sanchez N, *et al.* Nicaraguan surgical and anesthesia infrastructure: survey of Ministry of Health hospitals. World J Surg 2013; 37:2109–2121.
23. Markin A, Barbero R, Leow JJ, *et al.* A quantitative analysis of surgical capacity in Santa Cruz, Bolivia. J Surg Res 2013; 185:190–197.
24. Blair KJ, Boeck MA, Gallardo Barrientos JL, *et al.* Assessment of surgical and trauma capacity in Potosí, Bolivia. Ann Glob Health 2017; 83:262–273.
25. Gelb AW, Morriss WW, Johnson W, *et al.* World Health Organization-World Federation of Societies of Anaesthesiologists (WHO-WFSA) international standards for a safe practice of anesthesia. Can J Anaesth 2018; 65:698–708.
26. Grabski D, Ameh E, Ozgediz D, *et al.* Optimal resources for children's surgical care: executive summary. World J Surg 2019; 43:978–980.
27. Goodman LF, St-Louis E, Yousef Y, *et al.* The Global Initiative for Children's Surgery: ■ optimal resources for improving care. Eur J Pediatr Surg 2018; 28:51–59.
This is a consensus guideline from the Global Initiative for Children's Surgery on optimal resources for pediatric surgical care at multiple care levels. This work served as an inspiration for a similar equipment and services list for otolaryngology-head and neck surgery.
28. Ploss B, Abdelgadir J, Smith ER, *et al.* Pilot use of a novel tool to assess neurosurgical capacity in Uganda. World Neurosurg 2017; 108:844–849; e844.

29. Okoye MT, Ameh EA, Kushner AL, Nwomeh BC. A pilot survey of pediatric surgical capacity in West Africa. World J Surg 2015; 39:669–676.

30. Bergmark RW, Shaye DA, Shrime MG. Surgical care and otolaryngology in global health. Otolaryngol Clin North Am 2018; 51:501–513.

31. ■ Haile LM, Kamenov K, Briant PS, *et al.* Hearing loss prevalence and years lived with disability, 1990–2019: findings from the Global Burden of Disease Study 2019. Lancet 2021; 397:996–1009.

This authors conducted an analysis of data from the 2019 Global Burden of Disease study to estimate the overall prevalence of disability burden of age-related hearing loss. It is the most recent estimate of the global burden of hearing loss to date.

32. Monasta L, Ronfani L, Marchetti F, *et al.* Burden of disease caused by otitis media: systematic review and global estimates. PLoS One 2012; 7: e36226.

33. ■ Patterson RH, Fischman VG, Wasserman I, *et al.* Global burden of head and neck cancer: economic consequences, health, and the role of surgery. Otolaryngol Head Neck Surg 2020; 162:296–303.

The authors conducted a statistical analysis of data from the World Development indicators and the 2016 Global Burden of Disease study to project the macroeconomic effects of head and neck cancer. They were able to characterize mortality-to-incidence ratios across global regions and provide the first estimated global cumulative loss attributable to head and neck cancer.

34. ■ Saunders JE, Rankin Z, Noonan KY. Otolaryngology and the global burden of disease. Otolaryngol Clin North Am 2018; 51:515–534.

This review article is the most comprehensive summary of key conditions in otolaryngology-head and neck surgery and their respective global burden, including mortality and incidence. The authors sought to illustrate relative priority of conditions for global investment.

35. Pederson H, Okland T, Boyers LN, *et al.* Identifying otolaryngology systematic review research gaps: comparing Global Burden of Disease 2010 results with Cochrane Database of Systematic Review content. JAMA Otolaryngol Head Neck Surg 2015; 141:67–72.

36. ■■ Nuss S, Patterson RH, Cahill GL, *et al.* Delphi method consensus on priority global otolaryngology-head and neck surgery conditions and procedures. Otolaryngol Head Neck Surg 2022; 167:669–677.

This study from the Global OHNS Initiative utilized the Delphi method among a cohort of otolaryngologists across several countries to derive a consensus on the priority otolaryngology-head and neck surgery conditions and surgical procedures that all national health systems should be capable of managing. This list was used to compile the initial list of equipment and services for baseline management of high-priority OHNS conditions.

37. Saadi RMD, Goldenberg D, Goldenberg DMD. Using technology in global otolaryngology. Otolaryngol Clin North Am 2018; 51:555–561.

38. Kligerman MP, Lamour S, Okerosi S, *et al.* Challenges facing otolaryngologists in low- and middle-income countries during the COVID-19 pandemic. Int J Pediatr Otorhinolaryngol 2020; 138:110322.

39. Franzen AM, Sykora H, Hauptmann M, Coordes A. Contemporary use of instruments during clinical examination in German ENT departments and private practices. HNO 2022; 70:125–132.

40. Dunklebarger J, Rhee D, Kim S, Ferguson B. Video rigid laryngeal endoscopy compared to laryngeal mirror examination: an assessment of patient comfort and clinical visualization. Laryngoscope 2009; 119:269–271.

41. Righini CA, Morel N, Karkas A, *et al.* What is the diagnostic value of flexible bronchoscopy in the initial investigation of children with suspected foreign body aspiration? Int J Pediatr Otorhinolaryngol 2007; 71: 1383–1390.

42. Cutrone C, Pedruzzi B, Tava G, *et al.* The complimentary role of diagnostic and therapeutic endoscopy in foreign body aspiration in children. Int J Pediatr Otorhinolaryngol 2011; 75:1481–1485.

43. Cohen S, Pine H, Drake A. Use of rigid and flexible bronchoscopy among pediatric otolaryngologists. Arch Otolaryngol Head Neck Surg 2001; 127:505.

44. Tamiru T, Gray PE, Pollock JD. An alternative method of management of pediatric airway foreign bodies in the absence of rigid bronchoscopy. Int J Pediatr Otorhinolaryngol 2013; 77:480–482.

45. Ravindra VM, Kraus KL, Riva-Cambrin JK, Kestle JR. The need for cost-effective neurosurgical innovation—a global surgery initiative. World Neurosurg 2015; 84:1458–1461.

46. Steyn A, Cassels-Brown A, Chang D, *et al.* Frugal innovation for global surgery: leveraging lessons from low- and middle-income countries to optimise resource use and promote value-based care. Bull R Coll Surg Eng 2020; 102:198–200.

47. Thompson R, Basura G, Din TF, Jayawardena A. A step towards achieving sustainable otologic surgery in low-resource settings: a cost comparison between shipping and otologic versus microscopic surgical setup. Audiol Res 2022; 12:388–392.

48. Ross DA, Ariyan S, Restifo R, Sasaki CT. Use of the operating microscope and loupes for head and neck free microvascular tissue transfer: a retrospective comparison. Arch Otolaryngol Head Neck Surg 2003; 129: 189–193.

49. Dhanush CV, Sham E, Reddy TJ, *et al.* Comparison between an operating microscope and high magnification surgical loupes in microvascular reconstruction of head and neck defects in a tertiary healthcare center. J Maxillofac Oral Surg 2022; 21:136–140.

50. Ridge SE, Shetty KR, Lee DJ. Heads-up surgery: endoscopes and exoscopes for otology and neurotology in the era of the COVID-19 pandemic. Otolaryngol Clin North Am 2021; 54:11–23.

51. Kiringoda R, Kozin ED, Lee DJ. Outcomes in endoscopic ear surgery. Otolaryngol Clin North Am 2016; 49:1271–1290.

52. Han S-Y, Lee DY, Chung J, Kim YH. Comparison of endoscopic and microscopic ear surgery in pediatric patients: a meta-analysis. Laryngoscope 2019; 129:1444–1452.

53. Ridge SE, Shetty KR, Lee DJ. Current trends and applications in endoscopy for otology and neurotology. World J Otolaryngol Head Neck Surg 2021; 7:101–108.

54. Schmale IL, Vandelaar LJ, Luong AU, *et al.* Image-guided surgery and intraoperative imaging in rhinology: clinical update and current state of the art. Ear Nose Throat J 2020; 100:NP475–486.

