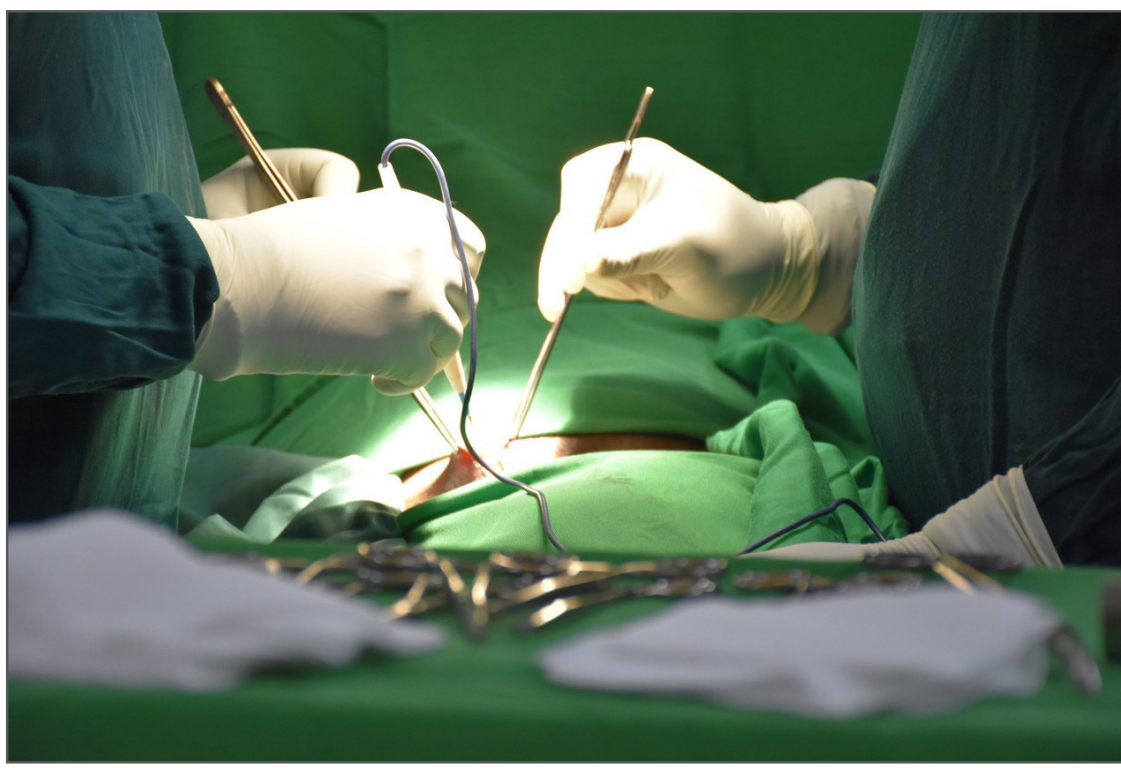
SURGICAL APPROACHES
TO THE UROGENITAL MANIFESTATIONS OF LYMPHATIC FILARIASIS

REPORT FROM AN INFORMAL CONSULTATION AMONG EXPERTS



World Health Organization

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Consulted experts

The ad hoc group of experts comprised the following individuals: group chair Catherine R. deVries (Center for Global Surgery, University of Utah, United States of America), Andualem Deneke Beyene (Addis Ababa University School of Medicine, Ethiopia), Sakti Das (University of California Davis School of Medicine, United States of America), Apul Goel (King George's Medical University, India), Trilok Chandra Goel (King George's Medical University, India), Serigne M. Gueye (Grand Yoff Hospital, Senegal), Sunny Doodu Mante (37 Military Hospital, African Filariasis Morbidity Project, Ghana), S.P. Pani (Quest International University Perak, Malaysia), Richard A. Santucci (Michigan State College of Medicine, United States of America) and Zeina Sifri (Helen Keller International, United States of America).

Peer review

The following individuals served as the peer reviewers of the report and provided valuable input: Gautam Biswas (WHO/NTD), Corinne R. Capuano (WHO, Fiji), Georges-Pierre Capuano (independent consultant surgeon, Fiji), Frank Richards (The Carter Center, United States of America) and Caitlin Worrell (Centers for Disease Control and Prevention, United States of America).

Illustrations

The illustrations in this report were the work of Jill Rhead (Figure 1), Tiffany S. Davanzo (Figures 2–3) and Catherine R. deVries (Figure 6).

Terminology, abbreviations and acronyms

ADL	acute dermatolymphangitis
ADLA	acute dermatolymphangioadenitis
DCP2	Disease Control Priorities (second edition) series published by the World Bank (http://www.dcp-3.org/dcp2)
DCP3	Disease Control Priorities (third edition) series published by the World Bank (http://www.dcp-3.org/)
FASTT	Filaricele Anatomical Surgical Task Trainer A (computer-generated) program developed by Helen Keller International and the MMDP Project that includes a life-sized mannequin and a training curriculum with both theoretical instruction and videos demonstrating each step in the process.
GPELF	Global Programme to Eliminate Lymphatic Filariasis
HIC	high-income country
LF	lymphatic filariasis: a disease of humans caused by filarial parasites
LMIC	low- and middle-income country
MDA	mass drug administration
MMDP	Morbidity Management and Disability Prevention project A five-year effort by the United States Agency for International Development to manage the morbidity associated with lymphatic filariasis and trichiasis (www.mmdpproject.org)
NPO	nil per os (nothing by mouth)
NTD	neglected tropical disease
SAT	surgical assessment tool
SSI	surgical site infection
TAS	transmission assessment survey
WHO	World Health Organization

1. Introduction

Lymphatic filariasis (LF) is a significant public health problem caused by infection of the lymphatic system with filarial parasites. According to the World Health Organization (WHO), approximately 120 million people are affected by filariasis, including up to one-third who are symptomatic of whom 25 million (63%) are men who exhibit urogenital manifestations including hydrocele and penoscrotal lymphoedema. In addition to experiencing the physical discomfort of genital swelling, these men suffer also from psychosocial sequelae at home and in their communities and are economically disadvantaged due to their inability to work. Low- and middle-income countries (LMICs) bear the burden of LF disease and this community-wide economic effect can exacerbate their already weakened economies (*1–4*). While early medical treatment can help prevent genital disfigurement, surgery remains the only option once genital swelling and hydroceles have formed. Both training and advocacy are necessary to bring the benefits of surgery to affected men; community and public health workers should understand the advantages of surgery for restoring function, and clinicians should receive training in the unique qualities of LF hydroceles that are different from hydroceles seen in areas where the disease is non-endemic.

Following the adoption by the Fiftieth World Health Assembly of resolution WHA50.29 on the elimination of LF as a public health problem in 1997, WHO launched the Global Programme to Eliminate Lymphatic Filariasis (GPELF) in 2000 (*5*). GPELF set the target year of 2020 to achieve the elimination goal and defined two programmatic axes to achieve it: (i) preventive chemotherapy for affected populations and people at risk; and (ii) management of clinical manifestations. For preventive chemotherapy, mass drug administration (MDA) is designed to interrupt transmission of the infection within communities, thereby preventing new cases. Concurrently, medical and surgical therapy are both indicated for management of clinical manifestations resulting from the infection. Because scrotal swelling, including the swelling due to hydrocele, is the most common and debilitating manifestation of LF in men, surgical hydrocelectomy is considered an essential component of WHO's recommended minimum package of care for morbidity management and disability prevention (MMDP) (*1*).

Surgical care requires a strategy for training and implementation with a strong quality assurance component. Resolution WHA68.15 (2015) on strengthening emergency and essential surgical care and anaesthesia as a component of universal health coverage includes provisions for data collection on surgical conditions as well as building surgical service capacity at district hospital level to deliver adequate emergency and essential surgical care and anaesthesia when and to whom it is necessary. A surgical care health workforce able to deliver this care is also necessary (*6*).

Hydrocelectomy has been identified by Disease Control Priorities (DCP-3) series as one of 28 essential surgical procedures that should be available at first level referral hospitals worldwide (*7*). As described in section 9 on site of care below, first level referral hospitals in DCP3 terminology correspond to WHO Level II facilities. Recent evidence also has highlighted the importance of basic surgical care as a part of public health. Statistics reported in the DCP3 showed that the cost effectiveness of hydrocelectomy is similar to that of low-cost herniorrhaphy; which in turn is as cost effective as vaccines and 10 times as cost effective as treatment for HIV infection (*8*). In a cost–effectiveness analysis of treatment strategies for LF, Turner and colleagues found surgery to be cost effective or highly cost effective (*9*). WHO reports the cost of hydrocele surgery to be US$ 80–360 in LICs.

In order to achieve the aims of resolutions WHA50.29 and WHA 68.15 and to facilitate safe, effective surgical care for men suffering from genital manifestations of LF, a committee of experts on urological and surgical care in low resource countries was convened to update the previous WHO document, *Surgical approaches to the urogenital manifestations of lymphatic filariasis*, published in 2002 (*10*). The Committee reviewed and identified updates for existing procedures and processes, taking into consideration the geographical, economic and resource differences inherent in endemic countries. It also reviewed current recommendations for facility and personnel resources with attention to promoting safe surgical care for patients with LF and simultaneously strengthening surgical care as a critical component of universal health coverage. This holistic approach addresses the sustainability of surgical care as an axis of morbidity management for LF, while simultaneously bridging potential gaps between public health and clinical approaches to management and elimination of the disease in resource poor settings.

The Committee noted the importance of collecting data on the prevalence and stage of urogenital manifestations of LF. Continual updating of data will also help communities and countries in their surgical planning. These data will help in management of residual morbidity, even after transmission of LF has been interrupted. As part of the validation dossier submitted to WHO for acknowledgement that LF has been eliminated as a public health problem, countries are required to submit data on the estimated number of LF cases (*11*).

2. Objectives and outcomes

During the 17 years since *Surgical approaches to the urogenital manifestations of lymphatic filariasis* was first published (*10*), there has been heightened awareness of the physical, economic and emotional burden of the genitourinary manifestations of filariasis. With the impetus to provide better guidance for care of those suffering from LF, this update was both warranted and timely.

The Committee consisted of experts from South Asia, Africa, the Americas and Caribbean, and further input was garnered from experts from the WHO Western Pacific Region. The Committee met over the course of 3 months to review the current status of surgical care for LF patients and to adhere to new global guidelines and recommendations for surgical care in LMICs for facilities, surgical site infection and other factors. These experts represented urological and surgical care, public health, and both public and private sector management. The list of participants is annexed to this report.

At the outset, the Committee noted that barriers continue to exist in care of patients affected by LF-associated morbidity. These barriers include lack of information for patients as well as for many healthcare providers, including general surgeons and others within health systems. As noted in the report of the first consultation (*10*), "likely reasons for the poor access of patients to this form of treatments" were:

- ignorance that they can be cured of their condition;
- fear of surgery and its potential complications;
- lack of facility or facility too far from patient's home; and
- cost of surgery, hospitalization and transport, and loss of wages during the perioperative period.

One reason why patients do not seek surgery is that they feel that hydroceles are a "quality of life" disease that is not life-threatening. Additionally, there are facility and surgeon factors that remain today, notably:

- Lack of awareness among some surgeons that LF hydroceles differ from idiopathic hydroceles and that they require specific training to manage the full range of complications, as well as variability of findings at surgery.
- Poor coordination among public health programmes, surgeons and hospitals.
- Lack of available time in the operating room or resources (oxygen, water, electricity, etc.) to care for patients in appropriate hospitals.

This update offers a new consensus of the Committee regarding the staging of hydroceles caused by LF, also known as "filariceles" (*12*). It recommends integrating LF surgery with other efforts to strengthen surgical care by assessing health facilities for their surgical readiness using the WHO surgical assessment tool or "SAT" (*13*). It also recommends integrating hernia surgery with hydrocele surgery and integrating standards for prevention of surgical site infection (SSI) (*14*).

The update revises recommendations for standard procedures and processes, offers an algorithm for diagnosis (including the use of ultrasound) and discusses postoperative care. It recommends collecting data using the staging and grading system described by Capuano and Capuano (*15*) along with other metrics for public health management of LF.

A multifaceted approach has therefore been recommended to coordinate public health outreach with national surgical planning and local health systems to include supporting partners such as nongovernmen-

tal organizations. Surgical camps with mobile teams, as well as training of personnel at DCP3 "first level" or WHO Level II hospitals (depending on region and resources), have important roles for reducing LF morbidity.

3. Epidemiology, and social and economic burdens of LF hydroceles

3.1 Epidemiology

In tropical regions, an estimated 25–27 million men suffer from filarial hydroceles (*1*). Locally in many communities, most adult men with LF develop symptomatic hydroceles (*16–22*). Hydroceles are also common in young men and have been identified in a large number of military recruits in northern Brazil (*22*). It has been found that population-based surveys and household surveys consistently underestimate the true prevalence of hydrocele and its resultant disability. Personal modesty, social stigmatization and shame often impede accurate reporting of hydroceles in household surveys. Because the clinical disease usually is evident only after puberty, and because the population is young, in many affected African countries spot mapping may produce imprecise estimates of the burden of LF disease. Clinical examination of patients is the most precise method for identifying hydroceles for the purpose of data collection and clinical care (*15, 22–25*).

An updated report from 2016 on the status of each endemic country reveals that many national programmes have met the established criteria for stopping MDA, including transmission assessment surveys (TAS), to validate the claim of elimination of LF as a public health problem. Success in stopping MDA has been documented in 20 endemic countries and in another 30 countries the intervention has been expanded to full scale. These successes in stopping transmission will still have a lag period for elimination of established morbidity. Expansion of national surgical plans for improved access to care is equally needed to enhance opportunities for care of LF patients and alleviate their suffering (*24–25*).

3.2 Economic burden

A number of studies have attempted to estimate the economic burden of LF. It is clear that the disease not only affects predominantly the world's poor, but it also perpetuates poverty (*21, 26*). The economic burden can be measured as direct disease-related costs to individuals and households, lost productivity of individuals, reduced productivity due to changes in the economies of affected communities, and costs to government-funded healthcare systems (*9*).

In 2000, more than 10 million people in India sought medical care for symptoms associated with LF (*21, 27*). However, the number of people who seek treatment varies from community to community depending on the availability of care and other factors (*28*). The economic loss due to disability from LF in India alone was estimated at US$ 1–1.5 billion annually in 2000; a further US$ 1 billion was attributable to LF in Africa. Some 83% of this total was contributed by hydrocele (*27–28*). Entire communities have had to adapt their economic structure, for example from fishing to agriculture on the eastern coast of Africa, because of the high prevalence of LF in the region (*29*). Even as national efforts to eliminate transmission of LF become increasingly effective, for some time in the future residual disability due to hydroceles will remain that will require surgical management. These persistent sequelae of hydroceles will continue to have a social and economic impact on individuals and communities. Therefore, it is critical that management of the morbidity associated with LF and other NTDs be considered when planning for development and surgical system strengthening (*30–31*).

3.3 Economic benefits of prevention: global elimination efforts

During the first eight years of MDA supported by the GPELF and made possible through generous donations by key pharmaceutical companies globally, more than 570 million individuals at risk for LF infection were treated for 4–6 years. The economic benefits have been measurable. More than 1.9 billion treatments were given in 48 endemic countries. It is estimated that this effort has yielded USD$ 21.8 billion in economic benefits for affected individuals and saved US$ 2.2 billion for health systems (*9, 28*). About 6.6 million newborns potentially were protected from developing 1.4 million symptomatic hydroceles attributable to LF later in life. Among those already affected by LF but with subclinical disease, MDA is expected to prevent progression of the disease.

In individual terms, the cost of preventing one case of hydrocele, acute dermatolymphangitis (ADL) or lymphoedema in India has been calculated to be US$ 8.41 with 58.35 working days saved annually, improved wages of US$ 39.39 and a treatment cost of US$ 1.44. The cost–benefit ratio has been calculated to be 52.6, which is among the most cost effective of any disease control programme (*31*). In another study, Stillwaggon and colleagues calculated that the "per-person savings are more than 130 times the per person cost of the program" for a community-based programme for lymphoedema and ADLA in Odisha State, India (*32*).

On average, patients with hydrocele spend US$ 2.90 per year in out-of-pocket expenses for non-surgical management of their chronic conditions (*30*). However, the number of operations is small. Therefore, the cost of the operation is not a significant component of patient expenditures when considered with the total population of patients with LF hydroceles.

In Ghana in 2013, the cost of a hydrocelectomy at a district hospital was US$ 200 (Mante SD, personal communication, 2010). The potential economic benefit of hydrocelectomy has not yet been calculated but may be similar to that of hernia surgery, scaled to the known number of cases of existing disease. Unfortunately, access to hydrocelectomy in LMICs is limited. The waiting lists for hydrocele repair in government-sponsored health programmes annually are huge in some African countries where the disease is endemic. The need for hydrocelectomy in these settings clearly exceeds the surgical capacity.

3.4 Social burden

The social burden of filarial hydroceles has been explored by Babu and colleagues in Orissa State, India (*17*). In their ethnographic study, the authors interviewed hydrocele patients, their wives and the general public to understand how hydroceles impact sexual activity and married life. Among these couples, a high rate of depression accompanied the loss of a satisfactory sexual life. An unmarried man with a hydrocele seeking a wife is seen as a last choice marriage prospect. Given the severity of the psychological impact on patients, Addiss has argued for an "uprising of compassion" for people disabled by LF (*19*). He has pointed out that as resolution WHA50.29 adopted in 1997 launched the GPELF to eliminate LF as a public health problem, it was charged not only to interrupt transmission of the disease but also to alleviate the disability related to filarial infection.

Accounts of men suffering from LF and its manifestations, including hydrocele, in Brazil, the Dominican Republic, Ghana, Haiti and India serve to highlight the very high human cost of these disabilities. These have largely not received the same international attention afforded to other disabilities such as obstetric fistula, yet they affect at least 15 times as many people (*18, 33–36*). The impact of hydroceles on communities also has been grossly underestimated, especially when the psychosocial impact of disfiguring hydroceles is considered (*36*). The preventive role of hydrocele surgery in averting the human and monetary costs of disability-adjusted life-years (DALYs) attributable to depression is potentially huge (*37*).

4. Filarial biology

The life cycle of *Wuchereria bancrofti* has been well-described. Humans are the definitive host, and mosquitoes contribute to transmitting the immature forms from host to host. Not all mosquitoes are able to serve as intermediate hosts, however. *Culex*, *Aedes* and *Anopheles* mosquitoes are able to carry the larval forms of the parasite. Responding to circadian cues, viviparous adult female worms produce thousands of microfilariae each evening, coinciding with peak mosquito activity. The microfilariae exit the lymphatic system via the thoracic duct in humans and into the venous drainage. Mosquitoes then ingest them during blood-feeding, and in the mosquitoes they undergo further larval development in three stages within the stomach and thoracic musculature before leaving the mosquito via the proboscis sheath during another blood meal approximately 14 days later. Contributing to the pathobiology of both *W. bancrofti* and *Brugia* spp. is the presence of the endosymbiont bacteria, *Wolbachia*, which is present at all life cycle stages of the parasitic worm. It is essential for larval development and for adult worm viability and fertility.

5. Anatomy

The urological manifestations of filariasis are extensive and include not only the male genital area but also the bladder and kidneys in some patients. Indeed, the most challenging manifestations of LF include fistulas between the lymphatic system and the urinary system around the kidney, causing leakage of lymphatic chylous fluid into the urine.

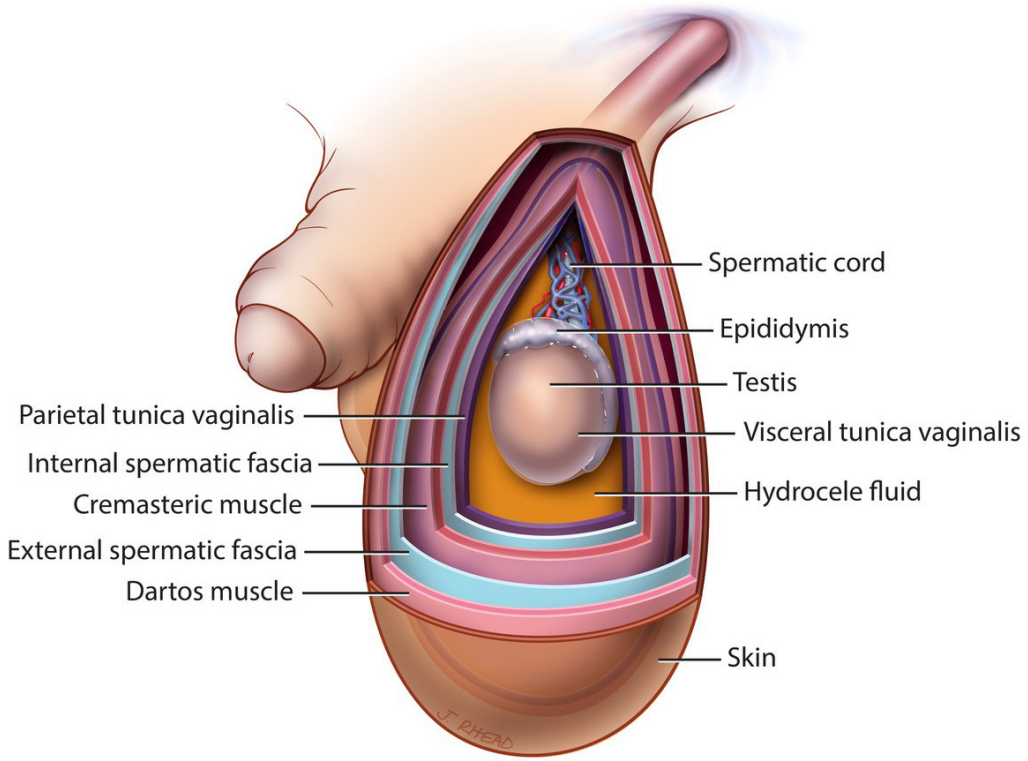
The principle mechanism of LF disease, common to all manifestations, is inflammation and dilation of the lymphatic vessels. Filarial worms of the species *W. bancrofti* have adapted over millennia so that individual worms may inhabit the lymphatic system of humans for many years without causing sufficient immune response to force rejection of the parasite. Although other filarial parasites such as *B. malayi* may also occupy the lymphatic system and are transmitted by mosquitoes, scrotal disease including hydroceles is most often caused by *W. bancrofti*.

For surgeons and others caring for people with genital disease due to LF, it is important to be mindful of pelvic and genital anatomy. Surgeons should not assume that healing will occur as it does in healthy patients, as LF patients are particularly at risk for wound infections and for poor healing.

5.1 Anatomy of the scrotum

The layers of the scrotum are (from outside in): the skin, dartos muscle, external spermatic fascia, cremasteric (middle spermatic fascia and cremasteric muscle), internal spermatic fascia, parietal tunica vaginalis and visceral tunica vaginalis (**Fig. 1**). Especially

Fig. 1. The layers of the scrotum



when inflamed or scarred, it might be difficult to differentiate these layers, but all surgeons should know what they are and be mindful of them. The anatomy has implications when infected, because infection commonly travels along planes. Anatomical planes are usually defined by fasciae and the embryological origin and migration patterns of tissue. The anterior (skin) wall of the scrotum is supplied by the external pudendal arteries and veins. They do not cross the midline raphe. The posterior (skin) wall of the scrotum is supplied by the posterior scrotal branches of the perineal arteries. The spermatic fascia and cremasteric muscles have their own (separate) arteries and veins – different from the skin. The vas and testicle also each have their own arterial dedicated arterial supply, but they also receive collateral arterial supply and venous drainage from the cremasteric vessels and from each other.

Veins draining the testicle form a pampiniform plexus that converges to a single external spermatic vein at approximately the internal ring. Dilation of the venous plexus is known as a varicocele, which can at times be confused with dilated lymphatics in LF on physical examination. The differential diagnosis can be made by ultrasound and also by physical examination with the patient standing and performing a Valsalva manoeuvre.

5.2 Scrotal lymphatics

There are no lymphatic vessels in the epidermis of the skin; however, just beneath the superficial dermis lies a rich network of lymphatic capillaries without valves. The capillaries of the superficial dermis drain into valved vessels of the deep dermis and subcutaneous tissues. The valves help to maintain the directional flow of lymph fluid towards the larger ducts. The scrotal lymphatics do not cross the midline of the scrotum or "median raphe". The lymphatics of all layers drain laterally to deep and superficial inguinal lymph nodes. Conversely, the lymphatics of the testicle and epididymis drain retroperitoneally along with the testicular veins. Lymphatic ducts drain to regional nodes and ultimately, via the cysterna chylae, to the thoracic duct and the left subclavian vein, and to the venous side of the heart. The lymphatics of the anterior scrotum drain to the superficial inguinal and subinguinal nodes, and the posterior scrotum also is drained by vessels from the perirectal system. A detailed description of the anatomy of the lymphatic system including embryology and variations pertinent to LF can be found in publications by Goel TC and Goel A (*38*) and others (*39–41*). The implications of lymph node anatomy for reconstructive surgery as well as descriptions of lympho-venous shunt procedures have been described by Manokaran (*42*).

5.3 Lymphatics of the testicle and vas deferens

The lymphatics draining the testicle and the vas deferens are entirely separate from those of the scrotum and the penis. The distinction is important because the management of hydroceles, chyloceles and abnormalities of the testis and tunica vaginalis differs from the management of lymphoedema of the scrotum and penis. Lymphatics draining from the testicle and vas deferens follow the arteries and (more closely) the veins pertaining to the testes and follow their embryonic path of descent. For the testicle, the arterial and venous flow originates near the vessels of the kidney; the vessels and lymphatics of the vas are associated with the hypogastric vessels. Conversely, the lymphatics from the penis and scrotum drain to lymph nodes of the groin (see section on lymphatic anatomy).

5.4 Penile lymphatics

The lymphatics of the penis, like those of the arteries and the veins, are characterized by main channels as well as a network of collaterals. These networks include both superficial and deep channels. The lymphatic networks of the glans penis coalesce at the frenulum, where they also communicate with lymphatics associated with the urethra. From this ventral position, they travel laterally and dorsally on the penis in collecting trunks that run beside the deep dor-

sal veins to the pre-symphyseal plexus, which then drains to the superficial lymph nodes. Collateral lymphatic trunks also travel under Buck's fascia to the deep inguinal nodes of the femoral triangle (*39–40*).

The lymphatics of the skin of the shaft of the penis drain from ventral to dorsal along with the lymphatics of the inner and outer surfaces of the prepuce. These main trunks run along the dorsal or "top" of the penis, and ultimately to the superficial inguinal nodes. The lymphatics of the glans penis drain to the groin, with the deep subinguinal nodes found medial to the femoral vein.

From the point of view of the surgeon, the lymphatics of the skin of the scrotum, penis, perineum and buttock as well as the abdominal wall below the umbilicus drain to the subinguinal nodes, consisting of a superficial and a deep group. Lymphatic capillaries and ducts do not cross the midline. Because the anterior scrotum and the posterior scrotum have different lymphatic drainage systems, it is often possible to reconstruct the scrotum taking account of the more intact posterior tissues.

5.5 Lymphatics of the pelvis and retroperitoneum

The surgeon may be confronted with more complex urological lymphatic manifestations of filariasis including chyluria due to leakage of the lymphatics of the upper or lower urinary tract into the urine stream. However, this publication restricts discussion to caring for the more common genital and scrotal disease. The publication *Lymphatic filariasis* provides a comprehensive discussion of chyluria and its management (*38*).

5.6 Innervation of the scrotum

As with the lymphatics and blood vessels, the nerves supplying the scrotal tissues have separate developmental origins from those supplying the spermatic cord. When performing surgery under local anaesthesia, it is therefore critical to anaesthetize not only the skin and deep layers of the scrotum but also the spermatic cord. The nerves of the testis and epididymis travel within the cord. Anteriorly and laterally the scrotal tissue is innervated by branches of the ileoinguinal and genitofemoral nerves. Posteriorly, it is innervated by the perineal branches of the pudendal nerves. Many surgeons assume that the midline scrotum is not well innervated. However, Yucel and Baskin (*43*) have found that the inter-scrotal septum is densely innervated, primarily by the pudendal nerves. Horizontal branches supplying the scrotum course laterally from the midline, particularly at the penoscrotal junction. It should be noted that surgery in the midline septum has potential to injure nerves on both sides of the scrotum leading to postoperative numbness. For this reason, surgeons should attempt to minimize trauma to the inter-scrotal septum during surgery.

6. Female genital manifestations of LF

Hydroceles in women are exceedingly rare. They are most commonly caused by congenital failure of closure of the canal of Nuck, rather than LF. However, swelling of the vulva is not unusual and results from lymphoedema caused by pathological involvement of inguinal and pelvic lymphatics.

7. Identifying and staging of hydroceles due to LF

At hospitals where patients with genitourinary manifestations of LF are seen, urological specialists are rarely found. Scrotal swelling is often initially evaluated by health workers without medical degrees. Yet trained health workers can be vital members of the surgical team and detection of hydroceles by trained workers correlates well with those identified by physicians. Initial identification of both scrotal swellings by non-physician health workers has been through a valid rapid assessment procedure (*4*). Identifying the prevalence of scrotal swelling in communities with endemic LF and mapping them with MDA can help to demonstrate success in addressing the two aims of LF elimination: interrupting transmission and managing genital and other morbidity. Additional confirmation of the cause of scrotal swelling must be made by clinicians with advanced training, because other conditions such as testicular tumour, epididymitis or lymphoedema of the scrotum can be mistaken for hydroceles due to LF. Finally, confirmatory examination by the operating surgeon is essential before the patient is brought to the operating theatre and before surgery is undertaken.

7.1 Spectrum of genital manifestations of LF

Lymphatic filariasis affects the genitourinary system widely, and although the most obvious manifestation may be a "simple" hydrocele in men, the hydrocele is but a symptom of more profound damage to the lymphatics of the spermatic cord, the scrotum and often the pelvic plexus. The most common manifestation of LF – the hydrocele – is an enlargement of the tunica vaginalis sac around the testis due to an increase in the volume of the fluid it contains. Hydroceles are caused by an imbalance of fluid secreted and absorbed by the tunica vaginalis and its supporting lymphatics. The sac that surrounds the testicle – the tunica vaginalis – normally secretes a small volume of fluid that is resorbed and lubricates the testis and limited motion within the sac. With local inflammation, and especially with both inflammation and damage to the lymphatic drainage system, the balance is impaired, and fluid accumulates and expands within the sac. Because hydroceles in endemic regions are most often caused by filarial infection, they are also called "filariceles" (*12*). Over time, hydroceles may enlarge due to a combination of additional factors: (i) filarial infection may damage proximal lymph nodes and vessels, as well as the valves of the vessels, causing reflux of lymphatic fluid into the tunica vaginalis; (ii) lymphatic vessels may become "leaky", causing both clear and chylous fluid to fill the sac; and (iii) gravity, and a lack of skeletal elements such as fascia, allow the scrotum to stretch when patients are in the upright position. When the tunica vaginalis becomes thickened and loses its ability to "manage" fluid balance, it is not unusual for it to fill with milky chylous fluid (chylocele), blood (haematocele), or a muddy mixture of chylous fluid, old blood and sloughed tissue. In these cases, it is also common to find that the testicle has atrophied. The tunica vaginalis may also become calcified in places, due to chronic inflammation and, sometimes, dead filarial parasites.

When the lymphatics of the dermal layer of the scrotal skin are badly damaged, the skin thickens and is prone to bacterial and fungal infection. Surgery itself can also damage lymphatics. Great care must be taken during preoperative preparation, surgical planning and postoperative management to prevent such complications. This condition, known as scrotal elephantiasis, is described further below. When the surface of the skin begins to drip with leaking lymphatic fluid, it is called "lymph scrotum" (see *section 7.3.7*).

7.2 Staging and grading of hydroceles

For many years, hydroceles secondary to LF were described in terms of objects, such as "size of a tennis ball", "size of a grapefruit", etc. In order to improve communications, to facilitate data collection and to correlate clinical pathology with public health measures of disease burden, Capuano and Capuano proposed a staging (**Fig. 2**) and grading (**Fig. 3**) system that has been adopted by many who care for patients with LF (*15*). This system is proposed for general adoption by the Committee. It allows the development of standard operating procedures to guide the management of hydroceles based on stage and grade. Further advantages to the staging and grading system include the opportunity for consensus on research and for improving surgical technique based on defined parameters. The system allows researchers and practitioners to report on outcomes based on a standardized terminology. In the Capuano and Capuano system, the stage of a filarial hydrocele or "filaricele" relates to the size of the scrotum itself, whereas the grade describes the relationship of the hydrocele to the penis. In Grade 0, there is distinct separation of the intact penis from the hydrocele, whereas in Grade *4* the penis is totally buried within the enlarged scrotum (**Table 1**).

Table 1. Stage and grade of LF hydrocele based on Capuano and Capuano (*15*)

Type of hydrocele	Single	Bilateral
Side of hydrocele	Right	Left
Stage of hydrocele	I	Less than tennis ball (160 mL)
	II	Larger than stage I. Lower pole does not extend below mid-thigh
	III	Lower pole extends below mid-thigh but not below upper edge of patella
	IV	Lower pole extends below patella and not below the tibial tuberosity
	V	Lower pole extends below the tibial tuberosity but not below mid leg
	VI	Lower pole extends below mid leg
Grade of hydrocele	0	No visible burial of penis, no shortening of penis
	I	Partial burial of penis with visible length at least 2 cm
	2	Partial burial of penis with visible length at less than 2 cm
	3	Total burial of penis with glans or prepuce visible
	4	Total burial of penis with stretched skin of prepuce causing problems with urination

Fig. 2. Staging of LF hydroceles as described by Capuano and Capuano (*15*)

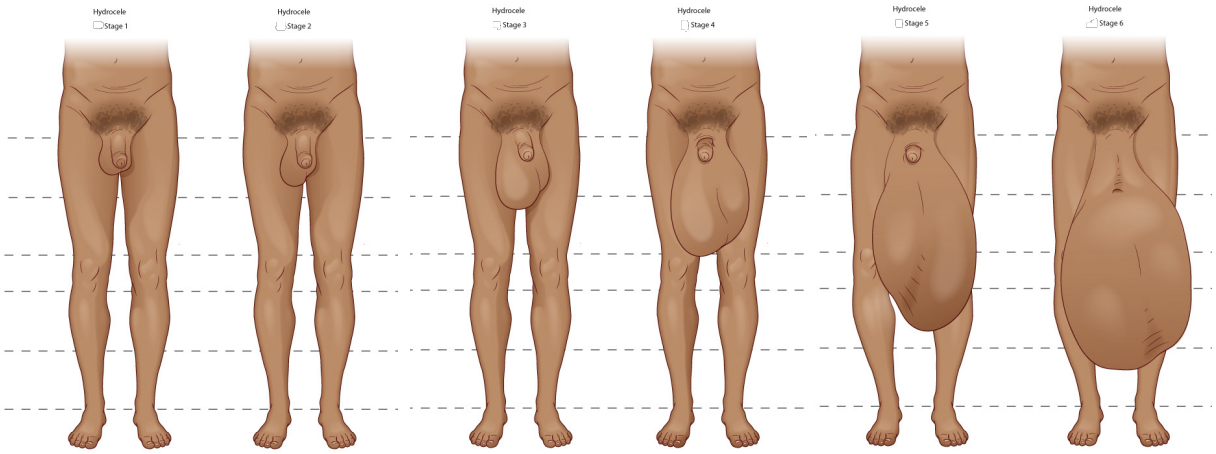
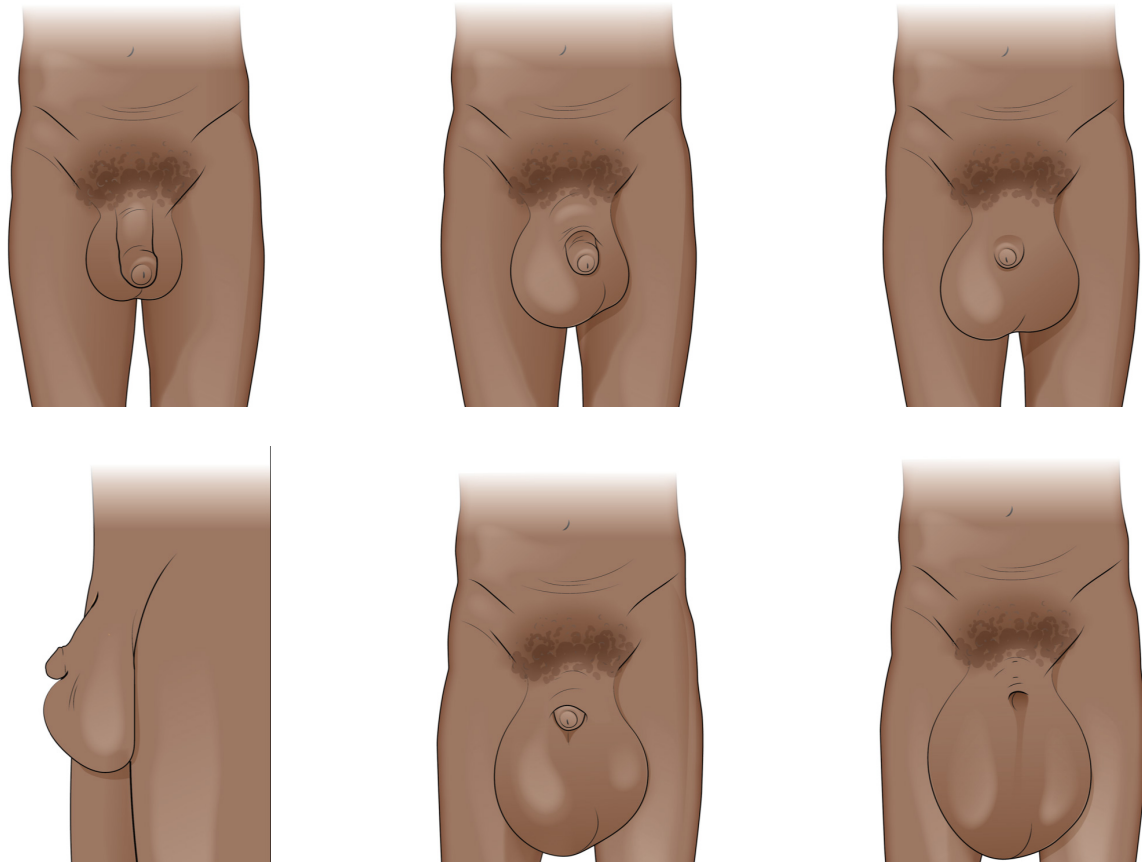


Fig. 3. Grading of LF hydroceles as described by Capuano and Capuano (*15*)



7.3 Other scrotal and testicular pathology

Ideally, preoperative ultrasound will have identified any potential pathology of the testicle such as atrophy or testicular tumour. Other findings, listed below, may be identified either preoperatively or during surgery. It is important to emphasize the need for proper diagnosis, especially differentiating hydrocele from a hernia or cyst. Four clinical signs are extremely useful:

1. A hydrocele mass usually has a palpable superior pole whereas a hernia has no superior pole.
2. There is usually a palpable tension or "resistance" of the hydrocele mass whereas a hernia is usually more mobile and soft and decreases in size when a person is supine.
3. An epididymal or cord cyst has both superior and inferior poles that are distinct from the palpable testicle.
4. A testicular tumour is usually hard, whereas a cyst, hydrocele or hernia is usually soft. (Sometimes, however, a tumour will also have a hydrocele around it, in which case it might not be possible to differentiate it by physical examination alone.)

7.3.1 Testicular tumour

If testicular tumours are identified at an early stage, surgery can be life-saving. The problem in low resource settings is that even if identified, carcinomas of the testis may require diagnostic and therapeutic modalities that are not available. After identifying a testicular tumour, the clinician should have a detailed consultation with the patient. If possible, the patient should be referred to a Level III hospital. During surgery, an inguinal approach rather than a scrotal approach to orchiectomy (radical orchiectomy) should be done. A testicular tumour may be accompanied by a hydrocele, especially in a young man. The surgeon must maintain a high index of suspicion when examining the patient. **Table 2** identifies features from the history and physical examination to help distinguish the two preoperatively. Testicular ultrasound is a great help in diagnosis of testicular tumours.

7.3.2 Groin hernia

A hernia can most often be diagnosed pre-operatively, but it may also occur on the same side or contralaterally to a hydrocele. Surgeons should be prepared

Table 2. Distinguishing features of hydroceles and testicular tumours

	Hydrocele	Tumour
History	Gradual, painless scrotal rather than testicular swelling. No history of trauma.	Painless or mildly painful testicular lump most commonly seen in adolescents or young men. Patient may first notice it after mild trauma.
Examination	Scrotum is translucent, smooth, non-tender; usually can be transilluminated.	Testis is heavy and firm. May have associated inflammation and erythema of the skin or reactive hydrocele.
Ultrasound	Clear fluid (except with chylocele or haematocele). Normal testicle – but note atrophic, calcific testis in cases of haematocele/chylocele. Atrophic testis will usually not have any areas of normal testis identifiable.	Usually heterogeneous enlarged mass within the normally homogeneous testis. When large, may affect the entire testis.

to repair inguinal/groin hernias using tension-free techniques in order to minimize recurrence. Mesh repairs are becoming more available even in low resource settings. They are preferred because of the high rate of recurrence with Bassini, Shouldice and McVay procedures, which range between 10–30%. The Lichtenstein (mesh) technique has a recurrence rate of 2–3%, similar to that of the Desarda technique which uses the undetached external oblique aponeurosis (*44–45*). Hydrocelectomies and herniorrhaphies have been recommended as essential procedures for DCP3 "first level" or WHO Level II hospitals (*4*).

7.3.3 Varicocele

Varicoceles are common worldwide and are due to stasis from incompetent valves of the left spermatic vein. They appear as a "bag of worms" when a patient is standing, and especially when bearing down with abdominal pressure. They are rarely uncomfortable, and present problems mainly when associated with infertility. In rare cases, varicoceles may be addressed surgically, but they require surgical expertise, magnification and fine sutures, which are rarely available in Level II hospitals. Bilateral varicoceles can be an indication of abdominal or retroperitoneal malignancy and should be investigated further.

7.3.4 Lymph varix (lymphangiovarix)

The testicular cord is a site preferred by filarial worms, and nests of male and female worms often develop in the lymphatic vessels of the cord where they cause dilation which can be confused with varicoceles. Like varicoceles, lymph varices dilate throughout the day and especially with increased abdominal pressure during the valsalva manoeuvre. Unlike varicoceles, they are not more common on the left side. Given the interconnectedness of the network of lymphatic vessels, excision may lead to chronic leakage and a lymphatic fistula. It has been recommended by some that symptomatic lymph varices be managed by nodovenous shunt (*41–42*), but this is a specialized procedure best done by experts in lymphology.

7.3.5 Epididymal cyst

Small epididymal cysts can be managed conservatively without surgery. However, occasionally, they are large and uncomfortable. Epididymal cysts should not be removed by surgeons unfamiliar with the anatomy of the epididymis. On the other hand, patients may choose this option when family planning options have been discussed and the patient understands the potential risk to fertility. In this case, removal of the epididymal cyst should be combined with bilateral vasectomy.

7.3.6 Adrenal rest

Adrenal rests are remnants of embryonic development that are not detectable preoperatively and are only seen during surgery. They are not medically significant and do not need removal. Typically, adrenal rests are golden and thus readily identified by their colour and location along the spermatic cord.

7.3.7 Lymph scrotum

Lymph scrotum is a devastating condition associated with lymphatic filariasis. It is recognized by thickening of the scrotal skin, with rupturing superficial lymphatic vesicles and draining lymph fluid. While filariasis is the commonest cause in endemic areas, lymph scrotum is not pathognomonic for LF. Other diseases of the lymphatic vessels can also rarely cause lymph scrotum.

Bacterial infection causing acute attacks of dermatolymphangioadenitis (ADLA) appears to be the greatest risk factor for development of lymph scrotum. Furthermore, continuous leakage of lymph causes moisture that can predispose patients to fungal infection associated with bacterial skin infection. Lymph scrotum often is seen with chylous drainage, which is an indicator of systemic lymphatic pathology. Chylous lymph indicates failure of lymphatic valves and/or fistulas, and reflux of fatty lymph fluid from more proximal lymphatics. For this reason, patients may

also experience leakage into other areas of the pelvis or scrotum in the form of chyluria, lymph varix and/or chyloceles. The skin of the penis may also be involved, but the vesicles usually spare the glans.

Medical management and surgery for lymph scrotum is best done at Level III hospitals where surgeons experienced with reconstructive scrotal surgery can be found. However, in LMICs, these specialists may not even be available regionally. Telemedicine provides an opportunity for evaluation by experts from around the world and guidance for management and operative planning. A network of reconstructive experts is associated with international urological organizations such as the Societé Internationale d'Urologie (https://www.siu-urology.org/) as well as regional surgical societies. Even in remote locations where the Internet is unreliable, this network can be accessed using affordable technology and mobile applications such as WhatsApp Messenger (WhatsApp Inc., Mountain View, California, USA).

Since the tissue pathology associated with lymph scrotum is often irreversible, management of lymph scrotum is similar to that of lymphoedema management of the extremities, namely hygiene and skin and wound care. This management includes addressing localized bacterial or fungal infection and inflammation as well as the clinical hypovolaemia from significant fluid losses. Antibiotics including penicillin and doxycycline have been recommended for treatment of flare-ups and before reconstructive surgery for lymph scrotum. While reducing long-chain fatty acids in the diet can reduce the quantity of chyle in lymphatic fluid, and is frequently recommended for chylous fistulas, this diet is rarely available in LICs. In many settings surgical management of lymph scrotum may not be available or accessible to patients. In such cases, medical management of lymph scrotum should be advised. Dreyer and colleagues detail information about the medical management of lymphoedema of the penis or scrotum and lymph scrotum (*46*). In brief, individuals with lymphoedema of the penis, scrotum, or those with lymph scrotum, should be advised to wash and carefully dry their penis, scrotum and areas around the scrotum daily with clean water and soap. Furthermore, any portals of entry should be treated with antibacterial cream after washing and drying the area. For patients with recurrent ADLA episodes, prophylactic antibiotics may be prescribed in accordance with local antibiotic protocols.

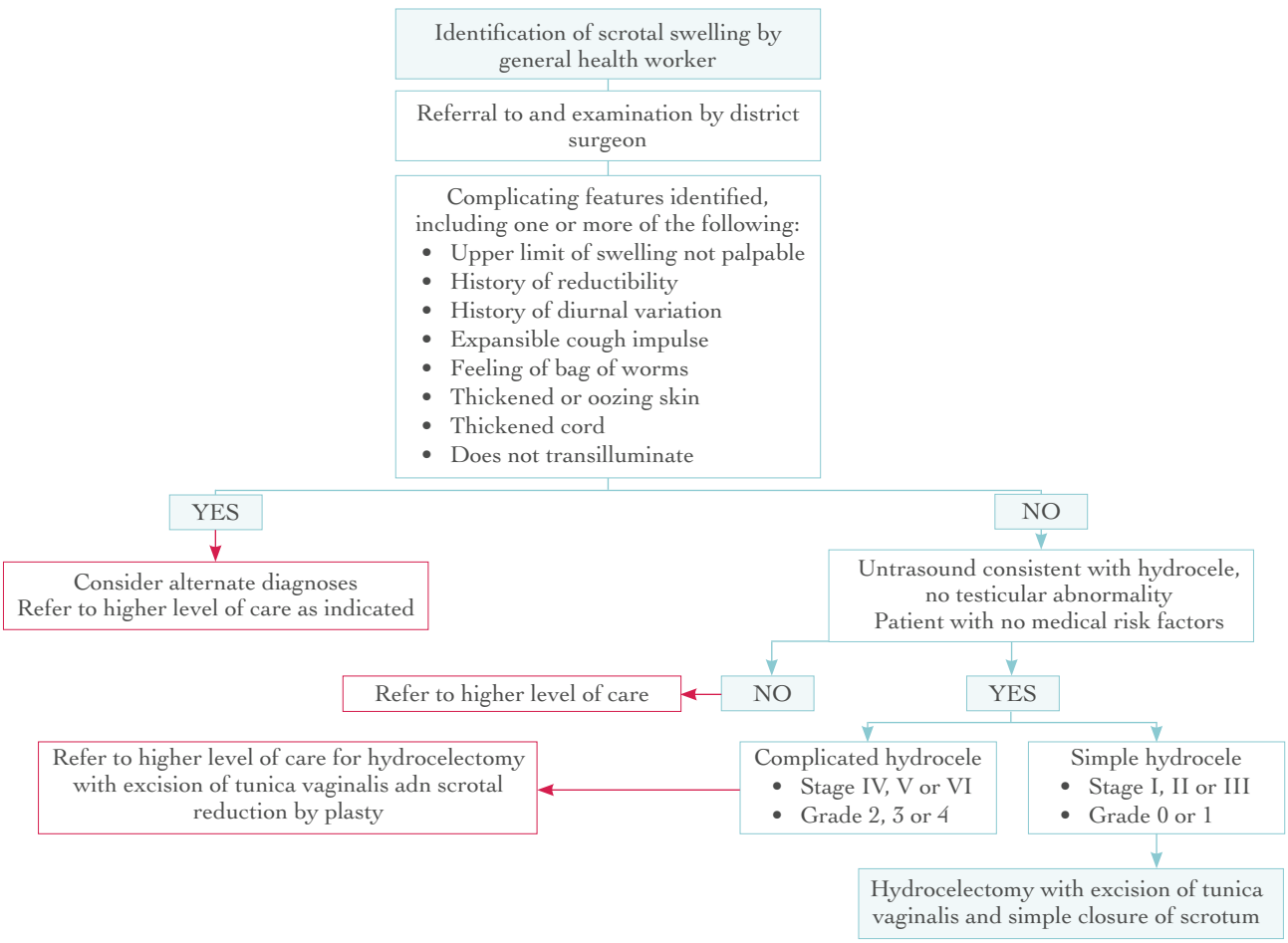
It is recommended that after treatment for localized infection and optimization of the patient's metabolic status, patients be referred to specialist hospitals. Expert opinion from reconstructive surgeons on this Committee suggests that the affected skin and subcutaneous tissue be excised, with full-thickness skin grafting for the penis and either partial thickness grafting for the scrotum or posterior-based skin flaps, relying on the peri-rectal lymphatic system for blood supply and lymphatic drainage.

8. Algorithm for surgical planning

An algorithm for management of scrotal swellings was proposed in the 2002 edition of *Surgical approaches to the urogenital manifestations of lymphatic filariasis* (*10*). Technology has improved since then, and ultrasound is becoming more widely available, particularly at Level II hospitals, and with specialized surgical camps. The algorithm takes these advances into account (**Fig. 4**). The Committee also acknowledges that other pathology such as hernia may accompany hydroceles and should be addressed at the same time when discovered during the operation or before.

With ultrasound and a good physical examination, it should be possible to confirm Stage I–II hydroceles, to identify testicular and scrotal pathology such as spermatoceles and tumours and to identify hernias. It is recognized that transillumination may not be sufficient to rule in or out other scrotal pathology. Therefore, ultrasound is recommended as the preferred diagnostic modality. The Committee also recognizes that Stage III hydroceles may also be successfully operated at Level I or II hospitals depending on the experience level of the surgical staff.

Fig 4. Algorithm for management of scrotal swelling, adapted from (*10*)



9. Site of care

9.1 Levels of hospital care

Because *W. bancrofti*, affects people in many regions of the world, the type, level and capacity of facilities available to provide care varies widely. Filariasis predominantly affects the rural poor, and the availability of surgical facilities is often scarce.

The Committee considered historical and contemporary recommendations for types of facilities that can provide care for patients with LF hydroceles. Hospitals are categorized by types of capacity that they may be expected to provide. The WHO definition of levels of facility from 2002 varies significantly from the DCP3 definition and expectation of capacity. In the first (2002) edition (*10*) the following classification was proposed for levels of hospital care:

- **Level I** is the community level, where patients with scrotal swellings are detected. The community health care worker or the patient himself detects the swelling. Once a scrotal swelling is identified, the patient is referred, or reported, to a level II facility.
- **Level II** is where surgery for uncomplicated hydroceles can be performed. Depending on the country, this could be a health centre or a rural/community hospital. Level II health facilities should include a room in which minor surgical procedures can be performed under local anaesthesia. They need to be equipped to perform basic resuscitation, and to have facilities for observation of patients for 24–48 hours if required. A general physician, trained to perform surgery on patients with simple hydrocele, should be available.
- **Level III** is equivalent to the district hospital level, and is where patients with more serious problems or complicated hydroceles can be referred for surgery.

In this edition, the definition of level of care has since been updated to align with the standardized definitions as described in DCP3. The first volume of DCP3 (*Essential surgery*) focused on "First Level Hospitals" in LMICs specifically with respect to surgical care (*48*) and recommended a different standard and nomenclature. In DCP3 terminology, a "First Level Hospital" would be roughly equivalent to a WHO Level II hospital except that there is now a higher expectation of safety measures and facilities with capacity for surgery.

Regional differences in classification of hospitals and resources within those hospitals vary greatly. Therefore, the Committee reviewed recommendations for site of care for patients with LF, recognizing that the "level of care and facility type" will be impacted by the country and region where care is provided. For example, in sub-Saharan Africa, DCP3 "First Level Hospitals" are often staffed by non-physician clinicians, recent medical school graduates or general practitioners. These practitioners may perform major surgery but may have limited training and experience in specific diseases.

Conversely, in South Asia, "First Level Hospitals" often have specialist physicians on staff and serve larger populations. Surgical specialists are commonly available, and non-physicians rarely perform surgery. In Latin America and the Caribbean, DCP3 "First Level Hospitals" tend to be smaller and serve a smaller population size, but they are typically staffed by at least one surgeon and an obstetrician. Non-physicians do not perform major surgery at these hospitals.

The DCP3 recommended that both hernia and hydrocele surgery be offered at first level hospitals. It is clear that currently in Sub-Saharan Africa, herniorrhaphy and hydrocelectomy are among the most common operations done at "First Level" hospitals, accounting for up to one third of non-emergency operations (*48–49*).

Table 3. Classification of levels of care, adapted from (48)

Level of care	Alternative terms
First Level Hospital Basic care, including internal medicine, pediatrics, obstetrics and gynecology, surgery Staff: General practitioner or non-physician practitioner Limited laboratory capacity 50–250 beds	Primary level hospital District hospital Rural hospital Community hospital General hospital
Second Level Hospital More specialized services including surgeons, anaesthetists and other clinical specialties 200–800 beds	Regional hospital Provincial hospital General hospital
Third Level Hospital Specialized staff and technical equipment, laboratories and teaching facilities 300–1500 beds	National hospital Central hospital Academic or teaching university hospital

Both the 2002 and the 2017 Committees reviewing *Surgical approaches to the urogenital manifestations of lymphatic filariasis* (*10*) recommend that hydrocele surgery be done at a facility where surgery for uncomplicated hydroceles can be performed. The recommendation in 2002 was that the facility should include "a room in which minor surgical procedures can be performed under local anaesthesia."

The current (2017) Committee revised this statement to align with current WHO recommendations for essential surgery as follows:

Surgery should be done in a proper operating room rather than a minor procedure room. The room should be fitted with oxygen, good lighting, suction, patient monitoring equipment (at a minimum, pulse oxymetry) and resuscitation medications and equipment. An electrocautery machine is highly recommended.

Frequently, what appears at preoperative examination to be an uncomplicated hydrocele will turn out to be more complicated during the course of surgery – especially if preoperative ultrasound is not available for differential diagnosis. Therefore, it is wise to have the necessary resources to manage all eventualities safely. Patients should be observed in hospital for at least 2 days after surgery and until the first dressing change, especially if they live at a great distance from the hospital and do not have running water, soap or toileting facilities or vehicular transportation. It is not recommended that outpatient surgery be done where these socioeconomic and environmental concerns are present. Moreover, a clinician trained to recognize and perform surgery on a wide spectrum of scrotal and inguinal pathology should be in attendance because it is common to encounter inguinal hernias during surgery for large hydroceles. If testicular pathology is encountered, surgeons should be ready to manage it.

It has also been pointed out that in some regions, patients do not present to the surgeon for care when hydroceles are small but wait until they become significantly large and symptomatic; in other regions, patients are seen more often with lower stages of hydrocele. Patients may not seek care from the health system for LF hydroceles for many reasons including shame and cultural belief. Hence it is important to pursue proactive identification of cases in regions where LF is endemic and to refer patients to an experienced clinician to confirm diagnosis. For lower stages of hydrocele – Stage I–II (and possibly Stage III) – the Committee considered it appropriate for surgery to be done at DCP3 "First Level" hospitals as defined by the facility resources and personnel. This is particularly relevant where access to referral hospitals is poor.

Since hydroceles are not life-threatening, many local clinicians consider hydroceles to be a low public health priority. Both hospitals and doctors often defer care until outreach programmes come, and then they plan to do a larger number of operations. With improved resources and advocacy, it is hoped that patients with hydroceles will receive a higher priority of care in order to relieve their current suffering and to prevent progression of the disease.

9.2 SAT analysis

The WHO Surgical Asssessment Tool (SAT) is designed to assist facilities in gap analysis and in planning for safety and care of surgical patients (*13*). With regard to hydrocele surgery for LF patients, it is recommended that surgery be done in facilities with sufficient resources to ensure safety and to prevent SSIs. Additionally, the SAT addresses the criteria for assessing the quality and readiness of the health system to provide the recommended basic package of care for LF patients required to be documented in the LF elimination Dossier (*11*).

9.3 Surgical camps and mobile teams

Specialized surgical platforms, such as surgical camps, mobile teams and specialist hospitals also play a role in surgery for hydroceles. Surgical camps can play a role in strengthening local care for patients with LF, particularly when considered for outreach and training. Such camps can also bring specialists to teach local surgical teams, and can bring other resources such as suture material, medications and consumables, which are often in limited supply in rural hospitals. Engagement with experts can be energizing for rural surgeons and can also provide recurrent review of surgical process (*50–52*). Special care should be taken to ensure that SSI recommendations are followed in surgical camps and that logistical arrangements are in place to ensure patient transport and that patients can be admitted for at least 72 hours. **Table 4** highlights the advantages and disadvantages of camps and mobile teams.

Table 4. Advantages and disadvantages of surgical camps and mobile teams

Advantages	Disadvantages
Cohort of clinicians and staff that can work together on the disease and perioperative care	Less privacy
Classes in surgical preoperative, perioperative and postoperative care benefit patients and hospital staff Social connectedness among patients	Can overwhelm hospital staff Potential longer wait for surgery until availability of next surgical camp or outreach
Greater expertise on surgery/anaesthesia can be brought in to manage a greater range of cases	Camps and mobile surgical teams may not build local surgical capacity
Coordination with LF public health mass drug administration	
Easier payment schemes for hospitals and doctors, when covered by nongovernmental organizations	
Planning for adequate consumables and time in the operating room	
Potential to build local surgical capacity by training in multiple cases in limited time	

10. Surgical system

To ensure safety and high-quality outcomes of surgery for both patients and staff, a surgical system should have certain equipment and processes in place. This includes a process for maintenance and cleaning of facilities and equipment, a process for in-service staff training, a process for acquisition and disposal of medications and supplies, and a process for identification of patients/site of treatment. Although it is not the remit of this Committee to go into detail about each of these processes, it has been noted that outcomes of surgery in LMICs, even when performed according to technical standards of high-income countries (HICs), have been poorer than in HICs. Therefore, the Committee recommends standards and practices that can reasonably be achieved for surgery in LICs to improve outcomes for hydrocele surgery.

10.1 Facility inventory and process

10.1.1 Wards

Hospitals should have the ability to house patients on site for up to 72 hours after surgery. Prior to surgery, patients should have toileting and bathing facilities for preoperative preparation. They should bathe with soap and water, with particular attention to the genital area on both the evening before surgery and on the day of surgery. Hand washing stations should be available in wards for patients to wash frequently during their hospital stay. In West African settings, hospitalization for 5 days has been practiced to allow for preoperative investigations as well as aseptic dressing changes on days 3, 5 and 7 (*50*). However, usually, resources do not allow for such a lengthy hospital stay, and so patients are often discharged on day 3. In India, Stage I hydroceles are usually surgically managed as outpatients. The decision to admit can be decided based on the surgeon's experience and the patient's wishes.

Wards should have sufficient lighting for night-time examination of dressings and wounds. Nurses should have the ability to communicate with physicians by telephone. Regular records should be maintained by nursing staff for each patient.

Wards should also have sufficient medication and supplies, including alcohol, antiseptic liquid, soap, gloves and dressing materials, for hydrocele surgery. Toileting and washing facilities for staff should be separate from those for patients, for public health reasons. As with all hospital facilities, the flow of contaminated materials including supplies should be one-way, towards disposal, and not be stored near clean materials.

10.1.2 Pharmacy and supplies

It is not uncommon in some countries for patients to be required to pre-purchase medications and supplies before their planned surgery. In other countries, pharmacies are available within the hospital to provide medication for patients. Supplies may be available through a central purchasing process. Hydrocele surgery requires compressive dressings that may not be available in all DCP3 "first level" and some "Level II" hospitals. When hydrocele surgery is planned, rolls of elastic gauze should be ordered and be on hand because of the higher risk of complications such as haematoma if compressive dressings are not applied (*50*). If patients are required to pre-purchase supplies, they should be given a list of necessities and reliable sources. Otherwise, pharmacy and supply supervisors should be advised of the required medications and materials in sufficient time in advance of surgery. A hydrocele surgery procurement calculator (the MMDP FASTT procurement calculator) is available online (http://mmdpproject.org/resources/lymphatic-filariasis) and in the preoperative checklists (*Annex 1*).

10.2 Preparation

The operating room should have been cleaned according to WHO protocol before each surgical case. Instruments should have been cleaned, sterilized and ready, as should have all anticipated supplies (53–55).

10.3 Operating theatre/room

The operating room should have ample light not only for the anticipated superficial scrotal surgery, but also for deeper surgery should it become necessary. For this reason, an overhead light is necessary as well as a power back-up system that runs on a generator (with sufficient fuel) or battery as well as sufficient ambient light for nursing and anaesthesia.

Whether the surgery is done entirely with local anaesthetic or with regional or general anaesthesia, monitoring support must be available and utilized. This means that pulse oximeters should be used to document sufficient oxygenation, respiration and heart rate. If patients have been given preoperative medication and sedatives, this is particularly important. Further monitoring of heart rate is encouraged. Sufficient capability for anaesthesia should be available to convert from planned local to general anaesthesia if necessary, including staffing, equipment and medications. Oxygen tanks and suction systems should be available and be full and functional to assure safety of the airway.

10.4 Anaesthesia

While local anaesthesia is preferable in most cases, regional (spinal) or general anaesthesia can be given. A spermatic cord block as well as good local anaesthesia of the scrotal skin is important to achieve sufficient comfort for the patient during surgery (see *section 5.6*). In all situations, patients should have an intravenous line placed in order to provide intravenous fluids and medications as necessary during surgery, even for local anaesthesia, as hydrocele surgery can be painful, and it is important to be able to adjust medication as necessary. A trained anaesthesia provider should be available during all surgeries. Even if awake, patients will often be dehydrated after being NPO (nil per os) overnight and may need fluids during surgery. In LF hydrocele surgery, it is not unusual to discover during the operation that the pathology is more complicated than anticipated, requiring greater sedation, pain medication or anaesthetic. For this reason, even for cases that are expected to be simple, it is wise to have back-up human and medical resources available. Detailed instruction on administering local anaesthetic for hydrocele surgery is offered in the MMDP FASTT packet (*51*).

10.5 Equipment

The Committee recommends use of a monopolar electrocautery machine with functioning cut and coagulation settings, along with grounding pads, gel and sterile wand and blade tips wherever possible. Surgeons should expect that the scrotum and tunica vaginalis will bleed, often profusely, and haematoma is a common complication if meticulous haemostasis is not achieved. Electrocautery does not substitute for the need for good surgical technique, as lock-stitching and suture ligature of vessels and tissue edges is recommended even when cautery is available. Cautery, however, adds security and, additionally, helps to seal lymphatic vessels.

10.6 Surgical instruments, supplies and medication

The instruments required for uncomplicated hydrocele surgery are essentially the same as those required for hernia or other similar cases. It is wise to have more instruments than anticipated in case an instrument becomes contaminated or the operation has unexpected developments. The anaesthesia kit should include appropriate medications and supplies for spinal anaesthesia, general anaesthesia and resuscitation. In cases where bilateral hydroceles or hernias are present, a spinal anaesthetic is often more appropriate than a local block. A procurement calculator has been developed by the MMDP to assist the surgical team in planning for hydrocele and hernia surgery (http://mmdpproject.org/resources/lymphatic-filariasis).

11. Team process

Team process refers to routine activities engaged in by the entire surgical team, including the surgeon(s), anaesthetist, nursing staff and support staff. It is designed not only for patient safety but also for the safety of the surgical team. Many studies have demonstrated the utility and wisdom of "time out" and preoperative surgical checklists. Care of surgical instruments is the responsibility of surgeons, nursing staff and support staff, and proper disposal of surgical and anaesthetic waste ensures the safety of the entire hospital team.

11.1 Time-out and surgical safety checklist

The WHO Surgical Safety Checklist resulted from WHO's Second global patient safety challenge: *safe surgery saves lives* (2009). This tool has become standard in operating theatres around the world (*56–57*) (**Fig. 5**).

Fig. 5. WHO Surgical Safety Checklist

11.2 Care of surgical instruments

Cleaning, disinfecting and sterilizing instruments and supplies for use in surgical procedures has been studied for best practices and with consideration for the many pathogens that can tolerate even extreme conditions. The risks to patients and to staff of bloodborne infections is well-known. Yet, in low-resource settings, sterile processing of surgical instruments and equipment is often not standardized, or standards are not adhered to. The WHO 2009 Surgical Safety Checklist requires confirmation of instrument sterility before surgery (*56–57*). However, sterility may be difficult to confirm in LICs due to a lack of sterility indicators. The 2016 WHO manual for decontamination and reprocessing of medical devices provides a template for how to proceed. Several studies researching quality-assured sterile processing in LICs have found a worrisome lack of training in proper care of instruments at Level I and II hospitals that have been evaluated in sub-Saharan Africa (*53–54*).

Processing of instruments requires three steps:

1. Cleaning
2. Decontamination
3. Sterilization.

The first two steps can eliminate 99% of microorganisms; however, without proper cleaning, blood and other contaminants can become baked onto instruments during steam processing, providing protection for the microorganisms to survive. Processes include training workers, providing appropriate personal protective equipment (PPE), separating decontamination areas from sterilization areas and separating workflow from dirty to clean; restricting entry to sterilizing area; and ensuring access to clean water supply and electricity.

An almost universal practice that is actually **not** recommended is using bleach solutions to clean or decontaminate instruments. This practice damages instruments and does not eliminate the need for further cleaning and sterilization. Enzymatic detergent, rust remover and instrument lubricant "milk" are advised in all facilities that provide surgical care. Both autoclave (steam) and dry heat sterilizers can be appropriate, provided that they achieve the proper temperature and pressure for the proper amount of time.

11.3 Waste disposal

Both sharps and other disposable surgical supplies should be counted during and after surgery, and the counts confirmed with the number of packages opened. Additionally, sharps such as needles and blades must be disposed of in specialized boxes. Most other surgical waste can be incinerated; however contaminated "red bag" waste poses special risk and should be disposed of according to infectious disease protocols.

12. Preoperative, operative and postoperative considerations

12.1 Preoperative evaluation

Patients suffering from LF hydroceles often suffer also from a low socioeconomic status and consequently are at risk for poor nutritional status and concurrent disease including parasitic diseases (malaria, intestinal parasites). Additionally, they may experience depression, which can impact the immune system and healing. Therefore, individuals should have a comprehensive preoperative work-up including their general physical condition, economic condition, social conditions, psychological condition and the surgical problem for which they have presented.

Laboratory assessment should include haemoglobin to assess for anaemia, urine for glucose, and, in some settings, HIV screening. It is common practice in some settings also to test patients for LF, especially if they have not received treatment through public health outreach previously. (Other tests such as serum urea and creatinine, screening for bleeding disorders, including bleeding time and coagulation profile, may be done as per local hospital protocols). The Committee recommends scrotal ultrasound wherever possible, as discussed elsewhere in this document. The benefits to preoperative ultrasound include knowing whether the testicle is normal or diseased, whether the hydrocele fluid is normal or dense, as seen with blood, and whether there is a concurrent hernia. Other investigations should be tailored to individual indications. The physical examination is not different from any other preoperative or general physical examination. Informed consent is mandatory, and it is very helpful to provide the patient with printed material including illustrations, in addition to the verbal information, for the patient to refer back to and to share with family and other support networks. The WHO Surgical Safety Checklist should be adhered to wherever possible (Fig. 5).

There should be a designated place for patients to await surgery. The Committee recommends that patient be admitted to the hospital one day before surgery in order to complete all laboratory investigations, to re-examine the overall health and operative site and to prepare the patient for surgery. If they have not had the opportunity to bathe the night before on the ward or at home, patients should bathe before arriving at the surgical theatre. They should not shave the scrotal area. Patients should be NPO (nil per os), even if the plan is for surgery under local anaesthetic. The patient's medical chart should be available in the operating theatre, with notes from initial evaluation including laboratory investigations and examination notes, as well as a signed or marked consent. Patients with uncomplicated hydroceles should not take an antibiotic the night before surgery but should take all of their normal medications with a sip of water the morning of surgery. They may also take a pain medication such as pethidine (meperidine) hydrochloride and/or anxiolytic such as diazepam, prior to surgery under local anaesthesia, but non-steroidal pain medications such as diclofenac should be avoided due to risk of increased bleeding. Nonsteroidal anti-inflammatory medications are not recommended until after surgery. Regarding antibiotics, there is great concern in the public health and surgical community about evolving resistance to common antibiotics. Resistant skin and gut bacteria are increasingly found locally and regionally worldwide, including in LICs. For this reason, local public health and infectious disease guidelines should be consulted, taking into account prevalence patterns of resistant bacteria in the hospital and in the community. Antibiotic choice, if needed, should be based on these considerations. Most protocols for surgery on uncomplicated Stage I–II hydroceles call for two antibiotics to be given parenterally within one hour of incision.

The intake nurse should verify the above-mentioned activities, and also verify the patient's name and understanding of the intended procedure. The patient and doctor should mark the intended side and site of procedure with a surgical marking pen, even though it may seem obvious to all concerned.

12.2 Family planning

Patients undergoing scrotal surgery for hydrocele may be offered the opportunity for elective vasectomy if they desire it for family planning within the contexts of local cultural norms and practices. Since hydroceles due to LF disproportionately affect the poor, this population also has less access to vasectomy as a method of family planning. While it is also recognized that inadvertent injury to structures of the cord or the epididymis can be a complication of surgery, it is also considered that for patients who would otherwise elect to have a vasectomy, the opportunity should be offered.

12.3 Prevention of surgical site infections

Surgery for an uncomplicated Stage I or II hydrocele is considered a "clean" operation in HICs. Nevertheless, although the scrotum may be clean, the immune system that normally can be relied upon to help prevent infection is compromised due to the association with filarial worms. Patients are at higher than normal risk for skin infections even without surgery due to potential damage to dermal lymphatics. And finally, because the majority of patients live in poverty, in conditions where there may be no bathing facilities or access to running water or soap, their ability to keep wounds clean during the postoperative period may be limited. The Committee considered that published recommendations for HICs (that no antibiotics be given preoperatively for "clean" operations) may need re-evaluation in the context of LF.

The Committee was also mindful of the risk of overuse or indiscriminate use of antibiotics in LMICs, with consequent antimicrobial resistance (*55*). However, uncomplicated hydroceles should not need more than one dose of antibiotic, given parenterally within 1 hour of the beginning of the incision, and not given afterwards. A typical protocol might include a first-generation cephalosporin in combination with an aminoglycoside. Antibiotics may well be needed for a longer period of time for higher stages and grades of hydrocele and for patients with elephantiasis of the scrotum. In higher stage and grade hydroceles, it is useful to culture the skin of the "buried penis" cavity preoperatively to ascertain the most appropriate antibiotics, because the microbial flora may vary widely from patient to patient, and preventive measures should be tailored to the individual (Dr Richard Santucci, Detroit Medical Center, Department of Urology, personal communication, 2017).

Skin preparation and clipping of hair: It is recommended that patients do not shave themselves before surgery; and in the operating room it is recommended that close clipping be done as little as necessary to clear the surgical field. The WHO SSI guidelines recommend chlorhexidine in alcohol, but chlorhexidine is not available in many LICs. Povidone-iodine is acceptable. Some surgeons also recommend an additional bathing of the scrotum with soap and water prior to application of antiseptic.

12.4 Surgical technique

12.4.1 Decision to operate

In areas endemic for LF, surgery is warranted even for small Stage I hydroceles in order to prevent progression to more severe stages which are difficult to treat (*58–59*). Also, engagement with patients in a formalized public health programme will help reduce the group of symptomatic patients, thereby also reducing the known carriers of the disease in the local population. From the social and community perspective, surgery for small hydroceles can prevent a spectrum of problems, including depression due to disability and economic hardship due to inability to work, because, over time, small hydroceles will often grow to considerable size.

12.4.2 Choice of operation

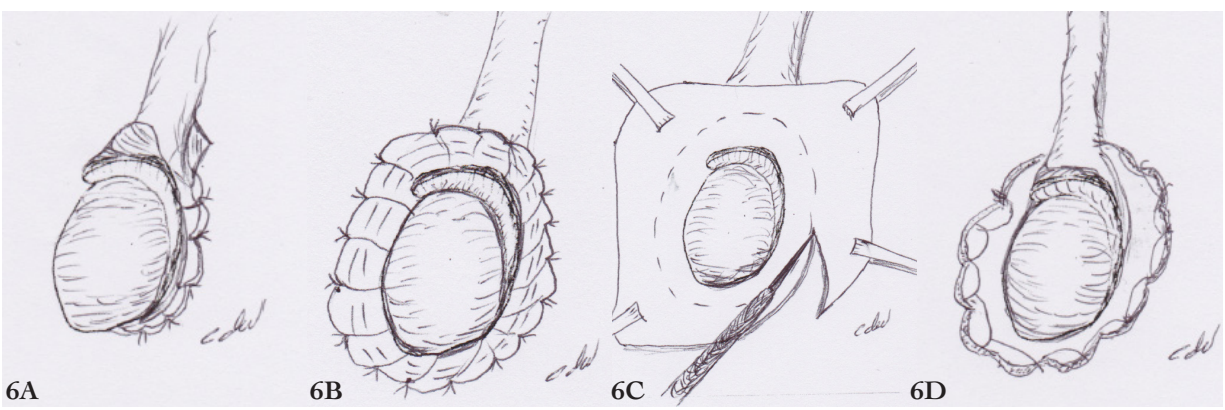
The surgical management of filarial hydroceles in LMICs is largely unstandardized. The Committee considered options for surgical technique that have been published in the scientific literature. There have been no prospective studies of surgical technique for hydrocele secondary to LF. The Committee reviewed three well-established techniques, including subtotal excision of the tunica vaginalis, eversion of the tunica vaginalis without excision (Jaboulay) and plication of the tunica vaginalis with over-sewing (Lord's). Most surgeons who care for LF hydroceles recommend excision of the tunica vaginalis for all stages of hydroceles because the primary cause of hydroceles is damage of the lymphatics of the tunica vaginalis. Leaving the tunica in place can invite recurrence, as has been documented in one observational study (*12*). Randomized studies would be helpful to identify measurable differences in outcome between these procedures for low stage hydroceles. Sclerotherapy is not recommended because it causes inflammation in tissue that may already be inflamed, it is difficult to standardize, and it can introduce bacteria into the hydrocele.

While excision of the tunica vaginalis is recommended for all stages of hydrocele, additional surgical management may also be indicated for more advanced disease, including Stage III–VI. When the scrotal skin is thickened, it may be necessary to excise a substantial amount. Lymphoedema of the scrotum and penis has also been successfully treated by lymphovenous shunt, as reported in the Indian literature (*41*). Particular consideration must be taken when the skin of the scrotum is thickened, and especially when dripping with lymphatic fluid – a "lymph scrotum." These cases require medical management and, where available, reconstructive surgery. Operating on such advanced disease should be undertaken in appropriate Level III facilities, and scrotal reconstruction should only be performed by skilled surgeons with knowledge of anatomical vascular, nerve and lymphatic supply and taking into consideration the patient's nutritional status and any concurrent diseases, such as diabetes or HIV, which could make healing substantially more difficult.

12.4.3 Technique for Stage I–III hydroceles

For surgery done under local anaesthesia, the surgeon must develop proficiency in the technique of spermatic cord block and anaesthesia of the scrotal tissue (*51*). While the technical excision of a hydrocele via a scrotal incision appears to be straightforward, the complex vascular and lymphatic anatomy is often underappreciated (*58–60*). As discussed above, the Committee recommends subtotal excision of the tunica vaginalis as a standard procedure for patients with LF (**Fig. 6C–D**). Successful surgery for hydrocele

Fig. 6. Hydrocele surgical techniques for tunica vaginalis: 6A, eversion; 6B, plication; and 6C and 6D, excision



does not rely on complete removal of the tunica vaginalis. In fact, it is impossible to remove the visceral layer of the tunica and, because it overlies both the testis and the epididymis, it is recommended that approximately 1 cm be left around these structures when using the excision technique for hydrocelectomy in order to prevent damage to the epididymis or vas deferens (**Fig. 6C**). It is thought that recurrence can result from too much sac remaining after excision, especially along the spermatic cord, the choice of the eversion (Jaboulay) technique or plication (Lord's) in a patient with severely compromised lymphatics or failure to recognize a communicating hydrocele.

12.5 Postoperative care

Application of a proper dressing is critical to optimize surgical outcomes and, in fact, the dressing may be as important as other aspects of the surgical technique. Postoperative compression of the scrotum with an elastic "turban" dressing prevents accumulation of serous fluid under the skin of the scrotal sac, rendering a drain unnecessary. Also, if patients are discharged with drains in place there is a risk of retention of the drain if patients fail to return for follow-up.

A tool adapted to the African setting has been developed to train surgeons on the excision technique in a reproducible manner using guided practice on surgical simulators, videos, and pre- and post-testing of surgeons on the simulator as well as on the patient (*51*). Experience in South Asia suggests that there may be a somewhat different demographic of patients where, in contrast to Africa, patients are often seen with low stage hydroceles. Surgeons TC and Apul Goel have described the pros and cons of surgical technique from the experience of South Asia, with a very large population in an endemic area (*60*).

13. Surgical complications and their management

Complication rates after hydrocelectomy can be high, even in HICs. In a retrospective series during 1998–2004 in the United States, a post-hydrocelectomy complication rate of 20% was found for non-LF, idiopathic hydroceles (*61–62*). The surgical techniques used in this series included: partial excision plus eversion of the tunica vaginalis, eversion alone and excision alone. The complications included recurrences of hydrocele, haematoma, infection, and testicular infarction. The authors concluded that subtotal excision of the sac was superior to complete excision but, in this study, it was not noted whether a standardized drainage or dressing protocol was used. As discussed above, these important elements of procedure can influence surgical outcomes.

13.1 Recurrence

Recurrence after surgery can be a problematic complication requiring re-operation, if the hydrocele is symptomatic. In their study of mechanisms for chronic and recurrent filarial hydroceles, Noroes and Dreyer (*12*) describe an observational study in which large groups of patients who had had different techniques of hydrocelectomy for LF were compared and followed up for more than 6 years. Group 1 included 968 patients from LF endemic areas, aged 18–40, with no previous surgery. A comparison group of 218 patients who had had surgery at similar ages and had the same environmental risk factors, but who were operated at other facilities, was retrospectively evaluated for complications matched to surgical technique. The group operated using the excision technique according to the protocol for the Center for Teaching, Research and Tertiary Referral for Bancroftian Filariasis had a recurrence rate of 0.3% compared with the comparison group, which included mixed techniques including Lord's and Jaboulay, of 19.3%. Limitations of this study included no notation of postoperative scrotal compression in the comparison group, which also may have contributed to a higher recurrence rate. Although the study risks bias due to its design, it is one of the few published reviews comparing the outcomes of LF hydrocele techniques. As noted above, prospective studies controlling for these factors would be a great contribution to the field.

13.2 Haematoma

Haematomas can generally be avoided by meticulous attention to haemostasis. Whether this is done by cautery, suture ligature or a combination of both, it is essential to ensure haemostasis before closure of the scrotal incision. A compressive elastic bandage dressing also can help to prevent haematoma. In general, scrotal haematomas should not be explored nor attempts made to drain them, as they can easily become infected. Even large haematomas will resolve over time, but supportive underwear will help ease discomfort, as will elevation and bedrest. Large haematomas can take many weeks to resolve. As with all scrotal surgery, avoidance of valsalva manoeuvres for several days also helps to prevent haematoma; therefore, patients are encouraged not to engage in any strenuous physical activity for at least 2 weeks. Drains are not recommended for uncomplicated hydrocele surgery, and they will not prevent haematomas. Meticulous haemostasis and compressive dressings are the best prevention for haematomas.

13.3 Infection

In tropical climates where LF is endemic, it is also extremely easy for bacteria and fungi to proliferate. Strong efforts must be made at all points in care to prevent SSI. At the facility level, this means availability of hand washing stations and soap for both patients and staff, clean toileting facilities, and standardized protocols for administration of antibiotics within 1 hour of incision time. WHO recommends skin preparation with chlorhexidine (rather than povidone-iodine), although povidone-iodine is most commonly

available. Dressing changes should be minimized until the wound edges have healed, and chlorhexidine should not be washed off. If infection occurs, it is necessary to ensure adequate drainage, frequent cleaning and dressing changes. Deep infections should be treated with appropriate systemic antibiotics.

13.4 Wound dehiscence

Wound dehiscence usually results from infection. If it occurs, attempts should not be made to re-close the wound, but to keep it clean and dressed. It will generally heal acceptably.

13.5 Inadvertent vasectomy

During surgery, if the tunica vaginalis is thick-walled, it is possible to inadvertently injure or transect the vas deferens. If recognized immediately, an attempt can be made to re-approximate the edges with fine suture. If a preoperative ultrasound has been done, a thickened tunica vaginalis may indicate a potentially higher risk of injury to vas. It is therefore important to advise patients of this risk prior to surgery and include it as part of the informed consent.

13.6 Lymph scrotum

This devastating development can occur as a result of damage to the lymphatics of the skin and scrotal fascias by transverse incision, and by eversion of the sac rather than excision. A midline longitudinal incision disturbs the scrotal lymphatics least, and removal of the tunica vaginalis with a small cuff followed by cautery and suturing the cut edge with a running absorbable suture will minimize the chances of this (*59*).

13.7 Urinary retention

Urinary retention can complicate surgery under several circumstances: some men have underlying benign prostatic hyperplasia and baseline slow urinary stream. Under these conditions, pain, fear of pain, analgesics, anaesthesia medication and fluids can all tip the balance to urinary retention.

14. Postoperative and discharge planning, communication, follow-up

Antibiotics are not recommended beyond one dose just before surgery for uncomplicated hydroceles in healthy patients. A typical protocol might include a first-generation cephalosporin in combination with an aminoglycoside given within one hour before starting surgery in order to cover typical skin and enteral bacteria.

For higher stage hydroceles, postoperative antibiotics may be beneficial based on preoperative skin cultures, scrotal skin thickness and other considerations such as patient nutritional status and environmental conditions. The choice of antibiotics should be governed by local patterns of bacteria and antibiotic resistance as well as availability of medication at local facilities. Broad spectrum antibiotics should be avoided to reduce risk of antimicrobial resistance. In surgical camps where antibiotics are given per protocol, careful follow up should be implemented and coordinated with hospital-based infection control systems.

14.1 Discharge planning

Discharge planning should be a coordinated activity among the operating surgeon, the hospital team, the public health officer and other coordinating groups. The main objective is the safety and best outcome for the individual patient, but important secondary outcomes are for community adoption of LF prevention measures, quality measures of surgical care for the doctors and the health system, and public health coordination between MDA and morbidity management.

Discharge planning should take into consideration the conditions to which patients will return when they are released from the hospital. Many patients do not have ready access to soap or running water for bathing or washing their hands. Toileting facilities may be rudimentary.

In India, most patients with Stage I–II hydroceles are discharged to home having had their surgery as outpatients. However, the sub-Saharan African experience argues for a minimum 3-day postoperative in-hospital care plan, with re-dressing of the wound on day 3 using aseptic technique prior to discharge. In other endemic regions, surgeons should evaluate the needs of their patient populations and make adjustments based on population and individual patient considerations.

It has been argued that the risk for infection in the context of altered immunological status and poor hygienic conditions may be significant. Poor nutritional status and other factors may predispose patients to infection or sepsis. There have been no studies comparing different antibiotic regimens to no antibiotics in the LF hydrocele patient population. A protocol using both intraoperative and postoperative antibiotics has yielded a very low SSI rate of < 5% (*50*). Still, for uncomplicated hydroceles in healthy patients, the Committee did not find sufficient evidence to recommend antibiotics beyond the dose given in the operating theatre at the beginning of the surgery.

14.2 Discharge instructions

Whether discharge instructions are given as a class to a cohort of patients or to individual patients, it is important not only to give instructions about hand hygiene, bandage management, toileting and follow-up visits, but also to get information about the patient's satisfaction, concerns and potential problems for future management. Printed instructions with pictures and text as in the patient's language will aid in adherence to recommendations.

Sample recommendations would include:

- Date to remove the dressing
- How to wash and re-dress the wound
- How to take pain medication (if necessary)
- When to return for follow-up
- How to contact the surgical team in case of problems

15. Summary of preferred procedures and practices

The following subsections summarize preferred practices for site and technique for Stage I–II (and possibly III) hydroceles due to LF. The evidence supporting some preferred practices is limited by a paucity of prospective studies of surgical outcomes in the LF population and poor patient follow up in many locations. However, observational and retrospective studies as well as significant surgical experience support the expressed preferences. The Committee strongly supports future prospective studies, as they will benefit the many thousands of patients who still require surgery to relieve their suffering.

15.1 Nomenclature

The staging and grading system described by Capuano and Capuano (*15*) is preferred as a standard due to its ease of use and its potential for facilitating better reporting burden of disease and surgical outcomes.

15.2 Site of surgical care

1. Patients with uncomplicated LF hydroceles (Stage I–II or I-III), Grade 0–1 should be treated at First Level Hospitals (DCP3 terminology see **Table 3**).
2. Complicated hydroceles (Stage III or IV–VI), Grade 2–*4* should be treated at Second or Third Level Hospitals (DCP3 terminology see **Table 3**).
3. Mobile surgical teams or surgical "camps" can provide expert teams for teaching local surgeons about LF and can help to relieve the backlog of operative cases that are prevalent in many areas where LF is endemic.
4. In most settings, hydrocele surgery should be done as an inpatient procedure with patients admitted for a minimum of *72* hours to allow for preoperative, operative and postoperative care and counselling.

15.3 Diagnosis and differential diagnosis

1. Ultrasound is a preferred adjunct to physical diagnosis because it can help distinguish between "simple" hydroceles and complicated variants including chylocele and haematocele. It will show the quality of the testis, allowing the surgeon to plan an orchiectomy if the testicle is not viable, or a radical orchiectomy if a tumour is found.
2. Transillumination is inferior to ultrasound as a means of differentiating hydroceles from other scrotal and testicular pathology.

15.4 Surgical team process

1. Use of the WHO Surgical Safety Checklist is recommended.
2. Proper instrument care and waste disposal is recommended for patient and staff safety.
3. Surgical site infection (SSI) precautions require preoperative, operative and postoperative care from many different members of the hospital staff and should be included in team education as well as patient education.

15.5 Surgical technique

1. The technique of excision/resection of the tunica vaginalis is preferred for all stages of LF hydrocele.
2. When hernias are encountered in patients with hydroceles, surgeons should be prepared to deal with them in the same surgical procedure. Where mesh is available, it is the material of choice.
3. Scrotal skin excision should be reserved for conditions with significant skin thickening and pathology according to anatomical principles,

and by experienced surgeons. Skin excision is not recommended in Stage I–II hydroceles and is rarely recommended in Stage III.

4. Electrocautery using diathermy is preferred for use in hydrocele surgery in addition to suturing and vessel ligature for haemostasis and to seal lymphatic channels.
5. Drains are not recommended for Stage I–III hydroceles.
6. Parenteral antibiotics should be given within one hour before the incision time.
7. Elastic compression dressings applied at the end of surgery are an important component of surgical technique.

15.6 Postoperative care, case review and reporting

Surgical procedures for LF should have a standardized care plan that can be tailored to the patient. The care plan should be sufficiently routine to allow evaluation of outcomes as well as reporting and publication in order to benefit other clinicians and patients. Standardization as recommended herein will benefit not only individual patients, clinicians and hospitals, but will also facilitate planning for communities and national surgical and public health programmes.

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Annexes

Annex 1. Basic checklist for operating room set-up

For hydrocele surgery, a basic checklist will be similar to that for hernias and other minor surgery. The suction canister is extremely helpful, as many hydroceles contain from several hundred mL to a litre or more of fluid.

Operating room set-up checklist	
☐	Sterile trolley towel and back table cover
☐	Sterile surgical gowns for surgeon and assistant
☐	Non-permeable apron for surgeons
☐	Surgical gloves for surgeon and assistant
☐	Sterile wound drapes (disposable or sterile reusable)
☐	Sterile wound towels (2–4)
☐	Sharps container
☐	"Red bag" waste container
☐	Suction tubing and canister

Instrument checklist		
☐	Sponge forceps	2
☐	Knife handle	2
☐	Dissecting forceps, toothed	2
☐	Dissecting forceps, non-toothed	1
☐	Towel clips	4
☐	Metzenbaum scissors	1
☐	Mayo scissors	1
☐	Curved artery forceps	8
☐	Straight artery forceps	2

Instrument checklist (Ctd)	
☐ Allis clamps	2
☐ Needle holder	1–2
☐ Kidney basin	1
☐ Small steel cup	1
☐ Retractors (army/navy)	2
☐ Self-retaining retractor (hernia)	1

Consumables checklist for hydrocele surgery	
☐ Syringe Luer lock (10 mL)	2
☐ Syringe Luer lock (60 mL)	1
☐ Syringe catheter tip (60 mL)	1
☐ Needle (18-gauge)	1
☐ Needle (24-gauge)	2
☐ Surgical blades (size 15)	1
☐ Gauze (sterile, in packs)	20–50 pieces
☐ Suture: absorbable braided polyglactin (~Vicryl, Dexon) 2–0, 3–0, 4–0 (opened as necessary) 4–0 Monocryl or Vicryl Rapide for skin	
☐ Surgical mesh, if available (for hernia)* (available but not opened)	

*See *section 12.4* on hernia technique for references regarding tension-free hernia repair.

Medications for skin and cord block: have available on the sterile field
☐ 2% lidocaine 50–100 mL
or
☐ 50:50 mixture of 1% lidocaine with 0.25% bupivacaine
or
☐ 2% lidocaine with 1:200 000 epinephrine

Wound dressings	
☐	Gauze roll or gauze pieces
☐	Elastic bandage or crepe gauze – 5 rolls (to be used at the time of surgery and for subsequent dressings)
☐	Medical tape

Postoperative medications and supplies	
☐	Pain medication: diclofenac, acetaminophen
☐	Antibiotic (at the surgeon's discretion) (see discussion in *section 7.3.7*)
☐	Gloves for dressing changes
☐	Antiseptic solution: povodone-iodine or chlorhexidine
☐	Dressing (gauze pieces and crepe gauze)
☐	Medical tape
☐	Postoperative printed instructions for patients

Annex 2. List of participants

Catherine R. deVries, MS, MD, Professor of Surgery (Urology), Adjunct Associate Professor of Public Health, Center for Global Surgery, University of Utah, Salt Lake City, USA

Apul Goel, Professor of Urology, King George's Medical University, Lucknow, India

Trilok Chandra Goel, MD, Emeritus Professor of Surgery, King George's Medical University, Lucknow, India

Sakti Das, MD, Emeritus Professor of Urology, UC Davis School of Medicine, Sacramento, USA

Andualem Deneke Beyene, MD, Associate Professor of Surgery (Urology), Addis Ababa University, School of Medicine, Department of Surgery, Urology Unit, Addis Ababa, Ethiopia

Col (DR) Sunny Doodu Mante, MD, Urologist Director of Postgraduate studies, 37 Military Hospital and Surgical Coordinator, African Filariasis Morbidity Project, Accra, Ghana

Zeina Sifri, MSc, Senior Technical Adviser, Morbidity Management and Disability Prevention Project, Helen Keller International, New York, USA

Richard A. Santucci MD, Specialist-in-Chief, Urology, Detroit Medical Center; Chief of Urology, Detroit Receiving Hospital; Director, The Center for Urologic Reconstruction;
Clinical Professor, Michigan State College of Medicine

S.P. Pani MD, PhD, Research Professor; Director, Centre for Infectious Disease & Parasitology Research, Quest International University Perak, Malaysia

Serigne M. Gueye, MD, Professor of Urology, University of Cheikh Anta Diop; Head of Urology, Grand Yoff Hospital, Dakar, Senegal

During the 17 years since *Surgical approaches to the urogenital manifestations of lymphatic filariasis* was first published, there has been heightened awareness of the physical, economic and emotional burden of the genitourinary manifestations of filariasis. With the impetus to provide better guidance for care of those suffering from LF, this update was both warranted and timely.

The Committee consisted of experts from South Asia, Africa, the Americas and Caribbean, and further input was garnered from experts from the WHO Western Pacific Region. The Committee met over the course of 3 months to review the current status of surgical care for LF patients and to adhere to new global guidelines and recommendations for surgical care in LMICs for facilities, surgical site infection and other factors. These experts represented urological and surgical care, public health, and both public and private sector management. The list of participants is annexed to this report.

This update offers a new consensus of the Committee regarding the staging of hydroceles caused by LF, also known as "filariceles". It recommends integrating LF surgery with other efforts to strengthen surgical care by assessing health facilities for their surgical readiness using the WHO Surgical Assessment Tool, or "SAT". It also recommends integrating hernia surgery with hydrocele surgery and integrating standards for prevention of surgical site infection (SSI).

The update revises recommendations for standard procedures and processes, offers an algorithm for diagnosis (including the use of ultrasound) and discusses postoperative care.