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REVIEW

Urological Surgery Training in Low- and Low-Middle-Resource Settings: a Model for Success!

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Abstract

Purpose of Review This review addresses the growing need for enhanced surgical—and specifically urological—training in low- and low-middle-income countries (LLMICs). Outlined are the challenges host and visiting teams face in facilitating such training, the role of international collaborations and the various urological pathologies that necessitate attention.

Recent Findings Many challenges exist for the successful implementation of urological training in LLMICs. There is a clear need for specific, collaborative and sustainable approaches to address the gap in expertise between high-income countries (HICs) and LLMICs and enhance the delivery of safe, high-quality urological care.

Summary Advancements made in recent decades to address the deficiency in urological surgery training in LLMICs have been made; however, there remains a gulf in the standard of training between HICs and LLMICs. Ongoing international collaborations with remote mentoring utilising modern technologies will play an instrumental role in enhancing urological surgery training in LLMICs in the coming years.

Keywords Global health · Global surgery · Dissemination of training · Low- and middle-income countries · Mentoring · Training

Introduction: The Unmet Global Surgical Needs

Over the last 30 years, interest in providing surgical training in low- and lower-middle-income countries (LLMICs; Fig. 1 [1]) has become a priority of the global surgery family as evidenced by an almost tenfold increase in published literature on the subject [2]. However, the true magnitude of unmet global surgical needs came to attention with the publication of the Lancet Commission report in 2015 [3••]. The most significant findings of the report suggested:

- Almost five billion people globally lack access to safe and affordable surgical and anaesthesia care, with 90% of the population in LLMICs affected.
- Each year, there is a need for 143 million additional life-saving and disability-preventing surgical procedures in LLMICs.
- Catastrophic health expenditure affects 33 million individuals annually, due to patients being forced to resort to self-fund surgical and anaesthetic care.

Although the report has resulted in a surge of surgical workshops and improved training in LLMICs, it did not specifically address urological needs. Harrison and Eshleman [4] were pioneers of global urological philanthropic work and proposed a charter of basic urological rights describing seven urological conditions which can have a major impact on overall health (Table 1). Three decades on, the charter continues to represent a guiding source to facilitate and prioritise urological training in areas of need in resource-poor countries. The African Medical Research Foundation (AMReF) report echoed the charter, suggesting several urological pathologies as priorities for attention: benign prostate

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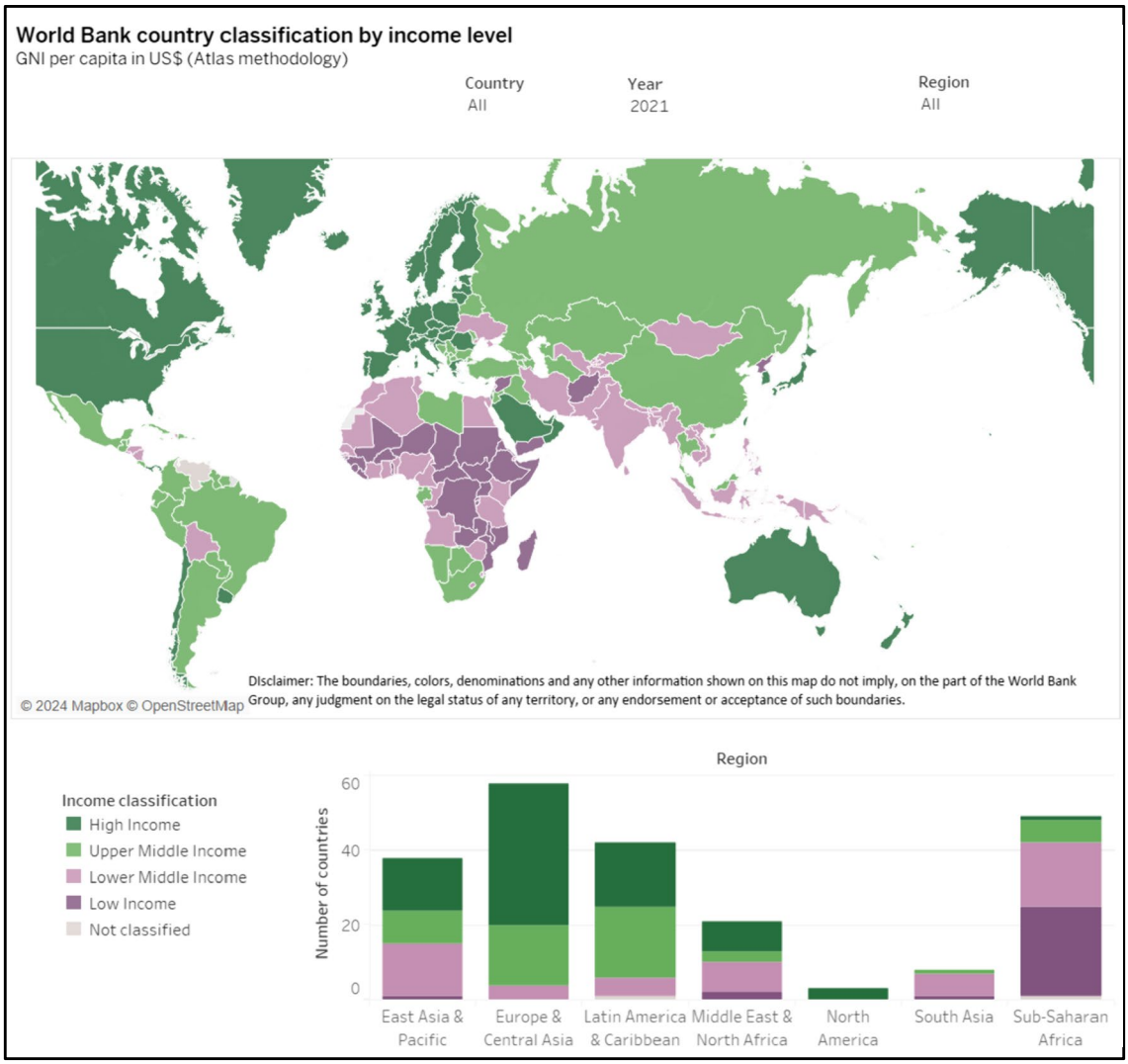

Fig. 1 World Bank country classification by income level (2022–2023) [1]

Table 1 Harrison and Eshleman's Basic Urological Rights Charter [5]

Condition	Treatment
1. Retention of urine	Early relief by urethral or suprapubic catheter Surgical treatment—endoscopic where appropriate
2. Haematuria	Education and early diagnostic investigation
3. Urethral strictures	Treatment by bouginage or visual urethrotomy and self-catheterisation
4. Urethral trauma	Safe initial management Referral for definitive treatment
5. Vesicovaginal fistula	Early surgical repair
6. Male circumcision	Safe techniques
7. Penile carcinoma	Early diagnosis and treatment

hyperplasia (BPH), urolithiasis, urethral stricture disease and pelvic (bladder and prostate) cancer [6].

Meeting the Needs: The Role of International Organisational Collaborations

Several international collaborations have made significant contributions to addressing differences in the standard of urological care between high-income countries (HICs) and LLMICs. These partnerships aim to improve surgical training and education and to address the shortage of the local workforce by increasing the number of trained clinicians and enhancing the training of existing surgeons.

A collaboration between the Royal College of Surgeons of Ireland (RCSI) and the College of Surgeons of East, Central and Southern Africa (COSECSA), funded by Irish Aid,

was established in 2007 to support surgical training in COSESCA countries and has made significant achievements [7]. One of the most significant ongoing objectives of this collaboration is to avoid "brain drain" from LLMICs to HICs. Since its inception, 93% of COSECSA-trained surgeons have remained in their home region after completing their surgical training. With improved training and examination processes, there has also been a significant increase in COSECSA surgical graduates over 15 years (Fig. 2).

The American College of Surgeons (ACS) also collaborated with COSECSA in 2018 with similar objectives as RCSI. This collaboration has so far established two pilot programmes with affiliations between thirteen American institutes that have developed global surgery programmes and two African centres in Ethiopia and Zambia.

Specifically focused on enhancing urological training, two organisations have led the way in establishing a strong and highly impactful concept of global urology. Within the United Kingdom (UK), Urolink was established as a subsection of The British Association of Urological Surgeons (BAUS) over 30 years ago [5] and has established strong connections with link centres throughout sub-Saharan Africa (SSA), providing training, equipment and support through direct visits and remote mentoring. Similarly, International Volunteers in Urology (IVUmed), a US-based non-governmental organisation (NGO) [8] has been active for a similar length of time in several LLMICs, predominantly throughout Africa and Asia. The objectives and principles of both organisations are similar: to establish and strengthen relationships with institutions and colleagues in LLMICs and to disseminate expertise, training and equipment to various host centres based on their needs; and to do so ethically and sustainably. The experiences of both Urolink and IVUmed have highlighted the importance of longitudinal surgical training models (LSTMs) where HIC urologists spend years building strong relationships with host institutions in LLMICs to provide consistent training, mentoring and support through clear objectives, regular reflection and meaningful collaboration to enhance and optimise training.

Challenges in the Delivery of Urological Training

Lack of Resources and Infrastructure

Access to healthcare in LLMICs is severely limited, with minimal universal health coverage (UHC). The lack of UHC forces impoverished families to self-fund their care with "out-of-pocket" payments (Fig. 3), often leading to significant financial crises. According to data from the World Bank, there is a substantial disparity in health expenditure between HICs and LLMICs, exemplified by the vast contrast in current health expenditure per capita between countries like the United States and African/Asian nations (Fig. 4) [9].

Several charitable hospitals have been built in LLMICs over the years, but many lack sustainable models for long-term operation. Even those hospitals that are currently functional face critical challenges such as the absence of reliable basic necessities like water, electricity and internet connectivity. These deficiencies severely hamper the efficient delivery of clinical services, highlighting the urgent need for comprehensive support and infrastructure development in healthcare facilities [10•].

Addressing public health challenges remains a priority in LLMICs, and these challenges encompass a wide range of issues including reducing transmission of communicable diseases; widening access to immunisations; improving access to clean water, sanitation and hygiene (WASH) facilities; and addressing maternal and child health and

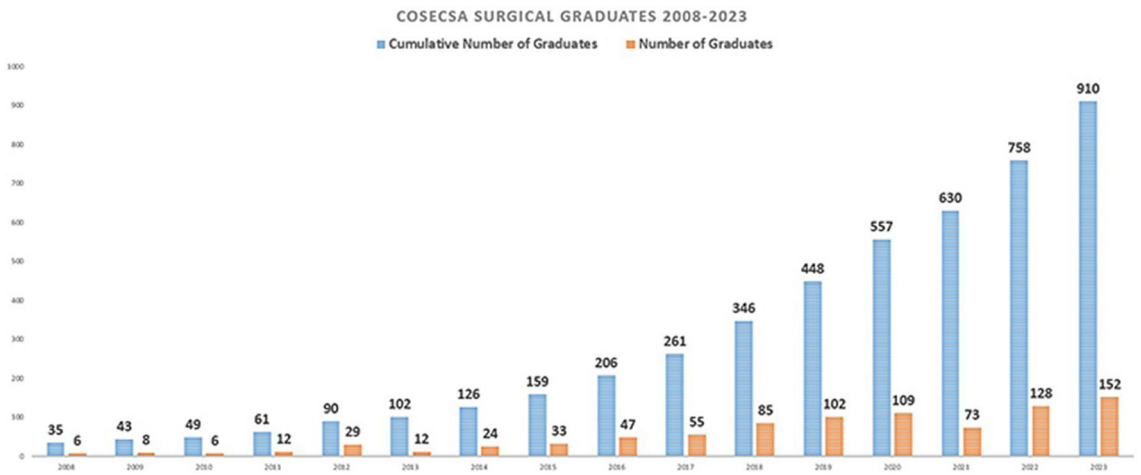

Fig. 2 Trends in COSECSA surgical graduates between 2008 and 2023 [7]

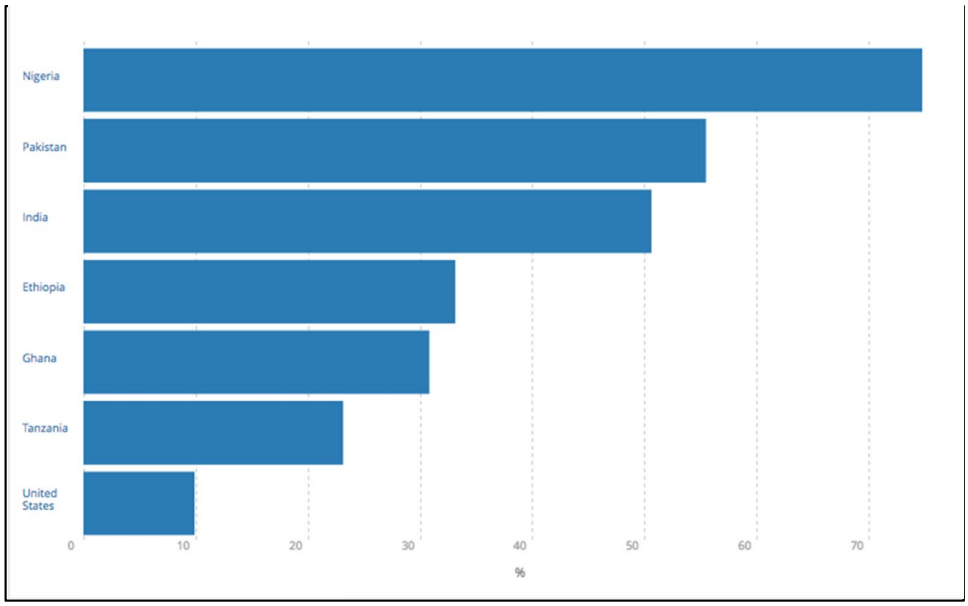

Fig. 3 Global out-of-pocket health expenditure (% of current health expenditure) [9]

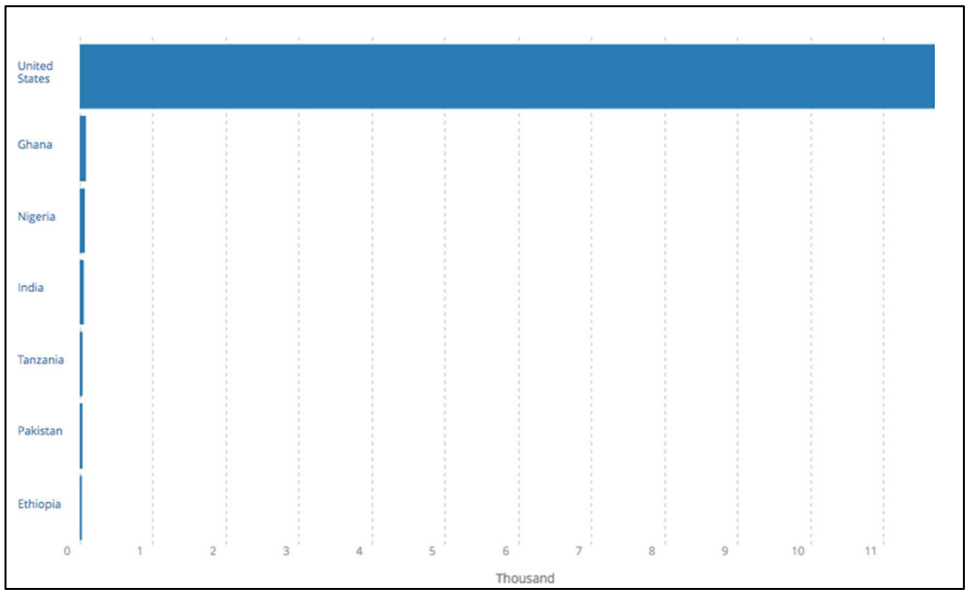

Fig. 4 Contrast in current health expenditure per capita between the United States and African/Asian nations in thousands US dollars [9]

malnutrition [11]. Funding organizations such as the World Bank, World Health Organization (WHO), Gates Foundation and local health ministries have supported various initiatives aimed at tackling these pressing concerns. Consequently, most available resources are allocated to these fundamental public health needs, leaving limited funding to be diverted towards specialised surgical care. This allocation reflects the critical need to address basic healthcare requirements before directing resources to more specialised medical services.

Based on the authors' experience, the availability of medical equipment remains a major challenge in many healthcare facilities in Africa and Asia. Essential disposables such as endoscopic guidewires, stone baskets, transurethral resection loops and urethral dilators are often in short supply in host centres, and these hospitals rely heavily on donations from visiting teams from HICs to replenish their stock. Resourcefulness is key, and despite being marketed as single-use disposables, many instruments are frequently reused, with local teams cleaning them in glutaraldehyde solution to extend their usability.

In terms of infrastructural support, the lack of basic amenities such as running water, electricity, irrigation solutions and anaesthesia services significantly hampers the delivery of urological services. A study conducted in Malawi, Tanzania and Zambia [12] highlighted the situation in district-level hospitals. It reported that only 29% of these

hospitals in Malawi had an uninterrupted supply of electricity, and merely 23% had a reliable water supply. Additionally, there was a severe shortage of anaesthesia practitioners, anaesthesia machines and related equipment in Zambia and Tanzania, further exacerbating the challenges faced by medical and surgical teams.

These infrastructural deficiencies present significant hurdles for healthcare providers, both local and visiting from HICs, necessitating careful consideration and planning when organising medical missions or visits to these regions. Addressing these challenges is essential to ensure the effective and sustainable delivery of urological services in LLMICs.

Cultural Challenges

Cultural beliefs play a significant role in explaining how some patients perceive disease and their willingness to seek timely healthcare in LLMICs, and it is therefore essential for visiting clinicians to understand and navigate these cultural intricacies respectfully and professionally [13•]. In some nations within Africa and Asia, for example, there is a practice of consulting traditional healers before seeking professional specialist input, and this can lead to delays in receiving appropriate medical care. In Ethiopia, a community-based study suggested that almost half of women attributed their obstetric fistula to evil spirits, curse or sin, immoral sexual practices and/or witchcraft [14, 15]. Such cultural beliefs and stigma can add to challenges in seeking appropriate surgical care. By acknowledging and respecting these cultural beliefs, healthcare providers can establish trust with the local communities and promote a more inclusive and effective healthcare system.

Spectrum of Disease Presentation and Lack of Training

The needs of urological surgery differ significantly in LLMICs compared to HICs. With half of the population in LLMICs under 14 years of age, the demand for paediatric and adolescent urology services is notably higher. Addressing congenital anomalies, urological cancers and developmental issues in this age group requires specialised expertise and resources [16].

A significant challenge in adult urology is the late-stage presentation of cancers. Due to the limited accessibility of primary care and screening programs, urological cancers are often diagnosed at advanced stages, hindering curative interventions. Early detection initiatives and increased awareness are vital to improving outcomes[15].

The shortage of urological specialists is a pressing concern in LLMICs throughout Africa and Asia. Most urologists in these regions are generalists managing a wide spectrum of cases, including paediatrics, uro-oncology and reconstructive urology. Furthermore, urological services in many institutes are provided by general surgeons, highlighting the lack of dedicated urological expertise [17•]. Sub-specialty-trained urologists are mainly concentrated in tertiary referral centres, and their scarcity poses a significant challenge. In some instances, a single urologist is responsible for up to one million patients, indicating the overwhelming patient-to-urologist ratio (BAUS Workforce Report 2020).

The deficiency of specialised urologists profoundly affects the training of the new generation of urological surgeons. Trainees in LLMICs have limited exposure to advanced procedures such as percutaneous nephrolithotomy (PCNL) and ureteroscopy (URS), which are performed in only a handful of centres. Instead, trainees are predominantly exposed to open procedures like simple prostatectomy, nephrectomy, pyeloplasty and cystolithotomy. Transurethral resection of the prostate (TURP) remains one of the most common endoscopic procedures, but even this exposure is limited[16].

Addressing these challenges requires a multi-faceted approach involving international collaboration, targeted training programs and increased investment in healthcare infrastructure. By focusing on these unique needs, the urological community can work towards enhancing care delivery and improving outcomes for patients in LLMICs.

Models of Training in LLMICs

Jedrzejko and colleagues have described a successful model of global surgical partnerships based on six pillars as outlined in Table 2 [18••].

In our extensive experience working in LLMICs, the training process commences with a comprehensive assessment of the specific needs within various urological specialities, such as urinary incontinence, uro-oncology and paediatrics. This evaluation considers factors like disease prevalence, the necessary number of surgical cases per year, existing medical services and the demand for training in particular procedures. Additionally, consideration is made to the availability of equipment, its procurement and the formulation of a sustainable long-term plan for its maintenance. An important aspect of this evaluation involves assessing the existing workforce and identifying clinicians within the team

Table 2 Jedrzejko's model of global surgical partnerships [18••]

Community engagement
Multidisciplinary collaboration
Education/training
Outcome measurement
Bilateral authorship
Multisource funding

who possess the appropriate expertise to undergo specialised training.

In the COSECSA region, we have observed that establishing a urological workforce comprising a minimum of three consultants is critical. This not only ensures a higher standard of competence but also leads to the recognition of the institute as having the requisite expertise to provide comprehensive training. Such meticulous evaluation and strategic planning are fundamental to building a robust and effective urological training program in resource-constrained settings [19].

Various training models have been trialled, encompassing short overseas fellowships in HICs for LLMIC trainees, as well as short-term surgical trips (STSTs) and extended visits from clinicians hailing from HICs, lasting for durations of 2–3 months [20], with the STST model most employed [21, 22]. As we will elaborate on later in this article, this STST model has yielded positive outcomes, whilst concurrently minimising the "brain drain" that results from the migration of healthcare professionals from LLMICs to HICs.

Major Urological Sub-specialities Requiring Training

Female Incontinence

In LLMICs, the most common cause of urinary incontinence (UI) is vesicovaginal fistula (VVF)—with obstructed labour the cause for over 90% of these cases [23–25]. However, more recent evidence suggests that non-fistulous incontinence (NFI) is also common. The true scale of UI among women in LLMICs remains challenging to fully grasp due to underreporting and various social factors. However, a recent comprehensive meta-analysis, which included data from 17,863 women across nine Sub-Saharan African (SSA) countries, suggested a prevalence rate of 21% [26].

This high prevalence underscores the urgent need for targeted healthcare interventions and increased awareness campaigns. Additionally, it emphasises the necessity of creating safe spaces for women to openly discuss their health concerns, enabling early detection, access to appropriate medical and surgical care and psychosocial support. Addressing the issue of UI comprehensively will not only improve the quality of life for affected individuals but also contribute significantly to the overall well-being of communities in LLMICs.

The lifetime prevalence of VVF in SSA is estimated to be 3 per 1000 women in their childbearing years [27], while a recent World Bank estimate suggests an annual global prevalence of 50–100,000, of which most—50–90,000 cases—occurred in SSA [25].

The risk factors for NFI in SSA are similar to those in HICs including multiparity, advancing age, chronic coughing, obesity and constipation. The risk of UI is greatest with a history of vaginal delivery, which is further worsened by forceps-assisted and instrumental delivery. The Caesarean section is a less common mode of birth in LLMICs due to challenges with access and lack of safe obstetric services [28•].

In addition to the related health aspects, UI results in significant social and mental health consequences for individuals and their families as noted by an Ethiopian study—the inability to work adequately (both in the home and outside), to have marital relations, associated negative stigmatisation, divorce, inability to pray in religious settings and ostracism from the community—often leading to depression and suicidal ideas [15].

Due to the magnitude of the problem, several international organisations have been working to address the need including the United Nations Population Fund (UNFPA) supporting both training at specialist hospital levels and camps for more inaccessible rural areas. For example, in Uganda, the Ministry of Health supports Uganda fistula camps.

Freedom from Fistula (FFF) charity organisation was founded in 2008 and has been working in several African countries providing surgical treatment as well as maternity care to prevent VVFs. The most remarkable project by FFF has been running in Malawi since 2010 and it opened the Fistula Care Centre (FCC) in Bawaila Hospital, Lilongwe, in 2012. This 35-bed unit gives full access to rural areas' population through a community programme and treats up to 400 patients each year.

As discussed earlier, the lack of surgeons and capacity building in female urology and incontinence surgery in LLMICs is a major issue. Until the number of trained urologists increases, a model that has been successfully implemented is that of training non-physician clinical officers (NPCO) to perform reparative surgeries for uncomplicated VVFs [29].

In the Malawian model, with the UNFPA and Ministry of Health partnership, NPCOs are trained for a duration of 3 years. The training consists of screening, proper diagnoses and surgical mentoring of simple VVF cases by expert surgeons. After achieving competencies to operate independently, the NPCOs are assigned to rural hospitals which lack a surgical workforce. While they deal with simple VVFs only, more complex cases get properly screened and subsequently referred to specialist tertiary hospitals.

As several VVF patients are based in rural areas, the FFF charity also successfully runs an ambassador program in Malawi where former patients educate the population about VVFs, safe obstetric care, avoiding early marriages and pregnancies, and the importance of accessing the fistula care

centre for proper surgical treatment. This programme has been a huge success with over 250 ambassadors involved.

Female UI and VVFs remain a major urological need in LLMICs that requires further capacity building through proper surgical training and social support.

Paediatric Urology

The biggest challenge in the delivery of effective and timely paediatric urology services in LLMICs is the lack of trained personnel, most of whom are based in specialist tertiary care hospitals. Consequently, many cases of hypospadias and undescended testes, the two most common problems, are dealt with by general urologists and/or general paediatric surgeons before referral to a more specialist urology centre [16, 30].

More complex congenital problems may require a referral to a neighbouring country, or participation in specialised surgical workshops. The most prominent reason for this is the lack of fellowship-trained paediatric urologists. For example, Uganda has just one for a paediatric population of approximately 20 million while the Democratic Republic of Congo has none for a population of over 50 million [31].

Currently, neither COSECSA nor the West African College of Surgeons (WACS) has any specialist paediatric urology training or fellowships in their programme [32, 33]. A further limitation is the lack of appropriately trained paediatric anaesthetists which makes the delivery of services more challenging [34].

Specific Paediatric Urological Conditions

Hypospadias Successful outcomes for hypospadias surgery are limited due to the lack of proper instrumentation, appropriate level of surgical expertise, availability of sufficient tissue due to prior circumcision in which the hypospadias was missed and high postoperative complication rates. This discourages parents from seeking medical care for the problem. Clearly, the only solution that remains here is appropriate surgical training in specialised paediatric procedures [35].

Phimosis and Undescended Testicle In addition to religious circumcision, voluntary circumcision has also been highly recommended by both the WHO and the United Nations to reduce the risk of endemic HIV [36]. With non-medically trained personnel performing a vast proportion of circumcisions, a high rate of complications such as penile injuries and amputations, excessive removal of foreskin and meatal stenosis has been noted [37].

Delayed presentation of cryptorchidism is a significant issue with a mean age of 4 years for corrective orchidopexy, as noted in one published series [38]. A further limitation in LLMICs is the lack of access to minimally invasive laparoscopic surgery, thus requiring an open exploration for impalpable testicles.

Exstrophy-Epispadias Complex (EEC) Perhaps one of the most complex paediatric conditions, extrophy-epispadias complex (EEC) requires multi-institutional collaborations and referrals even in HICs. An extrapolative data analysis from Ethiopia suggests a national backlog of over 575 cases [39]. Another series suggests the creation of ureterosigmoidostomy (Mainz II pouch) in one-third of cases of staged EEC as this avoids the use of intermittent self-catheterisation which is not well supported in the community. This also allows more social acceptability in terms of attendance at school and maintaining continence [40].

Congenital Obstructive Posterior Urethral Membrane (COPUM) Unlike HICs, in LLMICs, antenatal screening is often not available; thus, the early diagnosis of COPUM is not possible, and the risk of progression to end-stage renal failure is significantly higher as reported in series from Nigeria and Cameroon [39, 41]. With the lack of renal replacement therapy and transplant programs, the outcome in such patients unfortunately is very poor.

Addressing the Paediatric Urology Needs

With no formalised training structure in LLMICs and with an expanding paediatric population, paediatric urology requires more sustainable collaborations between trained professionals in HICs and areas of need in LLMICs, than any other urological sub-specialty.

Tanzania presents a successful model where collaborators between HICs and LLMICs jointly decide the needs. They focused more on existing resources and the capacity to create surgical theatres and wards focused on paediatric patients with significant attention on surgical skills training [42]. A UK-based organisation in Uganda, KidsOR, has adopted a similar model of separating paediatric services from adult services, thereby removing the competition between adults and children for access to surgical resources; this has resulted in improved outcomes overall [43]. Further long-term collaborations could be developed by online teaching programmes involving residents in training; such is the model followed by IVUmed.

Endourology (Urolithiasis, BPH and Urethral Stricture Disease)

Stone disease (urolithiasis) affecting the upper and lower urinary tract, male urethral stricture disease and BPH are amongst the most common urological pathologies in LLMICs. Furthermore, urinary retention secondary to BPH and urethral stricture incorporates a substantial proportion of

the emergency urology workload [44]. However, despite the high prevalence of these conditions, training in their endoscopic management remains lacking.

In many LLMICx, most surgical interventions for BPH continue to be performed via an open approach, and the authors' experience is that local surgeons are highly skilled in some open procedures now seldom undertaken in HICs—for example, retropubic simple prostatectomy for BPH [3••, 45•, 46], thereby placing a considerable burden on healthcare systems. It has been suggested that many such countries currently find themselves at a stage in the provision of endoscopic surgery that HICs (such as the UK) experienced in the early 1980s when such technology was beginning to show widespread adoption [47•]. Furthermore, the provision of laparoscopic urological surgery remains lacking in LLMICs for a multitude of reasons [48], including the initial financial burden of purchasing necessary surgical equipment and the lack of local expertise, although progress has been made in recent years to enhance these provision [49–51]. This situation highlights the significant disparity between the availability of minimally invasive surgical techniques between LLMICs and HICs.

The BAUS Urolink group has significant experience in delivering training workshops and mentoring programmes for centres in LLMICs wishing to enhance their access to endourological procedures such as TURP, TURBT, URS and PCNL. It has been demonstrated that it is feasible to teach the full breadth of endoscopic urological procedures in the LLMIC environment [50, 51]; however, there are significant challenges—not least the requirement for adaption of local infrastructure which may require charitable funding for long-term sustainability. Within Ethiopia, there are 15 urologists for a population of > 120 million people [52], with a growing demand for training in endourological procedures. Since 2010, BAUS Urolink has collaborated with Hawassa University Referral Hospital (HURH), a tertiary hospital located in Hawassa, a major city in southern Ethiopia, which serves a population of over 20 million people. The progress made during this collaboration is a good example of a successful model for enhancing endourological training in LLMICs. An initial "scouting visit" was undertaken to establish a working relationship with the local team and community and gain a better understanding of the local urological disease burden and needs of the local healthcare system. Whilst the team observed there was some availability of endourological equipment at HURH, knowledge and expertise relating to its use and maintenance were lacking. Thus, a strategy and long-term plan were developed to enhance training and development of endourological services within HURH [53•]—with the ultimate objective of developing a formal urology training programme. Subsequent visits began with teaching cystoscopy, with an emphasis on learning the functionality of endoscopic instruments and teaching important anatomical landmarks. This initial training was complemented by simulation in endoscopic resection using the Bristol TURP trainer (Limbs and Things, Bristol, UK). Progression to the first TURP was not without its challenges, including difficulties with instrument sterilisation, electrical supply and management of irrigating solution—with 5% dextrose as the only available irrigant. Resourcefulness and adaptation to the available equipment are essential in resource-poor environments. Over time, with regular visits from the Urolink team and support between visits, the HURH team became proficient in undertaking flexible and rigid cystoscopy, bladder neck incision (BNI), TURP and replaced blind urethral dilatation with direct-vision internal urethrotomy (DVIU). However, training of clinicians represents only one facet of the process, and visiting teams must also consider important aspects such as financial support, audit of local practice and maintenance of equipment to ensure long-term sustainability. Figure 5 demonstrates the trend in some core endourological procedures relating to BPH and urethral stricture management, with a clear move away from traditional open operations and towards endoscopic TURP, BNI and DVIU. This is a testament to the success of this partnership and the importance of developing long-term strategies and persistence to achieve meaningful results. This strategy applied by Urolink has been replicated for workshops in other LLMICs including Gambia, Senegal and Zimbabwe.

Urolithiasis is associated with substantial morbidity, and the evaluation and treatment of recurrent disease can impose a considerable financial strain on healthcare systems worldwide [54]. According to the 2019 Global Burden of Disease (GBD) study [55], the incidence of renal calculi (nephrolithiasis) has been steadily rising over recent decades. The prevalence remains significant in LLMICs [54] although there is a lack of primary data reporting in these nations [56]. The minimally invasive treatment of urolithiasis through procedures like URS and PCNL was first documented nearly 40 years ago. However, the widespread adoption of these techniques has been hindered by a range of complex factors [57]. There have been increasing efforts to enhance the provision of endoscopic renal calculi management in recent years [49], primarily by PCNL. Whilst renal calculi would predominantly be treated using URS and laser lithotripsy in HICs, this procedure is prohibitively expensive for most centres—with procurement and maintenance of equipment such as flexible ureterorenoscopes, laser systems, laser fibres, ureteric stents and endoscopic stone baskets carrying a significant cost. Thus, the focus in many LLMIC centres has been to enhance provision to PCNL as equipment is more affordable and reusable, nephrostomy tubes are more freely available than ureteric stents, and cases can be undertaken using a mechanical ballistic lithoclast rather than a laser. The MediTech organisation has successfully

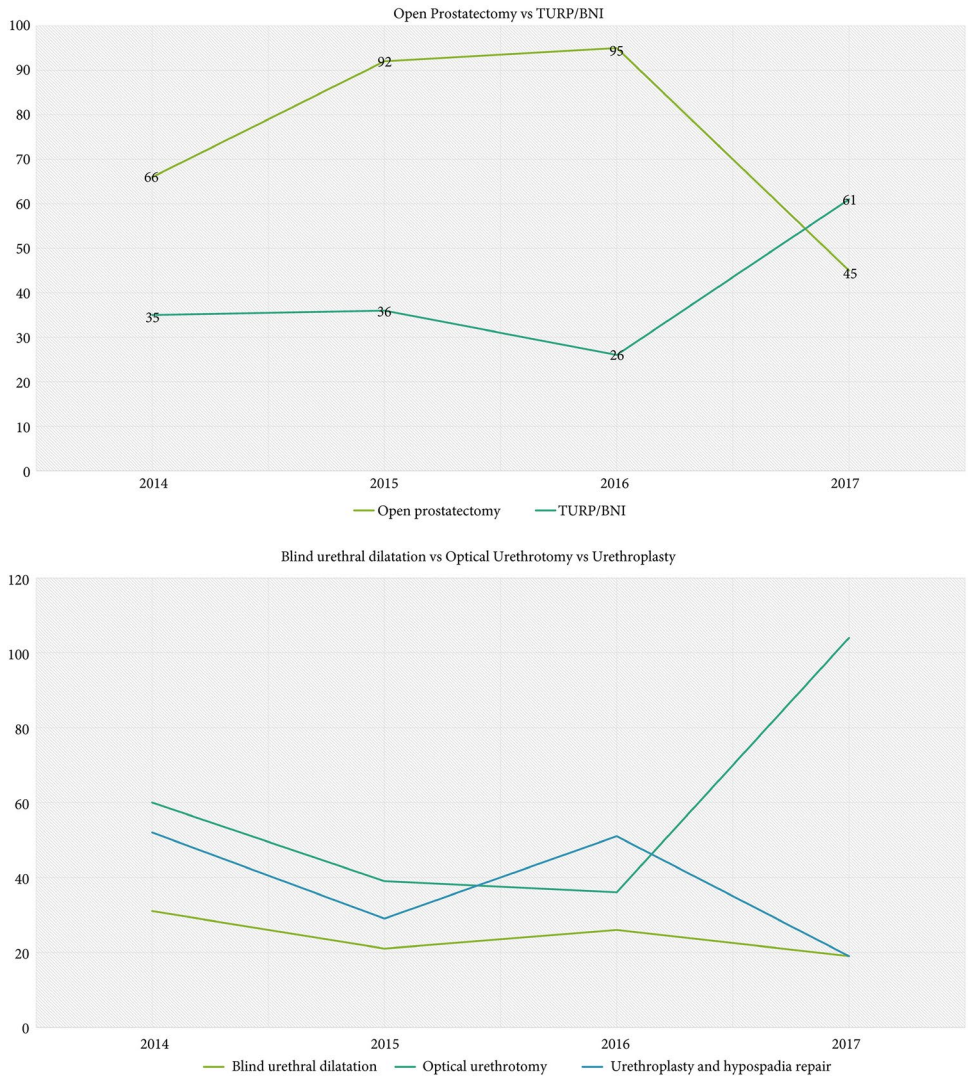

Fig. 5 Trends in endoscopic management of benign prostatic enlargement (BPE) and male urethral stricture disease at Hawassa University Referral Hospital (HURH), demonstrating an increase in the provision of TURP/BNI and DVIU as a consequence of collaboration with BAUS Urolink [52]

implemented PCNL in seven LLMICs. Each of the successful models [48] has relied heavily on the nomination of a "local champion" who can act on behalf of the supporting team to help procure equipment, develop technical proficiency and eventually train local surgeons and disseminate skills to achieve long-term sustainability [58].

Modernising Urological Training

Augmented Reality for Remote Mentoring

Augmented reality (AR), a form of virtual reality, has increasing utility in surgical training as cameras attached to the primary surgeon via a head-mounted device (HMD) allow individuals or groups to view images from the perspective of the surgeon—either within the operating theatre or remotely through the remote projection of images via the internet [59]. The technology is particularly useful in the training of endoscopic or laparoscopic operations; however, its utility may extend to some open procedures such as urethroplasty.

The Urolink organisation, in collaboration with the MediTech trust and using the Proximie® device [60] trialled AR technology with some success during the COVID-19 pandemic when visits were not possible [54]. However, whilst AR has the potential to revolutionise training in LLMICs by sustaining long-term international collaborations and building on skills gained and professional relationships developed during STSTs whilst minimising the cost of travel and associated carbon footprint, its use is not without its challenges. These include the initial financial outlay for the host centre to purchase equipment, the requirement for a stable power supply and Internet connectivity and the navigation of international time zone differences. Thus, further pilot studies are needed to evaluate the feasibility of AR as a tool in the long-term training of surgeons working within LLMICs.

Simulation Courses

Simulation-based education (SBE) has developed a prominent role in HIC surgical training in recent years, and it is well-evidenced that simulation improves trainees' ability to undertake a task with a subsequent reduction in operative time [61, 62]. In recent years, there has been an increase in the delivery of simulation training workshops in LLMICs, with several taking place under the jurisdiction of COSECSA, whilst other low-cost workshops have been run successfully in Rwanda [63] and rural Tanzania [64]. However, widespread provision of SBE remains lacking in LLMICs, with a lack of funding, resources and infrastructure among the rate-limiting steps. However, access to online platforms, mobile apps and virtual communication has increased amongst surgical trainees in LLMICs, propelled by the opportunities for international virtual training collaborations during the COVID-19 pandemic, and so it is hoped that simulation will form an increasingly important role in the training of residents throughout LLMICs in the coming years [65].

Concluding Remarks

In recent decades, efforts have been made to improve surgical and urological training in LLMICs. Despite these advancements, there remains a significant disparity in training quality compared with HICs. However, the future appears promising with the emergence of international collaborations and the implementation of remote mentoring programs using modern technology. These initiatives will play a vital role in the years to come and pave the path to a more equitable landscape for urological training worldwide.

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Declarations

Conflict of Interest Matthew Trail and Muhammad Zeeshan Aslam declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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