

Consensus recommendations for essential vascular care in low- and middle-income countries

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Objective: Many low- and middle-income countries (LMICs) are ill equipped to care for the large and growing burden of vascular conditions. We aimed to develop essential vascular care recommendations that would be feasible for implementation at nearly every setting worldwide, regardless of national income.

Methods: The normative Delphi method was used to achieve consensus on essential vascular care resources among 27 experts in multiple areas of vascular care and public health as well as with experience in LMIC health care. Five anonymous, iterative rounds of survey with controlled feedback and a statistical response were used to reach consensus on essential vascular care resources.

Results: The matrices provide recommendations for 92 vascular care resources at each of the four levels of care in most LMICs, comprising primary health centers and first-level, referral, and tertiary hospitals. The recommendations include essential and desirable resources and encompass the following categories: screening, counseling, and evaluation; diagnostics; medical care; surgical care; equipment and supplies; and medications.

Conclusions: The resources recommended have the potential to improve the ability of LMIC health care systems to respond to the large and growing burden of vascular conditions. Many of these resources can be provided with thoughtful planning and organization, without significant increases in cost. However, the resources must be incorporated into a framework that includes surveillance of vascular conditions, monitoring and evaluation of vascular capacity and care, a well functioning prehospital and interhospital transport system, and vascular training for existing and future health care providers. (*J Vasc Surg* 2016;64:1770-9.)

Rapid population aging and increased exposure to modern risk factors (eg, tobacco smoke, poor diet, sedentary lifestyles, road traffic) has created a large and increasing burden of noncommunicable diseases (NCDs) in low and middle-income countries (LMICs)^{1,2}; seven of 10 deaths in LMICs will be due to NCDs by 2020.^{3,4} In response, the World Health Organization (WHO) has set a target to reduce NCD deaths in people aged <70 years by 25% by 2025.^{5,6} Although prevention, risk-factor reduction, and a public health approach are fundamental to reducing the global NCD burden, planning NCD-related health care capacity improvements in LMICs is also important.⁷

Among NCDs, the increasing incidence of vascular conditions is particularly dramatic.² Population-based studies in the Central African Republic and Republic of Congo reported the prevalence of peripheral vascular disease (PVD; ie, ankle-brachial index <0.9) in older adults is between 12% and 32%.^{8,9} Studies from Ghana, South Africa, India, and Ecuador support these findings.¹⁰⁻¹³ The Global Burden of Disease 2010 study reported a nearly twofold increase in PVD compared with the two previous decades and that the rate of change was higher in LMICs than in high-income countries.¹⁴ Further, PVD is no longer a disease of the elderly, but now affects young adults, even in LMICs.¹⁵

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Despite this burden, many LMICs still perform more vascular procedures for injury than for PVD. A tertiary center in Tanzania performed more than four times the number of amputations for trauma than for PVD.¹⁶ Similar reports from Nigeria, Kenya, and Iran suggest this is not an isolated pattern.¹⁷⁻¹⁹ Inopportunistly, the growing burden of vascular conditions falls on health systems that are not well equipped to provide essential trauma care, manage challenging vascular problems, or care for the unique requirements of the growing geriatric population.^{7,20,21} Sustaining these deficiencies is a lack of recommendations for LMIC health care systems to follow regarding the essential functions and resources for vascular care.

To address this gap, we aimed to develop recommendations for essential vascular care functions and resources that would be feasible for implementation in nearly every setting worldwide, regardless of national income. With sound planning and organization, the recommendations might improve care for people at risk of or with a vascular condition in LMICs and prevent otherwise avertable death and disability.

METHODS

Delphi method. We used normative Delphi methodology to develop consensus on recommendations for essential vascular care functions and resources (ie, knowledge, skills, equipment, and supplies) in LMICs. The Delphi method is an iterative, anonymous, data-driven survey method that facilitates expert-group consensus building.²² The four defining characteristics of the Delphi method were upheld throughout the process: anonymity, iteration, controlled feedback, and statistical group response.²³

Panelist selection. To ensure that the recommendations were both appropriate for low-resource contexts and represented quality vascular care, we approached experts who met the following criteria:

- Professionals in LMICs or professionals who have significant experience working in LMICs (ie, at least 1 cumulative year of work in a LMIC); and
- Expertise in an area relevant to vascular care.

The areas of expertise included public health, vascular surgery, trauma surgery, anesthesia, primary care, cardiology, and cardiothoracic surgery. In total, 27 panelists took part in the consensus-building process. All communication was blinded.

Survey methods. Panelists participated in five survey rounds. For each round, responses to open-ended questions regarding which resources to include or exclude, at what level of care, and why, were examined using a content analysis framework²⁴ in which qualitative responses were grouped into categories by codes that represented clustered responses; after which, categories were further refined into useful themes and described. Responses were triangulated between panelists to evaluate the extent of theme convergence. Themes that emerged from the panelists' responses were described to panelists in the subsequent round to allow consideration before offering further recommendations.

In addition to open-ended questions, panelists were asked to rank proposed vascular care resources on a scale from 0 (ie, not essential, do not include in the recommendations) to 10 (ie, absolutely essential, must include in the recommendations) until consensus was achieved. Resources with a median rank of ≤ 4 of 10 were not included in subsequent rounds. Target consensus was defined a priori as a median rank of ≥ 8 for each proposed resource on a scale of 0 to 10 and an average percent majority opinion cutoff rate of ≥ 0.8 . The average percent majority opinion cutoff rate is a consensus measure that is calculated by adding agreements and disagreements, dividing the sum by all responses, and multiplying the result by 100%.²³ Agreement was defined as a resource rank of ≥ 7 and disagreement as a resource rank of ≤ 4 .

After consensus on the resources to be included in the recommendations was achieved, panelists assigned the level of care for which each resource should be "essential," "desirable," or "irrelevant." This system was used based on the success of the WHO *Guidelines for Essential Trauma Care*.²⁵ As in the *Guidelines*, we defined:

- Essential resources such as those that should be ensured at the stated level regardless of national income, that can be made available through better organization and planning without necessarily increased expenditure, and add significant value that would increase the probability of a successful outcome.
- Desirable resources are those that increase the probability of a successful outcome, but also add cost, and should be strongly considered by health care systems with greater resources or larger burdens of vascular disease.
- Irrelevant resources would not ordinarily be expected to be available at the stated level.

Panelists assigned a designation of essential, desirable, or irrelevant to each resource at each level of care. The resource designation with the greatest number of panelist assignments at each level of care was used for the recommendations. Panelists were instructed to align the recommendations with related WHO (*Best Buys, Global Action Plan for the Prevention and Control of NCDs 2013-2020, Guidelines for Essential Trauma Care*) and The World Bank guideline documents, when appropriate, so that they fell within a coherent and externally validated framework for health systems in LMICs.²⁵⁻²⁸ However, some resources were considered to be particularly important for addressing the growing burden of vascular conditions in LMICs; thus, these were included in the present recommendations. SurveyMonkey (SurveyMonkey, USA, <https://www.surveymonkey.com/>) was used for data collection, and Stata 13 software (StataCorp LP, College Station, Tex) was used for data analysis.

Survey rounds. The first three survey rounds were used to build consensus on which vascular care resources were to be included in the recommendations. Panelists additionally proposed resources to be evaluated and offered comments on reasons that specific resources should be changed, removed, or added in the subsequent rounds.

Each round was left open for panelists' responses for 3 weeks or until 23 of the 27 (85%) of panelists responded.

A summary of the comments was provided to the panelists after each round so that they could consider the others' perspectives and ideas before the next ranking exercise. In the second and third rounds, resources without consensus (ie, rank >4 and <7 of 10) and newly proposed resources were reranked or ranked in light of the summary comments from the previous round. Consensus on the resources to be included in the final recommendations was achieved after the third round.

Panelists assigned each resource a designation of essential, desirable, or irrelevant at each level of care in the fourth and fifth round. After the fourth round, a summary of comments was again provided to the panelists so that they could consider others' perspectives and ideas when assigning or critiquing designations in the final round.

Resource matrices. We used the resource matrix format used by the WHO, which is easily interpreted and has been widely adopted.^{21,29-35} Resources are listed in the matrices in the left-hand column. The level of care—primary health centers (PHCs), first-level hospitals, referral hospitals, and tertiary hospitals—for which the resource designation corresponds is represented horizontally. The resources designations of essential (E), desirable (D), and irrelevant (I) are listed vertically. Resources essential at one level are essential at all higher levels as well.

The nomenclature and capacity of these levels of care differ between and within LMICs.³¹ For these recommendations, we used the definitions offered by the WHO and The World Bank^{25,28,36}:

1. PHCs are located in communities countrywide, even in rural areas. In urban areas they represent outpatient clinics. The staffing of PHCs range from village health workers (ie, no formal medical education; typically with a few months of health-related training) to general practitioners (GPs). PHCs are minimally equipped.
2. First-level hospitals are typically staffed by GPs. These facilities may or may not provide surgical services, depending on the skill of the GP and the available resources. Some first-level hospitals are well resourced and well functioning and perform the scope of first-level essential surgical care (eg, those with a skilled surgical care provider, such as an experienced nonsurgeon or a surgeon).³⁷
3. Referral hospitals are usually staffed by at least one specialist provider (eg, internist; obstetric, general, orthopedic surgeon). These facilities almost uniformly provide some range of diagnostic and surgical services.
4. Tertiary hospitals generally offer a broader range of specialties (eg, cardiology, general surgery, orthopedic surgery). In addition, they have more advanced laboratory and diagnostic imaging capacity.

It is important to note that many individuals in LMICs face extraordinary barriers to care that prevent presentation

or transfer to hospitals that are not in their community, regardless of the risk for death or disability.³⁸⁻⁴⁰ Further, most LMICs lack a formal, efficient, and free prehospital care and interhospital transfer system. The only care they might access, regardless of the acuity of their condition, may be a proximate first-level hospital.

Ethics. Consensus building among the participating professionals met the nonresearch criteria of the Stanford University Institutional Review Board; thus, the requirement for Institutional Review Board approval was waived.

RESULTS

The matrices provide recommendations for 92 vascular care resources. These are divided into resources for prevention, screening, counseling, and evaluation; diagnostics; medical care; surgical care; equipment and supplies; and medications.

Prevention, screening, counseling, and evaluation.

There was strong consensus regarding the importance of cardiovascular health promotion, disease prevention, and identification of risk factors. These capabilities are vital to population health and are low cost; thus, they are recommended for each level of care.⁶ These resources include the capability to provide screening and counseling for healthy dietary and exercise habits; screen, counsel, and provide cessation opportunities for smokers; and recognize and screen patients at high-risk for vascular conditions (Table I).

In addition, early identification of patients at risk of deep vein thrombosis (eg, hospitalized, injured, and post-surgical patients), compartment syndrome, and blunt cerebrovascular injury requires few resources but adds significant value to vascular care (Table I). Blunt cerebrovascular injury should be assessed, at least clinically, at first-level hospitals; higher levels of care should consider diagnostic imaging, if available.

Many LMICs have high rates of human immunodeficiency virus (HIV) infection. HIV-associated vascular disease and adverse effects of antiretroviral therapy (eg, metabolic syndrome) place an additional burden of vascular conditions on populations that are not otherwise at high risk of vascular disease.⁴¹ Active screening and counseling are important for at-risk patients. Given the decentralized platforms of HIV care in LMICs, these capabilities are essential at all levels of care (Table I).

All levels of care should have protocols that direct timely triage and treatment or transfer of patients with emergency conditions; these protocols should include emergency vascular conditions (eg, vascular injury, acute limb ischemia; Table I). Further, facilities should have a referral mechanism for patients with nonemergency vascular conditions who require more advanced services.

Diagnostics. As an extension to the vascular physical examination, the capability to perform and interpret an ankle-brachial index is essential at the first-level hospital (Table II).

Many first-level and referral hospitals in LMICs do not have an ultrasound machine.⁴² However, this technology is becoming available more commonly.²¹ Therefore, the

Table I. Prevention, screening, counseling, and examination

<i>Screening, counseling, and evaluation</i>	<i>Facility level^a and resource designation^b</i>			
	<i>PHC</i>	<i>First-level</i>	<i>Referral</i>	<i>Tertiary</i>
Dietary screening and counseling	E	E	E	E
Exercise screening and counseling	E	E	E	E
Smoking screening and counseling	E	E	E	E
Smoking cessation opportunities	E	E	E	E
Blood pressure measurement	E	E	E	E
Recognize and screen patients at high-risk for vascular disease	E	E	E	E
Take vascular history and physical examination	E	E	E	E
Prevent, recognize, and evaluate diabetic foot lesion in a diabetic patient	E	E	E	E
Deep vein thrombosis risk-assessment and evaluation	D	E	E	E
Recognize and evaluate possible compartment syndrome	E	E	E	E
Blunt cerebrovascular injury evaluation	D	E	E	E
HIV- and HAART-related vascular disease screening and counseling ^c	E	E	E	E
Protocols for timely triage and treatment or transfer of vascular conditions	E	E	E	E

HAART, Highly active antiretroviral therapy; HIV, human immunodeficiency virus; PHC, primary health center.

^aPHC is an outpatient clinic staffed by nonphysicians; *First-level hospital* is typically staffed by general practitioners (GPs) and may or may not provide surgical services; *Referral hospital* is typically staffed by specialists, usually including a general surgeon; *Tertiary hospital* offers a wider range of specialists and laboratory and imaging capabilities.

^bResource designation at a particular level: E, essential; D, desirable; I, irrelevant (ie, resource not considered to be available at the particular level even with full resource availability).

^cEssential when the local epidemiology warrants.

Table II. Diagnostics

<i>Diagnostics</i>	<i>Facility level^a and resource designation^b</i>			
	<i>PHC</i>	<i>First-level</i>	<i>Referral</i>	<i>Tertiary</i>
Ankle-brachial index	D	E	E	E
Exercise ankle-brachial index	I	D	E	E
Venous compression and duplex ultrasound imaging to evaluate for DVT	I	D	D	E
Peripheral and central arterial duplex ultrasound imaging	I	I	D	E
Carotid duplex ultrasound imaging	I	I	D	E
Clinician interpretation of arterial duplex ultrasound imaging	I	I	D	E
Technician/radiologist interpretation of arterial duplex ultrasound imaging	I	I	D	E
Point-of-care and/or glucose testing	E	E	E	E
Hemoglobin	I	E	E	E
Complete blood count	I	D	E	E
Creatinine	I	D	E	E
Chemistry	I	D	E	E
Coagulation profile	I	D	E	E
Type and crossmatch for blood and blood products	I	E	E	E
Lipid profile	I	D	D	E
Hemoglobin A _{1c}	I	D	D	E
Syphilis assay for vasculitis/aortitis (eg, VDRL)	I	E	E	E
Hypercoagulability evaluation (eg, fibrinogen, factor assays, etc)	I	I	D	D
Blood and/or tissue culture	I	D	E	E
Gram stain	I	D	E	E

DVT, Deep vein thrombosis; PHC, primary health center; VDRL, Venereal Disease Research Laboratory.

^aPHC is an outpatient clinic staffed by nonphysicians; *First-level hospital* is typically staffed by general practitioners (GPs) and may or may not provide surgical services; *Referral hospital* is typically staffed by specialists, usually including a general surgeon; *Tertiary hospital* offers a wider range of specialists and laboratory and imaging capabilities.

^bResource designation at a particular level: E, essential; D, desirable; I, irrelevant (ie, resource not considered to be available at the particular level even with full resource availability).

capability for first-level and referral hospital providers to use ultrasound imaging to diagnose deep venous thrombosis is desirable (Table II). Arterial duplex capabilities (including carotid duplex) are beyond the scope of most first-level hospitals. The capability for clinicians or

technicians to perform and interpret these studies is essential at the tertiary level.

Glucose testing is essential at all levels of care (Table II). Early identification and secondary prevention of diabetes mellitus is vital to the prevention of vascular

Table III. Medical care

Medical care	Facility level ^a and resource designation ^b			
	PHC	First-level	Referral	Tertiary
Counseling and multidrug therapy for patients at high-risk of or with CVD	D	E	E	E
Nonoperative lower extremity wound care and appropriate documentation	E	E	E	E
Ambulation, extremity elevation at rest, and compression therapy for DVT	E	E	E	E
Physiotherapy for vascular health and/or claudication	D	E	E	E
Complete decongestive therapy for lymphedema	D	D	D	E
Blood transfusion capabilities	I	E	E	E
Anticoagulation therapy	I	D	E	E
Warfarin monitoring system	I	D	E	E

CVD, Cardiovascular disease; DVT, deep vein thrombosis; PHC, primary health center.

^aPHC is an outpatient clinic staffed by nonphysicians; *First-level hospital* is typically staffed by general practitioners (GPs) and may or may not provide surgical services; *Referral hospital* is typically staffed by specialists, usually including a general surgeon; *Tertiary hospital* offers a wider range of specialists and laboratory and imaging capabilities.

^bResource designation at a particular level: E, essential; D, desirable; I, irrelevant (ie, resource not considered to be available at the particular level even with full resource availability).

complications.⁴³ Hemoglobin determination and blood typing and crossmatching are essential at the first-level hospital. Most other laboratory capabilities are desirable at this level but are essential at the referral hospital level (eg, chemistry, coagulation profile, blood and tissue culture). The value added to numerous conditions by improving laboratory capabilities at the first-level hospital should be considered if resources permit.⁴⁴

Medical care. Counseling, recognition of, and multidrug therapy for patients at medium-risk to high-risk of vascular disease is cost-effective and essential at the first-level hospital (eg, aspirin, calcium-channel blocker or β -receptor blocker, angiotensin-converting enzyme inhibitor, and a statin; [Table III](#)).⁴⁵

The combination of an increasing prevalence of diabetes and vascular disease is causing an epidemic of lower-extremity wounds.⁴³ Thus, nonoperative wound care and appropriate documentation over time, which is low cost and requires minimal training, is essential for all levels of care ([Table III](#)). Given its low cost and proven effectiveness, physiotherapy for cardiovascular health or claudication is essential at the first-level hospital.⁴⁶

Emergency conditions that can be treated effectively with low-cost resources should be managed at the first-level hospital to avoid preventable death.³⁷ Thus, blood transfusion capability for the management of vascular injuries is essential at the first-level hospital ([Table III](#)).

Complete decongestive therapy for lymphedema is essential at the tertiary hospital level ([Table III](#)). However, in countries with endemic filariasis, this capability might be considered essential at lower levels of care to complement more less intensive therapies.

Anticoagulation therapy and a warfarin monitoring system are essential at the referral hospital level ([Table III](#)). First-level hospitals that care for a large number of patients in need of anticoagulation may consider making the requisite resources essential.

Surgical care. Basic interventions to control life-threatening hemorrhage, such as external direct pressure

and appropriate tourniquet application and time keeping, are essential at all levels of care ([Table IV](#)). Prehospital tourniquet use in areas where delays to surgical care are prevalent can save lives but can also result in limb loss, untoward consequences of prolonged limb ischemia, and death if inappropriately applied.⁴⁷ These potential problems may be less of a concern in hospitals that can quickly evaluate and control bleeding after tourniquet application.⁴⁸ Nonetheless, tourniquet use in all settings requires special training.⁴⁹

More complex, life-saving surgical interventions (eg, damage control shunting, fasciotomy, damage control amputation, vascular repair) are essential at first-level hospitals given the consequences of expected delays in transfer to higher levels of care in many LMICs.⁵⁰ However, these procedures require moderate skill and should only be performed at well-functioning hospitals with a surgeon or at least an experienced nonsurgeon available. For procedures that are beyond the scope of the first-level hospital, particularly those that are not emergencies, patients should be referred to a skilled surgical care provider (eg, peripheral bypass, surgical management of venous insufficiency) and a facility capable of caring for the complications that may be encountered.

As with decongestive therapy, surgical management of lymphedema at the tertiary level is essential in areas that continue to have endemic filariasis ([Table IV](#)).⁵¹ Negative-pressure wound management provides significant benefits to patients with open wounds, particularly when reconstructive options are not available.⁵² These systems can be improvised and made low-cost.⁵³ Thus, they are essential at the referral hospital level, although they could readily be made essential at the first-level hospital if resources allowed.

Equipment and supplies. The recommendations for essential equipment and supplies follow the recommendations above ([Table V](#)). Handheld Doppler devices are used in the maternity wards of many first-level hospitals in LMICs and are also essential for vascular examination at that level.

Table IV. Surgical care

<i>Surgical care</i>	<i>Facility level^a and resource designation^b</i>			
	<i>PHC</i>	<i>First-level</i>	<i>Referral</i>	<i>Tertiary</i>
External hemorrhage control with direct pressure	E	E	E	E
Appropriate tourniquet application and time keeping	E	E	E	E
Vessel ligation	I	E	E	E
Vascular anastomosis	I	D	E	E
Damage control shunting ^c	I	E	E	E
Fasciotomy (all sites) ^c	I	E	E	E
Débridement of mangled extremity	I	E	E	E
Local débridement of ulcer	D	E	E	E
Exposure and operative management of peripheral vascular injuries ^c	I	E	E	E
Exposure and operative management of central vascular injuries	I	D	E	E
Amputation				
Damage control (eg, guillotine, through joint)	I	E	E	E
Digital	I	E	E	E
Ray	I	D	E	E
Transmetatarsal	I	D	E	E
Below knee ^c	I	E	E	E
Above knee ^c	I	E	E	E
Upper extremity (nondamage control)	I	D	E	E
Visceral or peripheral thromboembolectomy ^c	I	E	E	E
Visceral or peripheral endarterectomy	I	I	D	E
Vein harvest and grafting ^c	I	E	E	E
Peripheral bypass	I	I	D	E
Carotid endarterectomy	I	I	I	E
Surgical management of varicose veins and chronic venous insufficiency	I	I	D	E
Elective abdominal aortic aneurysm repair	I	I	I	D
Arteriovenous fistula or graft for vascular access	I	I	D	D
Peritoneal dialysis catheter placement	I	I	D	E
Staged subcutaneous excision underneath flaps	I	I	D	D
Subcutaneous excision and SSTG resurfacing for chronic lymphedema	I	I	D	D
Central venous catheterization	I	D	E	E
Arterial pressure monitoring	I	I	D	D
Negative-pressure wound management	I	D	E	E

PHC, Primary health center; *SSTG*, split-thickness skin graft.

^a*PHC* is an outpatient clinic staffed by nonphysicians; *First-level hospital* is typically staffed by general practitioners (GPs) and may or may not provide surgical services; *Referral hospital* is typically staffed by specialists, usually including a general surgeon; *Tertiary hospital* offers a wider range of specialists and laboratory and imaging capabilities.

^bResource designation at a particular level: *E*, essential; *D*, desirable; *I*, irrelevant (ie, resource not considered to be available at the particular level even with full resource availability).

^cProcedure requires moderate skill and should be considered essential only at well-functioning first-level (and higher level) hospitals where a surgeon or at least a very experienced nonsurgeon is available.

Fogarty balloons and synthetic graft material are expensive and require some degree of vascular surgical training. The former is essential at the tertiary level, given its broader benefits to surgical care (eg, biliary duct exploration); the latter is desirable and should only be made available to providers trained in their use (Table V).

Similarly, advanced imaging equipment and supplies associated with angiography are desirable at higher levels of care, but could be made available for use by skilled providers if the need was present and resources allowed. However, a simplified angiography technique using an X-ray machine at a first-level hospital has been described⁴⁸; the resources for this technique might be considered desirable at a well-functioning first-level hospital with an experienced surgical care provider.

Medications. The WHO offers model lists of essential medications, including those for the management of

hypertension, diabetes, and dyslipidemia.⁵⁴ Thus, the current recommendations do not include the numerous medications essential for cardiovascular care. However, several vascular care medications are highlighted (Table VI). Aspirin and ivermectin in areas with endemic filariasis are essential at the PHC. Unfractionated heparin or generic low-molecular weight heparin, or both, protamine, vitamin K, and a statin are essential at the first-level hospital. Warfarin should only be available to facilities capable of anticoagulation monitoring.

DISCUSSION

This study provides consensus recommendations on essential vascular care functions and resources for LMIC health care systems. These recommendations might serve as useful guidelines for planning and organizing vascular

Table V. Equipment and supplies

Equipment and supplies	Facility level ^a and resource designation ^b			
	PHC	First-level	Referral	Tertiary
Sphygmomanometer	E	E	E	E
Tourniquet	E	E	E	E
Hand-held Doppler	I	E	E	E
Fogarty balloons of standardized sizes (eg, 3, 4, and 6) ^c	I	E	E	E
Ultrasound machine with vascular probe and duplex capabilities	I	D	D	E
Basic synthetic graft selection	I	I	D	D
Advanced synthetic graft selection	I	I	D	E
Standardized minor vascular tray	I	E	E	E
Standardized major vascular tray	I	D	E	E
C-arm fluoroscopy	I	I	D	D
Angiography ^c	I	D	D	D
Surgical loupes (simple, small magnification lens)	I	D	D	E
Polypropylene double-armed tapered suture (eg, sizes 2-0 to 7-0)	I	D	E	E

PHC, Primary health center.

^aPHC is an outpatient clinic staffed by non-physicians; *First-level hospital* is typically staffed by general practitioners (GPs) and may or may not provide surgical services; *Referral hospital* is typically staffed by specialists, usually including a general surgeon; *Tertiary hospital* offer a wider range of specialists and laboratory and imaging capabilities.

^bResource designation at a particular level: *E*, essential; *D*, desirable; *I*, irrelevant (ie, resource not considered to be available at the particular level even with full resource availability).

^cResource use requires moderate skill and should be considered essential only at well-functioning first-level (and higher level) hospitals where a surgeon or at least a very experienced nonsurgeon is available.

Table VI. Medications

Medications	Facility level ^a and resource designation ^b			
	PHC	First-level	Referral	Tertiary
Aspirin	E	E	E	E
Unfractionated heparin	I	E	E	E
Low-molecular-weight heparin	I	E	E	E
Protamine	I	E	E	E
Benzopyrones (eg, coumarin)	I	I	D	E
Warfarin	I	D	E	E
Vitamin K	I	E	E	E
Statin	D	E	E	E
Ivermectin ^c	E	E	E	E

PHC, Primary health center.

^aPHC is an outpatient clinic staffed by nonphysicians; *First-level hospital* is typically staffed by general practitioners (GPs) and may or may not provide surgical services; *Referral hospital* is typically staffed by specialists, usually including a general surgeon; *Tertiary hospital* offers a wider range of specialists and laboratory and imaging capabilities.

^bResource designation at a particular level: *E*, essential; *D*, desirable; *I*, irrelevant (ie, resource not considered to be available at the particular level even with full resource availability).

^cEssential when the local epidemiology warrants.

care in some LMICs, if resources permit. LMICs that are currently struggling to meet the needs of health problems that comprise a larger health burden than vascular conditions (eg, malnutrition, nonvascular trauma, poor maternal and child health) can use these recommendations while planning to prevent vascular conditions and meet future vascular care needs. Before considering the fitness of these recommendations, health care systems must assess the vascular care needs of their population through population-based studies of vascular conditions and facility-based registries.^{13,55} These recommendations can be considered once the need to improve vascular care is established.

It is important to note that these recommendations only consider the essential and desirable inputs (ie, structure) for vascular care. Inputs alone are insufficient for producing successful outcomes.⁵⁶ Health care systems must create and sustain evidence-based processes that improve vascular outcomes. These processes require ongoing monitoring, evaluation, and feedback to ensure they are successful. Potential monitoring points include health service delivery indicators (eg, proportion of patients counseled regarding cardiovascular risk factors), sentinel events (eg, death due to lack of external hemorrhage control), and meaningful outcomes (eg, amputation rate among patients with lower extremity diabetic foot lesion).

Although much can be done to improve vascular care at first-level hospitals, LMIC health care systems rely heavily on higher levels of care.⁵⁰ In such settings, ensuring that first-level hospital providers can recognize a condition that requires more advanced care and stabilize and transfer patients to a capable facility is imperative.⁵⁷ For example, patients with a major vascular injury require triage, early diagnosis, temporary hemorrhage control, and transfer to a hospital with a surgeon capable of performing vascular surgical techniques. To avert preventable death and disability, health care systems must ensure that vascular conditions are included in referral protocols, that efficient and safe interhospital transfer systems are in place, and that vascular emergencies are covered by national health insurance schemes to facilitate care.

Successful decentralized surgical care relies on the knowledge and skills of first-level hospital providers and the resources afforded to them.⁵⁸ These providers are often nonsurgeons or nonphysicians with little or no vascular surgical training. Although these providers are valuable for patients with common conditions that require moderate skill to treat effectively (eg, amputation for lower extremity gangrene), they may be less valuable for patients with complex surgical conditions, including those that require advanced vascular surgery (eg, late-stage PVD). Thus, surgeons trained specifically in vascular surgical techniques should be available in locations with the equipment and supplies to provide this type of care. It has been well documented that regional vascular care centers in high-income countries provide better outcomes than other hospitals given their volume and specifically designed processes to care for patients with vascular conditions and other comorbidities.⁵⁹ Evaluating similar models in LMICs is worthwhile to determine if regionalized systems should be developed to improve outcomes given the differences in prehospital care capacity and the quality of patient stabilization before and during interhospital transfer between high-income countries and LMICs.

Lastly, technical, nursing, medical, and surgical education in LMICs has focused on training providers to manage infectious diseases and ensure maternal and child health.^{60,61} Given the increasing burdens of injury and vascular conditions, the education systems and task-sharing programs must adapt their curriculum to the needs of the population.⁶² In addition, continuing vascular care education of existing providers should be incorporated into graduate and other levels of training modules.

CONCLUSIONS

These recommendations have the potential to improve the ability of LMIC health care systems to respond to the large and growing burden of vascular conditions. Many of these resources can be provided with thoughtful planning and organization without significant increases in cost. However, the resources must be incorporated into a system that includes surveillance of vascular conditions, monitoring, and evaluation of vascular capacity and care, a well-functioning prehospital and interhospital care and

transport system, and vascular training for both existing and future health care workers.

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