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Design of a Novel Online, Modular, Flipped-classroom Surgical Curriculum for East, Central, and Southern Africa

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Objective: We describe a structured approach to developing a standardized curriculum for surgical trainees in East, Central, and Southern Africa (ECSA).

Summary Background Data: Surgical education is essential to closing the surgical access gap in ECSA. Given its importance for surgical education, the development of a standardized curriculum was deemed necessary.

Methods: We utilized Kern's 6-step approach to curriculum development to design an online, modular, flipped-classroom surgical curriculum. Steps included global and targeted needs assessments, determination of goals and objectives, the establishment of educational strategies, implementation, and evaluation.

Results: Global needs assessment identified the development of a standardized curriculum as an essential next step in the growth of surgical education programs in ECSA. Targeted needs assessment of stakeholders found medical knowledge challenges, regulatory requirements, language variance, content gaps, expense and availability of resources, faculty numbers, and content delivery method to be factors to inform curriculum design. Goals emerged to increase uniformity and consistency in training, create contextually relevant material, incorporate best educational practices, reduce faculty burden, and ease content delivery and updates. Educational strategies centered on developing an online, flipped-classroom, modular curriculum emphasizing textual simplicity, multimedia components, and incorporation of active learning strategies. The implementation process involved establishing thematic topics and subtopics, the content of which was authored by regional surgeon educators and edited by content experts. Evaluation was performed by recording participation, soliciting user feedback, and evaluating scores on a certification examination.

Conclusions: We present the systematic design of a large-scale, context-relevant, data-driven surgical curriculum for the ECSA region.

Keywords: curriculum design, curriculum development, global surgery, Surgical education, surgical curriculum, sub-Saharan Africa

INTRODUCTION

Five billion people worldwide lack access to surgical care, with the greatest disparities in the rural areas of low- and middle-income countries (LMICs), like those of sub-Saharan Africa (SSA).[1,2] Expanding the surgical workforce is necessary for developing surgical care and improving patient access.[3] Therefore, surgical education is essential to closing this access gap in LMICs.[4–6] As surgical training expands throughout SSA, there is increased recognition of the need to enhance the quality of education.[7] Standardized curricula have increasingly become part of surgical education[8] worldwide, mainly to identify and emphasize the skills and knowledge necessary for surgeons at the completion of training.[9]

The numerous benefits of standardized curricula are significant given the ongoing increases in required medical knowledge for surgeons.[10] A standardized curriculum ensures trainees receive a uniform and targeted surgical education that enables flexibility within accepted parameters as a surgeon's career progresses, allows for learning that does not rely solely on case volumes or case-mix that are variable in training, and may improve in-training examination performance.[9–12]

In 2005, the American Surgical Association Blue Ribbon Committee report on surgical education called for a national, standardized surgical curriculum to provide a foundational framework for surgical residency education in the United States.[9] Consequently, the Surgical Council on Resident Education program was developed.[13] Similarly, the United Kingdom-based

Intercollegiate Surgical Training Program was created in 2007 to provide standardization of surgical curriculum for UK-trained surgeons.[14,15] Despite the development of large-scale curricula for surgical training in high-income countries, similar standardized curricula have not been designed for training programs in SSA.[5] Indeed, curricula that have input from and relevance to those working in SSA are recognized as a necessary part of surgical education in this region.[16–19]

The College of Surgeons of East, Central, and Southern Africa (COSECSA) is the largest surgical training institution in SSA. With training programs in 14 member countries and 6 affiliate countries,[20] COSECSA aims to advance surgical education in rural settings.[21] The institution offers a collegiate training program with a 2-year-plus-3-year graduate medical education structure. The first 2 years (the membership program) create a common foundation of surgical knowledge and practice. Following these 2 years of training, learners undergo written and oral examinations for certification as Members of the College of Surgeons (MCS).[21,22] They then progress to fellowship training in general surgery or a surgical sub-specialty like orthopedics or pediatric surgery. COSECSA has 113 MCS training programs with 327 MCS trainees. There were 144 member candidates in the most recent year.

Despite active training programs, COSECSA has not had a standardized curriculum program for trainees. To address this void, we developed and implemented a standardized curriculum designed for MCS trainees using Kern's 6-step approach to curriculum development, a widely endorsed process within medical education that allows the complexities of large-scale curriculum design to be anticipated and addressed.[23,24] This method provided a comprehensive framework for designing a data-driven curriculum with a focus on currently established best educational practices. This study describes the process of curriculum design, development, and implementation according to that framework. In a follow-up study, we describe the outcomes of the successful development of our robust curriculum.

STEP 1: PROBLEM IDENTIFICATION AND NEEDS ASSESSMENT

There has been a lack of standardized curriculum for surgical trainees in the region,[19,22,25] including COSECSA trainees, and curriculum decisions have depended on each training program and program director.[21,26] The COSECSA Education and Examinations Committees recognized this deficit as contributing to inadequate continuity and uniformity in training. This was further observed in written and oral certification examination performance. Therefore, a standardized curriculum was identified by the committees as an essential next step in the growth of surgical education programs in East, Central and Southern Africa (ECSA). The COSECSA Education Committee endorsed the process of curriculum development.

STEP 2: TARGETED NEEDS ASSESSMENT

Several unique factors were identified in assessing the characteristics, needs, and available resources of the trainees and faculty. These were identified through formal and informal discussions with trainees and surgical faculty at several COSECSA programs. Additional input was solicited from members of the Education and Examinations Committees of COSECSA. Findings from more than 20 structured interviews and focus groups, including more than 60 learner and educator participants in 5 countries, informed the design of the curriculum. The questions used for these interviews and focus groups are listed in Table 1. Specific factors uncovered during our needs assessment are described below.

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Data: Supporting data underlying this article may be available upon request to the corresponding author.Author Justification for Manuscript: Design of a novel online, modular, flipped-classroom surgical curriculum for East, Central, and Southern Africa. All authors listed in this article meet the criteria for authorship under Annals of Surgery guidelines. As this is a multi-national, large-scale initiative, there are numerous collaborators with various levels of involvement. We have tried to include all individuals who have provided a meaningful contribution to the design of the curriculum and thus have included all individuals who authored a week's worth of content. Given the structure of this article as describing a curriculum design and implementation, written submission of content is considered in lieu of data acquisition as significant to the implementation process. All authors have given final approval of the version to be submitted. A.P. made substantial contributions to the conception, design, and authorship of the modular content (acquisition of data), to the design of this study, analysis and interpretation of data, and to writing the article. K.H. made substantial contributions to the conception and design of the curriculum and has critically revised the article. B.S. made substantial contributions to the authorship of the modular content (acquisition of data) and has critically revised the article. M.B., C.B., N.C., R.D., J.D., D.E., A.F., J.K., R.K., F.K., P.K., J.L., H.M., V.M., A.McC., P.M., E.N., W.N., P.O., D.O., M.P., S.R., K.R., K.S., J.S., D.S., M.W., and M.W. made substantial contributions to the authorship of the modular content (acquisition of data) and have reviewed and revised any necessary components of the article. D.M., E.O'F., and N.B. made substantial contributions to the conception and design of the curriculum and have critically revised the article. L.T. has substantially contributed to analysis and interpretation of data and has critically revised the article. R.W. and A.B. made substantial contributions to the conception, design, and authorship of the modular content (acquisition of data) and have critically revised the article. R.P. has substantially contributed to the conception, design, and authorship of the modular content (acquisition of data), to the design of this study, analysis and interpretation of data, and writing and critical revision of the article.

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TABLE 1.

COSECSA Educational Needs Assessment Questions

Questions Used for Faculty	Questions Used for Trainees
Describe your position in the surgical education program here. What are your responsibilities?	Describe your position in the surgical education program here. What year? What responsibilities do you have in that year?
Tell me about the process of selecting trainees. What do you look for?	Tell me about the process of choosing where to train.
Tell me about the graduates of your program.	How did you ultimately end up here?
Describe a typical day for you.	Describe a typical day for you.
Describe the variety of patients you see.	Describe the variety of patients you care for.
• Do residents rotate through any different locations, subspecialties?	• Do you rotate through any different locations, subspecialties?
• If so, what has been especially valuable?	• If so, what has been especially valuable?
What suggestions do you have to improve any gaps in patient population?	• What suggestions do you have to improve any gaps in patient population?
Tell me about the dedicated educational time here.	Tell me about the dedicated educational time here.
• Who teaches? How often do you meet?	• Who teaches? How often do you meet?
• Is there a schedule? Who decides what topics are covered?	• Is there a schedule? Who decides what topics are covered?
• Tell me about topics that have been especially valuable.	• Tell me about topics that have been especially valuable. Tell me about a time that you learned something that changed how you cared for your patients.
• What topics have you found challenging to teach? Difficult for learners?	• What topics have been especially difficult?
Tell me about rounds.	Tell me about rounds.
• Who participates?	• Who participates?
• Describe the teaching that takes place on rounds.	• Describe the learning that you get from rounds.
Tell me about learning in the operating room.	Tell me about learning in the operating room.
• How does trainee responsibility progress through the years?	• How does your responsibility change as you progress through the years?
• What is your style of teaching in the operating room?	• What cases are most common?
• What cases are most common?	• What cases are most important for a surgeon to know?
• What cases are most important for a surgeon to know?	• What happens if a case goes poorly? Tell me about how you handle complications.
• What happens if a case goes poorly? Tell me about how you handle complications.	
Tell me about self-directed learning for trainees.	Tell me about learning on your own.
• Do you recommend books? Journals? Online content?	• Do you use books? Journals? Online content?
• What do you think is most utilized by trainees?	• What has been the best for you?
• Are there barriers to accessing internet-based tools?	• Are there barriers to accessing internet-based tools?
• How do trainees prepare for the COSECSA examinations?	What was your experience like taking the COSECSA examination(s)?
	• How did you prepare?
	• Did the written test content seem representative? Did the oral test content seem representative?
How do you assess trainees? What happens if there is a trainee who is struggling?	What happens if there is a trainee who is struggling?
How do you think the training here prepares trainees well to practice on their own?	How do you think your training has prepared you well to practice on your own?
What suggestions do you have that could make it better?	What suggestions do you have to make it better?

Medical Knowledge Challenges

COSECSA covers a geographically large area with tremendous diversity and heterogeneity. There is significant variability in medical education throughout ECSA, and baseline medical knowledge differs considerably upon matriculation into surgical training.[21] Trainees must overcome these knowledge discrepancies to achieve a standard and acceptable level of competence in surgical training.

Regulatory Body Requirements

National regulatory bodies have different requirements and expectations for graduate medical education throughout the ECSA region. Medical boards and ministries of health that oversee training program accreditation and surgeon licensing increasingly require minimum standards of basic science course work to ensure appropriate quality of education and training within their countries.

Language Variance

The English language abilities of COSECSA surgical trainees were recognized to be quite varied, evoking concern for surgical education stakeholders. Though COSECSA as an institution decided that all surgical education should be conducted in English, undergraduate medical education is conducted in four languages (English, French, Portuguese, and Arabic) within the region.[27] This results in inconsistent English-language comfort for learners entering COSECSA training programs.

Content Gaps

Content gaps occur when exclusively noncontext-tailored curriculum sources are used, either online curricula or textbooks.[17,28,29] Historically, surgical textbooks have been the primary source of the core material required for trainees; yet these lack the comprehensiveness necessary for training surgical trainees in SSA. Most English-language surgical textbooks are written by North American or European authors, and the content focuses on disease processes common to those regions and highlights resources frequently unavailable in ECSA. Further, such textbooks often exclude disease processes frequently or exclusively seen in SSA, like typhoid intestinal perforations, hydatid disease, and rheumatic heart disease. Images in the most commonly used medical textbooks do not represent physical examination findings as they appear on darker skin tones.[30] Additionally, general surgeons in SSA necessarily have a breadth of practice beyond what is classified as general surgery in high-resource contexts, performing surgical care in areas like obstetrics and gynecology, urology, neurosurgery, and orthopedics.[19,31] Rarely, if ever, are these specialties covered adequately in general surgery curricula from high-resource areas.

Expense and Availability

Beyond the knowledge gaps that can result for trainees, textbooks are expensive, difficult to ship, and require re-purchasing with new editions.[18] E-learning resources from high-income countries often require paid subscriptions, even if initially made available through free trials or as part of a study.[11,32] A prior

pilot program has demonstrated a favorable response to existing online educational content when made available to trainees within SSA.[32] However, typically, subscription costs are substantial and content inaccessible.

Limited Surgical Faculty

Several educators raised the issue of the paucity of surgical educators and faculty at many training programs in SSA.[5,7,18,25] On average, there are 3 to 4 surgical faculty per COSECSA training program (internal communication). These faculty are responsible for the clinical care of patients in addition to the administrative and educational responsibilities related to surgical training. Further, they often do not have advanced or subspecialty surgical training, which at times limits comfort with teaching certain topics.[7] We identified a desire for an educational intervention to offload the work burden on these faculty.

Online Resource Availability and Suitability for Content Delivery

Web-based curricula have been part of surgical education for many years,[33,34] increasing substantially during the COVID pandemic.[35] Although e-learning has grown in popularity, trainees have a desire for curricula that combine both web-based content and traditional teaching.[34] Such technology-based blended learning models like the flipped classroom have had high receptivity in high-income countries,[36] improving student learning compared to traditional teaching techniques.[37] Widening mobile internet spread and expanding penetration of tablets, smartphones, and other internet-connected devices[38] have provided the opportunity to deliver a web-based surgical curriculum within SSA.[18,32] Additionally, learners within COSECSA training programs have become facile with an online learning platform, School for Surgeons (www.schoolforsurgeons.net). Created as part of the collaboration between COSECSA and the Royal College of Surgeons in Ireland (RCSI) and hosted by RCSI, trainees were already required to engage with journal articles and case scenarios throughout their MCS years.[32,39] The use of an online learning platform was facilitated by the requirement for internet access for each training program, which is a prerequisite for certification as a COSECSA training program. This provided the opportunity for consideration of a web-based curriculum.

STEP 3: GOALS AND OBJECTIVES

Based on the targeted needs assessment, several broad goals and specific objectives were established for the curriculum.

Uniformity and Consistency

Standardized curricula should provide consistency in educational content. We recognized the need for our curriculum to create uniformity that would allow for a more consistent approach to surgical education within our context. While accounting for the heterogeneity of surgical disease in ECSA that our trainees must know, we sought to cover the foundational content necessary for surgeons practicing anywhere in the world. We further recognized that creating a curriculum that sufficiently covers this foundational material would likely satisfy the requirements of the regulatory bodies within various countries throughout the region. Considering the heterogeneity of SSA and the difficulties inherent in using content from high-resource settings,[25,28] we set a goal of creating a context-specific curriculum regarding pathologies, available resources, skin color and gender representation, and breadth of surgical practice in our region. We set an objective that learners who used the curriculum would show improvement in medical knowledge assessed subjectively, via self- and instructor-report, and objectively, through improved certification examination scores upon completion of MCS training.

Best Educational Practices

Data-driven application of best educational practices should inform curriculum design. Given our opportunity to build a novel curriculum, we thought it prudent to use available evidence and incorporate current best educational practices. Active learning, supported by a wealth of data in undergraduate and graduate medical education, is a method of intentionally engaging the learner through educational experiences and reflection.[40] This contrasts with the delivery of information to learners passively, as often occurs with traditional lecture-based teaching.[41] Interactive teaching has been found to improve engagement, information retention, problem-solving, critical-thinking skills, and motivation in learning.[41–46] The use of multimedia components further engages the learner in the education process,[47] improving retention of information and the ability to transfer learned information to novel settings.[48,49] Presentation of material using a more conversational and informal communication style has been shown to enhance retention of presented material,[50] an important consideration considering the language challenges in our context. Given these benefits, we sought to incorporate active learning components into the curriculum, both in structure and content delivery. We set as an objective that authors and content creators should engage the use of multimedia components and focus on simplicity of the written text.

Reduce the Burden on Faculty Trainers

An efficient curriculum should reduce the burden on surgical educators.[7] Given the low numbers of faculty and the scarcity of subspecialty expertise[25] in training many programs, we determined that the curriculum should provide the resources necessary for any surgeon to teach, regardless of area of expertise. We set an objective to create a robust facilitator's version of the curriculum with teaching aids to ease faculty workload.

Ease of Content Delivery and Updates

The curriculum should allow for ease of content delivery and updates. Given the large geographic area and marginal resources in ECSA, we prioritized ease of transfer of materials and limiting costs associated with the curriculum. We also focused on making the process of updating material and keeping content current more facile to better incorporate solicited feedback from users. We set as an objective the adoption of a platform that could be frequently updated and would remain accessible to trainees.

STEP 4: EDUCATIONAL STRATEGIES

Content

We determined necessary foundational material by evaluating existing surgical curricula and textbooks to formulate a 2-year content outline. The result was a year of content (Year A) focusing on underlying surgical principles and a year (Year B) focusing on organs and organ systems (Table 2). Rather than 1 year of content necessarily preceding the other, we opted to create a rolling curriculum; either year of content could be completed in a trainee's first year of training. This was intended to make less work for faculty in training programs.

Methods and Curriculum Structure

Given the COSECSA requirement of internet access for trainees, the support afforded by the COSECSA-RCSI collaboration, and the established use of online surgical training resources through

TABLE 2.

Thematic Topics and Weekly Modular Subtopics

Year A		Year B	
Topics	**Weekly Modular Subtopics**	**Topics**	**Weekly Modular Subtopics**
Statistics and Research Methods	Evidence-Based Surgery, Statistical Terminology, and Ethical Research	Breast	Anatomy, Physiology, and Benign Breast Disease
	The Basics of Biostatistics		Malignant Breast Disease
Oncology	Biology of Cancer	Endocrine	Thyroid
	Etiology of Cancer		Parathyroid and Adrenals
	Principles of Cancer Treatment	Hepato-Pancreatico-Biliary	Liver
Wound Healing	Physiology of Normal Wound Healing		Pancreas
	Pathophysiology of Impaired Wound Healing		Gallbladder and Extrahepatic Biliary System
	Wound Classification and Identification	Pediatric Surgery	Pediatric Surgery 1
	Wound Closure and Management		Pediatric Surgery 2
Fluids and Electrolytes	Normal Body Compartments, Fluid Balance, and Electrolytes	Soft Tissue Sarcomas	Soft Tissue Sarcomas
	Types of Intravenous Fluids, How to Treat Fluid Abnormalities	Skin and Soft Tissue	Skin and Subcutaneous Tissue
	Electrolyte Abnormalities and Considerations in Specific Patients	Plastic Surgery	Plastic and Reconstructive Surgery
	Acid-Base Disorders	Urology	Urology
Systemic Response to Injury	Overview of Systemic Response to Injury	Gynecology	Gynecology
	Mediators of Inflammation	Neurosurgery	Neurosurgery
	Surgical Metabolism	Vascular	Anatomy and Physiology
Shock	Understanding Shock and Hypovolemic Shock		Mesenteric Ischemia, Aortic Disease, Visceral Vascular Conditions
	Bradycardic, Cardiogenic, and Obstructive Shock		Cerebrovascular Disease, Venous and Lymphatic Conditions
	Vasodilatory Shock, Including Septic and Neurogenic Shock	Orthopedic Surgery	Orthopedic Oncology and Pediatric Orthopedics
	Differentiation of Shock		Joints and Sports Medicine
Hemostasis	Physiology of Hemostasis		Hand and Wrist
	Congenital and Acquired Impairments of Coagulation, Prothrombotic States	Thoracic	Anatomy, Physiology, and Benign Disease of the Lung; Pleura
	Transfusion Principles		Trachea, Chest Wall, and Mediastinum
Trauma	Initial Evaluation and Resuscitation of the Trauma Patient		Solitary Pulmonary Nodules, Premalignant and Malignant Lung Conditions
	General Principles of Trauma and Surgical Intensive Care Management	Cardiac	Acquired and Congenital Heart Disease
	Treatment of Specific Injuries	Head and Neck	Ear, Nose and Sinuses, and Salivary Glands
	Treatment of Specific Injuries		Oral Cavity, Larynx, and Neck
	Traumatic Injury in Special Populations: Pediatric, Geriatric, Pregnancy	Abdomen	Abdominal Wall, Omentum, Mesentery, and Retroperitoneum
Burns	Pathophysiology and Classification of Burns		Spleen
	Initial Treatment and Management of Burns		Inguinal Hernias
	Other Considerations in Treatment and Complications of Burns	Alimentary Tract	Esophagus and Hiatal Hernias 1
Surgical Infections	Immunity and Clinical Microbiology		Esophagus and Hiatal Hernias 2
	Infections in Surgical Patients		Stomach 1
Anesthesia and Perioperative	Pharmacology and Anesthetic Agents		Stomach 2
Care	Perioperative Considerations		Small Intestine
			Colon, Rectum, and Anus 1
			Colon, Rectum, and Anus 2
			Colon, Rectum, and Anus 3
			Appendix

the School for Surgeons e-learning platform, a web-based delivery vehicle for the curriculum was thought to be ideal. This was deemed feasible due to the increasing use of mobile internet in the region.[38] Internet-based distribution of content facilitated several of the goals for the curriculum, including avoiding the purchasing and shipping of textbooks, allowing for ease of delivery and content updates, and supporting the increased use of multimedia elements. Although e-learning seemed an excellent option, we decided to make an offline version of the curriculum available to programs with internet stability concerns.

We designed the curriculum with a flipped-classroom structure. We combined an online module created through the Articulate Rise 360 e-learning software (Articulate, New York, NY, USA) and a semi-structured group teaching session with suggested prompts. Each module consists of specific learning objectives, a precontent multiple-choice assessment, content sections for the learning material, and a postcontent multiple-choice assessment. Although a minimum score is not mandated for the precontent formative assessment, trainees must complete this assessment to access the content. After completing the content, the postcontent assessment requires a score of 80% for the module to be recorded as complete. All material remains unlocked for learner reference during the postcontent assessment, and unlimited attempts are allowed to obtain a "passing" score.

Active learning techniques were incorporated into each module. These included case scenarios, "clinical connections" that relate learned concepts in clinically applicable ways, and strategic "knowledge check" prompts and questions that assess the learner's understanding of the concepts. These strategies help to ensure the learner remains engaged in learning and is retaining presented information. Multimedia content in each module included images, interactive images, GIFs, activities like matching and sorting games, and videos. A video demonstrating a portion of the content from the Spleen module is included as Supplemental Digital File 1, http://links.lww.com/AOSO/A102.

Independent completion of the module was to prepare learners to participate in a group teaching session. Prompts were provided with each week of content to help structure the group time. The prompts incorporated the learning objectives, reinforcing

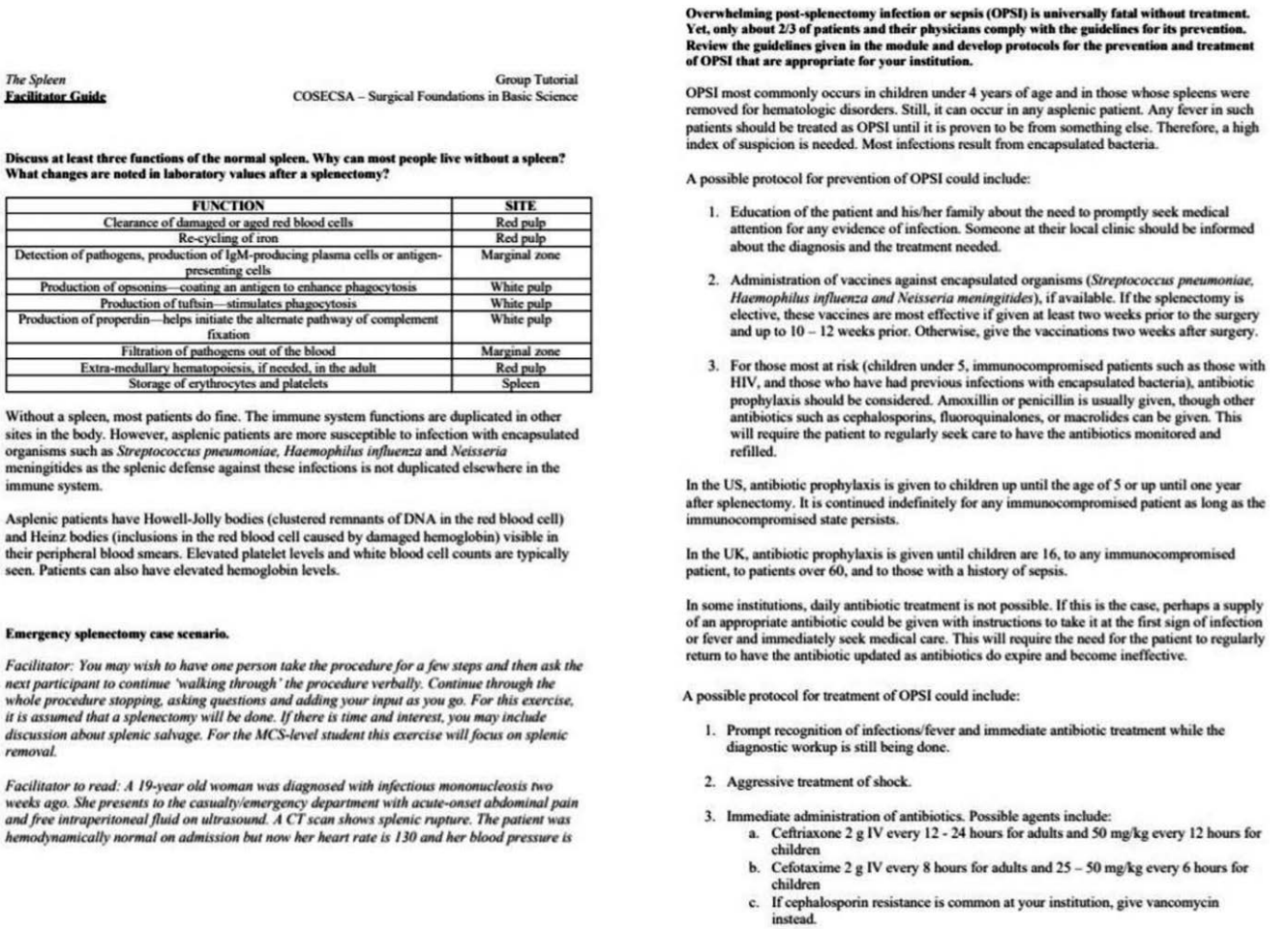
essential concepts within the content through active learning activities. Prompts included case-based discussions, role-playing exercises, competitions, and low-fidelity simulation projects.

Given the goal of easing the burden on surgical faculty at training programs, we opted to provide the curriculum in 2 formats. One version is accessible to trainees and requires completion of the precontent multiple-choice assessment and a mandatory 80% on the postcontent multiple-choice assessment. Although both assessments can be repeated as many times as necessary or desired, correct answers are not revealed, requiring more work on the part of the learner. The second version is accessible only to surgical faculty or senior trainees who may facilitate group times and does not require completing the assessments. Correct answers to questions are also included in this version. Importantly, ideal solutions are provided for each group tutorial prompt so that minimal preparation is needed to facilitate group teaching activities (Fig. 1).

STEP 5: IMPLEMENTATION

Thematic topics were outlined to ensure each subject was covered as comprehensively as necessary. Each topic was divided into 2 to 5 subtopics, depending on the amount of material to be covered. A module was created for each subtopic. We solicited the cooperation of surgeons and educators with significant experience in SSA to write content. We determined that regional surgical educators would be best suited as content writers to achieve the goal of context relevance within the curriculum. Content authors were identified by utilizing surgical education networks and personal contacts (A.P., K.H., R.W., A.B., and R.P.). Forty-seven individuals contributed material to the curriculum, of which 35 are surgical educators in ECSA. Contributions ranged from workshop participation involving content outline to authorship of one or more weeks of content, which included text writing, image curation, multiple-choice question creation, and development of group tutorial prompts and guides. Each author was given instructions to focus on the readability and simplicity of the written text and asked to emphasize the basic science (anatomy, physiology, histology, pathophysiology) aspects of each topic in addition to evaluation and diagnosis. Although management was discussed, a strong emphasis on operative techniques and complex decision-making was deemed more appropriate for the senior years of surgical training. Thus, this was not as heavily considered.

Written content submitted from the authors was entered into Rise 360. Multimedia components were added throughout the content. To avoid copyright infringement, content was chosen that was either (1) available to COSECSA trainees through the School for Surgeons library, (2) usable under creative commons licensing or within the public domain, (3) allowable for educational classroom usage, (4) hyperlinked for curated content, or (5) created by one of the authors or editors. Where relevant, permission was obtained for inclusion within the modules. Where possible, we used images and graphics that are appropriately representative of darker skin tones. After completing each module, editorial input was solicited from at least 2 content experts, who reviewed and edited the content for accuracy. Volunteer medical students reviewed each module for clarity, understandability, and grammatical correctness.



The Spleen Group Tutorial
Facilitator Guide COSECSA – Surgical Foundations in Basic Science

Discuss at least three functions of the normal spleen. Why can most people live without a spleen? What changes are noted in laboratory values after a splenectomy?

FUNCTION	SITE
Clearance of damaged or aged red blood cells	Red pulp
Re-cycling of iron	Red pulp
Detection of pathogens, production of IgM-producing plasma cells or antigen-presenting cells	Marginal zone
Production of opsonins—coating an antigen to enhance phagocytosis	White pulp
Production of tuftsin—stimulates phagocytosis	White pulp
Production of properdin—helps initiate the alternate pathway of complement fixation	White pulp
Filtration of pathogens out of the blood	Marginal zone
Extra-medullary hematopoiesis, if needed, in the adult	Red pulp
Storage of erythrocytes and platelets	Spleen

Without a spleen, most patients do fine. The immune system functions are duplicated in other sites in the body. However, asplenic patients are more susceptible to infection with encapsulated organisms such as *Streptococcus pneumoniae, Haemophilus influenza* and *Neisseria* meningitides as the splenic defense against these infections is not duplicated elsewhere in the immune system.

Asplenic patients have Howell-Jolly bodies (clustered remnants of DNA in the red blood cell) and Heinz bodies (inclusions in the red blood cell caused by damaged hemoglobin) visible in their peripheral blood smears. Elevated platelet levels and white blood cell counts are typically seen. Patients can also have elevated hemoglobin levels.

Emergency splenectomy case scenario.

Facilitator: You may wish to have one person take the procedure for a few steps and then ask the next participant to continue 'walking through' the procedure verbally. Continue through the whole procedure stopping, asking questions and adding your input as you go. For this exercise, it is assumed that a splenectomy will be done. If there is time and interest, you may include discussion about splenic salvage. For the MCS-level student this exercise will focus on splenic removal.

Facilitator to read: A 19-year old woman was diagnosed with infectious mononucleosis two weeks ago. She presents to the casualty/emergency department with acute-onset abdominal pain and free intraperitoneal fluid on ultrasound. A CT scan shows splenic rupture. The patient was hemodynamically normal on admission but now her heart rate is 130 and her blood pressure is

Overwhelming post-splenectomy infection or sepsis (OPSI) is universally fatal without treatment. Yet, only about 2/3 of patients and their physicians comply with the guidelines for its prevention. Review the guidelines given in the module and develop protocols for the prevention and treatment of OPSI that are appropriate for your institution.

OPSI most commonly occurs in children under 4 years of age and in those whose spleens were removed for hematologic disorders. Still, it can occur in any asplenic patient. Any fever in such patients should be treated as OPSI until it is proven to be from something else. Therefore, a high index of suspicion is needed. Most infections result from encapsulated bacteria.

A possible protocol for prevention of OPSI could include:

1. Education of the patient and his/her family about the need to promptly seek medical attention for any evidence of infection. Someone at their local clinic should be informed about the diagnosis and the treatment needed.
2. Administration of vaccines against encapsulated organisms (*Streptococcus pneumoniae, Haemophilus influenza and Neisseria meningitides*), if available. If the splenectomy is elective, these vaccines are most effective if given at least two weeks prior to the surgery and up to 10 – 12 weeks prior. Otherwise, give the vaccinations two weeks after surgery.
3. For those most at risk (children under 5, immunocompromised patients such as those with HIV, and those who have had previous infections with encapsulated bacteria), antibiotic prophylaxis should be considered. Amoxillin or penicillin is usually given, though other antibiotics such as cephalosporins, fluoroquinalones, or macrolides can be given. This will require the patient to regularly seek care to have the antibiotics monitored and refilled.

In the US, antibiotic prophylaxis is given to children up until the age of 5 or up until one year after splenectomy. It is continued indefinitely for any immunocompromised patient as long as the immunocompromised state persists.

In the UK, antibiotic prophylaxis is given until children are 16, to any immunocompromised patient, to patients over 60, and to those with a history of sepsis.

In some institutions, daily antibiotic treatment is not possible. If this is the case, perhaps a supply of an appropriate antibiotic could be given with instructions to take it at the first sign of infection or fever and immediately seek medical care. This will require the need for the patient to regularly return to have the antibiotic updated as antibiotics do expire and become ineffective.

A possible protocol for treatment of OPSI could include:

1. Prompt recognition of infections/fever and immediate antibiotic treatment while the diagnostic workup is still being done.
2. Aggressive treatment of shock.
3. Immediate administration of antibiotics. Possible agents include:
   a. Ceftriaxone 2 g IV every 12 - 24 hours for adults and 50 mg/kg every 12 hours for children
   b. Cefotaxime 2 g IV every 8 hours for adults and 25 – 50 mg/kg every 6 hours for children
   c. If cephalosporin resistance is common at your institution, give vancomycin instead.

FIGURE 1. Sample portions of facilitator guide for spleen (Year B).

The curriculum was uploaded to the COSECSA education platform, School for Surgeons, as the Surgical Foundations in Basic Science curriculum. The platform allows tracking of participation and completion of the modules by each registered COSECSA MCS trainee. Thematic topics were uploaded and released monthly as completed. Each thematic topic had 2 to 5 subtopic weeks of modular content. Trainees were instructed to complete a module over a 1-week timeframe. Faculty were encouraged to choose a weekly time for the group teaching period. Once uploaded, all modules remain available to trainees and faculty. COSECSA now requires participation in the modular curriculum.

In preparation for the rollout of the modular curriculum, trainers and trainees were provided with an orientation module that discussed the purpose, format, outline, and access logistics of the curriculum. Several teaching and training sessions were held for program directors and faculty to become familiar with the modules' structure, setup, and use. The modules were offered to faculty on USB drives in a fully functional offline HTML format. All content is designed to be utilized for educational purposes only. The curriculum is without any cost to trainees or trainers and is nonprofit.

STEP 6: EVALUATING THE EFFECTIVENESS

The curriculum was made available for use in January 2020 by MCS trainees in the 17 COSECSA countries that had MCS training programs at that time. In the first year, 271 (96%) of trainees accessed at least 1 weekly module. Trainees completed a median of 9 of 10 thematic topics that were available in the first year. Curriculum effectiveness was assessed in several ways. Satisfaction with the curriculum and subjective judgments of learning was evaluated by qualitative and quantitative feedback responses. At the end of each week of modular content, a feedback survey was embedded as a Google form (Google LLC). This form used open- and closed-ended questions, as shown in Table 3, to assess trainee perceptions of learning and confidence related to the learning objectives, quality of the modular content, and whether the learner experienced challenges, found the content helpful, or had suggestions for improvements. Therefore, all participants were included as part of the census strategy for feedback. We were also interested in the curriculum's impact on performance on a standardized written certification examination. Following 2 years of surgical training, candidates must take a written membership examination, which qualifies them for an objective structured clinical examination. Successful completion of both the written and oral examinations certifies the trainee as an MCS and qualifies the learner for ongoing training in general surgery or a surgical subspecialty. Comparison of the performances of those trainees who had completed modules with those who had not could demonstrate an objective measure of the effectiveness of the curriculum.[51] Module completion for each trainee was electronically tracked through the learning management system.

TABLE 3.

Postmodule Feedback Survey Embedded as a Google Form

Question	Response
Please rate the amount of learning you experienced in each of the following areas, as a result of this module (asked for each learning objective).	None at all A small amount A moderate amount A large amount
Please rate your confidence level in achieving each of the following objectives, as a result of this module (asked for each learning objective).	No confidence Slight confidence Moderate confidence High confidence
Please rate the quality of questions asked in the quizzes.	Poor Fair Good Very good
Please rate the value of the online module content (text, diagrams, pictures, videos).	Poor Fair Good Very good
How easy was the online module to use?	Very easy Somewhat easy Somewhat difficult Very difficult
Please list any specific technical challenges or issues you encountered while using the online module.	Free response
Please list any components of the module that were particularly helpful.	Free response
Please provide any suggestions on how to improve this module.	Free response

LESSONS LEARNED AND FUTURE DIRECTIONS

By following an established and accepted framework for curriculum design, we were able to anticipate and address the needs and desires of surgical faculty and trainees, incorporating these findings into the design of the MCS curriculum. This reduced speculation as to what components and factors would best serve the trainers and trainees in our region. Given the heterogeneity of the learning environments across such a vast geographical region, upfront needs evaluations and translating those to discrete goals and objectives, we believe, saved tremendous time and frustration in the process. It also allowed the opportunity to merge educational theory and best practices with the practical needs of surgeons in a specific context. Finally, incorporating assessment structures into the curriculum allowed the prospective collection of data about outcomes, vital for improvements. In the second article of this pair,[51] we describe the quantitative and qualitative results of the first year following the implementation of the curriculum and future directions for this curriculum, including ongoing revisions and updates based on feedback and beginning development of a curriculum for senior general surgical trainees.

CONCLUSIONS

Substantial strides have been made in designing a standardized surgical curriculum for trainees in ECSA, written by regional contributors and reflecting context-specific pathologies and resource availability. Importantly, this curriculum incorporates current best educational practices and is data-driven in its flipped-classroom structure and inclusion of active learning techniques and multimedia content. Use of Kern's 6-step process for curriculum development enabled the successful design and implementation of this large-scale, novel curriculum. As surgical trainees throughout SSA utilize this curriculum, we expect it will improve surgical education and advance surgical care and quality in a region of great need.

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