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Assessment of risk of peripheral vascular disease and vascular care capacity in Ghana

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No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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Abstract

Introduction—This study aimed to describe national peripheral vascular disease (PVD) risk and health burden and vascular care capacity in Ghana. The gap between PVD burden and vascular care capacity in a low- and middle-income country (LMIC) is defined and capacity improvement priorities identified.

Methods—Data to estimate PVD risk factor burden were obtained from: i) World Health Organization's Study on Global Ageing and Health (SAGE), Ghana; and ii) Institute of Health Metrics and Evaluation Global Burden of Disease database (IHME GBD). In addition, a novel nationwide assessment of vascular care capacity was performed, with 20 vascular care items assessed at 40 hospitals in Ghana. Factors contributing to specific item deficiency were also described.

Results—From the SAGE database, there were 4,305 respondents aged at least 50 years with data to estimate PVD risk. Out of these 57% were at moderate to high PVD risk with ≥3 risk factors, thus giving 1,654,557 persons when extrapolated nationally. Using IHME GBD data, the estimated disability-adjusted life years incurred from PVD increased 5-fold from 1990 to 2010 (1.3 to 3.2 per 100,000 persons, respectively). Vascular care capacity assessment demonstrated marked deficiencies in items for diagnosis, perioperative and vascular surgical care. Deficiencies were most often due to absence of equipment, lack of training and technology breakage.

Conclusion—Risk factor reduction and management as well as optimization of current resources are paramount to avoid the large burden of peripheral vascular disease falling on healthcare systems in low- and middle-income countries that are not well equipped to handle vascular surgical care, and for which rapid development of such capacity would be difficult and expensive.

Keywords

vascular; peripheral arterial disease; capacity; developing country; Ghana

Introduction

The very rapid rate of aging among the global population is on a collision course with westernisation in low- and middle-income countries (LMICs).[1, 2] By mid-century, there will be more than two billion people over the age of 60 years, the majority of whom will live in LMICs.[3] The synergy of rapid urbanisation, sedentary lifestyles, tobacco use, and poor dietary habits is leading to a plague of cardiovascular disease. By 2020, 7 out of 10 deaths in developing countries will be due to non-communicable diseases (NCDs).[4, 5] In response, the World Health Organization has set a target to reduce NCD deaths in people aged less than 70 years by 25% by 2025.[6, 7]Although a public health approach is required to reduce the global NCD burden, planning for future NCD-related capacity improvements in LMICs is also important.

Peripheral vascular disease (PVD) is a common NCD, incurring more than 500,000 disability-adjusted life years annually in high-income countries (HICs).[8, 9] Though the epidemiology of PVD in LMICs is poorly characterized, the intersection of larger populations, aging and westernisation foreshadows a major impending burden.[2] This burden will fall on health systems least equipped to care for challenging surgical conditions and the unique requirements of the growing geriatric population.[2, 10-15]

Surgical capacity assessments from LMICs have reported critical deficiencies in infrastructure, resources and training, and have been an important stimulus for building a foundation for advocacy and capacity improvements.[16] However, these assessments have not focused on essential equipment, supplies and personnel for provision of vascular care. Until recently, systematic examination of the causes of deficiencies has not been addressed, and has only been performed for trauma care technology in one state in India.[17] Such assessments are urgently needed to inform surgical capacity improvements, which have the potential to significantly reduce 11% of the global disease burden resulting from unmet surgical needs.[16, 18]

This study aimed to describe national PVD risk and burden and vascular care capacity in Ghana by estimating the number of Ghanaians at risk of peripheral vascular disease (PVD), quantifying the health burden of PVD over time, assessing national vascular care capacity and by identifying factors contributing to vascular care deficiencies. By doing so, the potential gap between PVD burden and vascular care capacity could be defined and capacity improvement planning priorities identified. In addition, possible solutions to inefficient features of healthcare management and maladapted equipment and technology essential for vascular care in LMICs could be proposed.

Materials and methods

Setting

Ghana is a heavily indebted, lower-middle income country in West Africa with a population of 26 million people and an annual per capita income of US$ 1,760.[19] Ghana has 10 regions divided into 110 districts. Most districts have several primary health centers (PHC) and a government or mission hospital that serves as a district (first-level) hospital. PHCs provide public health and primary care services and therefore they were not included in the vascular surgical care capacity assessment despite being an important entry point for patients with risk or symptoms for PVD and the frontline facilities for risk-factor identification, reduction and management initiatives. District-level hospitals, which have 50 – 100 beds, are staffed by medical officers and nurse anesthetists, usually offer surgical services. Regional hospitals (second-level) have 100 – 400 beds and are staffed by specialist providers (general and orthopedic surgeons), in addition to medical officers and nurse anesthetists and can therefore offer surgical services that are broader in scope. There are four tertiary care hospitals in Ghana and all are affiliated with a medical school and/or a residency program and offer more specialized care, including cardiovascular and thoracic surgery.[20]

Data sources

This study combined data from three sources: two publically available online databases and a novel nationwide assessment of vascular care capacity in Ghana. The two databases used to estimate PVD risk factor prevalence and disease burden in Ghana were: the World Health Organization's Study on Global Ageing and Health (SAGE);[21] and the Institute of Health Metrics and Evaluation's Global Burden of Disease Study 2010 (IHME GBD) online data visualizations.[9]

SAGE Ghana

SAGE Ghana was a nationwide, multi-stage, cluster randomized, community-based survey of health and aging performed in 2008 and released in 2010.[22] Detailed population proportional sampling and survey methods used for SAGE Ghana have been previously reported.[22-24] Demographic, risk factor and morbidity data, as well as anthropometric measurements were collected. For this study, known PVD risk factors were extracted from the SAGE database, described and extrapolated nationally.[25] The risk factors included: age, male sex, hypertension, diabetes mellitus, coronary artery disease (CAD), stroke and body mass index (BMI). Respondents were considered to have cardiovascular disease if they affirmed either CAD or stroke. Individuals at moderate to high risk of PVD were defined as having three or more of the aforementioned risk factors in keeping with published consensus.[25]

IHME GBD

IHME GBD was a systematic, scientific effort to quantify the comparative magnitude of health loss due to diseases by age, sex, and geography.[26] For this study, estimated rates of death and disability-adjusted life years (DALYs) incurred from aortic aneurysm, mesenteric ischemia and lower extremity vascular disease in Ghana in 1990 and 2010 were extracted from the database. The rates for each of the aforementioned conditions were added together to get an estimate for PVD.[2] The change in the death and DALY rates were presented to demonstrate change in PVD burden in Ghana over time. Detailed methods of how these estimates were obtained have been previously published.[27]

Vascular care capacity assessment

A novel nationwide assessment of vascular care capacity was performed in Ghana between September 2014 and January 2015. The assessment tool was adapted from the WHO *Guidelines for Essential Trauma Care*, which lists 260 items of personnel and physical resources *essential* or *desirable* at different levels within a healthcare system.[28] All regional and tertiary facilities and a selection of district-level hospitals (totalling 40 facilities) were purposively sampled to represent hospitals with high volume and the diversity of geography and local socioeconomics.

After hospital leadership approval at each facility, surgeons, anesthetists, medical officers, professionals, technicians and/or in-charge nurses from the casualty, theatre, critical care, laboratory, radiology, physiotherapy, procurement, accounts and engineering departments were asked to complete their respective part of the survey. Item availability was rated as:

0 – Absent but should be present;

1 – Inadequate, available to less than half of those who need it;

2 – Partially adequate, available to more than half, but not to everyone who needs it; or

3 – Adequate, present and readily available to almost everyone in need and used when needed.

For items rated 0 - 2, contributing factors were systematically asked and not considered mutually exclusive (except when items had never been present at a facility). These were: 'The item or service has/is:

- Never been present;
- Present but broken and awaiting repairs;
- Present and staff able to use it but when they go home at night or on the weekend no one is available to fill the position;
- No staff member trained in using the available item;
- Available but lacks reagents or supplies;
- Necessary equipment or supplies out of stock;
- Available, but only after pre-payment that prevents most from receiving the service or item; and/or
- Other, with explanation.'

Direct inspection of items was performed to corroborate ratings and further troubleshoot reason(s) for non-availability. A more detailed description of item availability and comprehensive root cause analysis, including other reasons for deficiency of some items presented here, is pending publication.[29] For this study, we describe items essential for vascular surgery. Items specific to vascular care include: equipment and supplies required for vascular surgery (e.g. 4-0 – 6-0 nylon suture, vascular clamps, Fogarty balloons); skill for vascular anastomosis or thromboembolectomy; duplex ultrasonography with interpretation; CT scan with lower-extremity runoff protocols; and diagnostic and therapeutic angiography.

Data analysis

The prevalence of PVD risk factors was calculated using SAGE Ghana data. Confidence intervals around risk factor prevalence estimates were calculated with sampling weights that reflect the inverse probability of being selected to survey at each sampling unit. For the survey, the primary sampling unit was the region; the secondary sampling unit was census enumeration area. Each area was stratified into rural and urban localities.[21, 30] National extrapolation was performed using age-specific risk factor prevalence and population figures from the 2010 census assuming a 2.1% population growth rate through 2014, as projected by the World Bank.[31] PVD risk score was calculated by adding the number of risk factors present in accordance with published risk models: male, each decade over age 50 years,

hypertension, diabetes mellitus, smoker, cardiovascular disease, BMI≥30.[25] Death and DALY rates for PVD and the change in rate from 1990 to 2010 were calculated using IHME GBD data as described above. Vascular care item availability rating (median and range) and factors contributing to non-availability (i.e. percent of hospitals reporting that factor for each specific item) were described by hospital level (i.e. district, regional, tertiary). All analyses were done with Stata v13 (College Station, TX, USA).

Ethics

Ghana Statistical Service census officers performed initial data collection for SAGE Ghana. Use of the anonymous database was authorized by the WHO Multi-Country Studies Archive.[21] IHME GBD data are open-access and without need for authorization.[9] For the capacity assessment, the Kwame Nkrumah University of Science and Technology, Komfo Anokye Teaching Hospital Committee for Human Research and Publication Ethics, and the University of Washington Ethical Review Board gave approval for the study. In addition, the Chief Director of the Ghana Ministry of Health, Director General of the Ghana Health Service and respective Regional Health Directors gave permission for research and facilitated hospital visits.

Results

Peripheral vascular disease population risk from SAGE Ghana

Of the 5,573 respondents, 4,305 persons were 50 years of age or older with data to estimate PVD risk representing 2,879,318 Ghanaians. Most respondents were younger than 70 years (67%) and 10% were older than 80 years of age. There was a slight predominance of males (52%) among the sampled population and persons living in rural areas were appropriately sampled (59%). Though most respondents had no education (65%), 21% had completed secondary school (Table 1).

The most frequently reported risk factor was hypertension (57% of respondents) followed by cardiovascular disease (i.e. history of stroke or angina pectoris; 25%), smoking history (25%), obesity (10%) and diabetes (4%). Thirty eight percent of respondents had 1 – 2 risk factors, 42% had 3 – 4 risk factors and 16% had ≥5 risk factors. Extrapolating nationally, there may be more than 1.65 million adults over the age of 50 years who are at moderate to high risk of PVD (i.e. ≥3 risk factors; 95%CI 1.56 – 1.75 million adults) (Table 2).

Estimated PVD burden from 1990 to 2010 from IHME GBD

The death rate from vascular disease in Ghana doubled from 1990 to 2010 and the DALYs incurred increased 4-fold with an estimated increase from 0.7 to 1.3 and 6.3 to 31.7 per 100,000 persons, respectively.[9] For comparison, equivalent figures from the United States are 10 and 121 per 100,000 persons, respectively.[9]

Nationwide vascular care capacity assessment

Outside of tertiary centers, perioperative equipment and supplies were not reliably available (median rating less than 3; i.e. basic airway equipment, electronic cardiac monitoring, and chemistry testing capacity). At tertiary hospitals, not all could consistently provide

mechanical ventilation (rating range 1 – 3), electronic cardiac monitoring (rating range 1 – 2), blood chemistry analysis (rating range 0 – 2) or arterial blood gas analysis (range 0 – 2) (Table 3).

Vascular diagnostic capacity was uniformly deficient. Duplex ultrasonography with trained personnel to perform the study and interpret the results was not available outside of tertiary facilities, where the median rating was only 1 (range 0 – 1). Computed tomography scan (CT) was also rarely available and lower extremity runoff protocols were absent at all hospitals capable of CT. Lastly, no hospital could perform diagnostic or therapeutic angiography (Table 3).

General surgical capacity (including amputations), though present at all levels of care, was widely variable at district-level (range 0 – 3) and regional hospitals (range 0 – 3). Tertiary hospitals dependably provided major surgical services (median rating 3). Equipment and skills to perform vascular anastomosis at the district or regional hospital level (median rating 0) were rare. Although, tertiary hospitals occasionally reported having the skilled staff, equipment and supplies necessary to perform vascular anastomosis, their availability was unreliable (median rating 2, range 0 – 2). Vascular graft material was unavailable at all levels of care; and, prosthetics for amputees were rarely available at the tertiary level (median rating 0) (Table 3).

Factors contributing to non-availability of vascular care

The preponderance of non-availability was primarily due to never having had the equipment or supplies necessary (absence). This was particularly the case for vascular grafts (100% due to absence), CT scan and angiography (95% due to absence) and prosthetics for amputees (90% due to absence). Lack of training and non-availability of duplex ultrasonography (92% of hospitals), equipment for vascular repair (68% of hospitals) and experience in major general surgery (including amputations; 48% of hospitals) are the main deficiencies limiting vascular care capacity. Of the two hospitals with angiography machines, both were broken and had been waiting on service calls for more than 6 months (Table 4).

Discussion

This study aimed to estimate the number of Ghanaians at risk of PVD and quantify vascular care capacity and factors contributing to item non-availability. By doing so, the information gained might aid healthcare planners considering capacity improvements and identify potential solutions to inefficient features of health systems management, training deficiencies and maladapted technology for vascular care in LMICs. This study identified more than 1.6 million Ghanaians older than 50 years at moderate to high risk of PVD (i.e. ≥3 risk factors) and this health burden is rapidly increasing. Additionally, there was a critical deficiency in vascular care capacity (i.e. diagnostics, perioperative and surgical care) due to absence of equipment, lack of training, and technology breakage. The limited vascular care resources were disproportionately distributed, being more available in urban centres and teaching facilities than in rural areas; this included diagnostic services for PVD and supplies for vascular injury control. However, there were several opportunities to maximise vascular

care capabilities by optimizing use of existing resources, such as ultrasounds not being used for duplex ultrasonography due to lack of training.

Though the burden of PVD in LMICs is poorly characterized, community-based surveys of PVD have consistently demonstrated high prevalence. A systematic review of studies from 12 LMICs that used ankle-brachial index (ABI) to diagnose PVD demonstrated a prevalence of 2 - 8% for individuals aged 45 - 49 years, and 12 - 23% for individuals aged 85 – 89 years.[32] Though there are no PVD estimates from community-based studies in West Africa to allow a more precise extrapolation, the present study demonstrated a similarly high co-prevalence of major risk factors for PVD in LMICs. Among rural black South Africans 50 years or older who attended an outpatient clinic, 29% were found to have an ABI less than 0.9. Smokers in that study had nearly 4.5 times the odds of having PVD compared to non-smokers.[33] This figure is somewhat greater than that found among smokers in HICs, where odds ratios of PVD among smokers have been consistently reported to be 2.4 – 3.1.[32] A community-based ABI survey of two districts in Central African Republic (CAR) reported a PVD prevalence of 15% and 32% in those who are 65 years or older. In the two sampled districts, the odds ratio of PVD for those with hypertension was 2.17 - 4.14. In non-African LMICs and HICs, the odds of PVD in individuals with hypertension has been consistently reported to be between 1.24 – 1.71.[32, 34] These studies suggest that, in addition to the high prevalence of PVD, there may be significant variation in the effect of individual risk factors on PVD among various epigenetic groups or regions. This observation has been corroborated by findings among African Americans residing in the United States who have a two-fold increased risk of PVD compared to Caucasians; this observation is not explained by increased levels of other risk factors, such as diabetes, hypertension, smoking history or obesity.[25, 35] Risk factor for risk factor, some African populations may have a disproportionately higher prevalence of PVD than other populations worldwide. This should be considered when planning vascular care capacity improvements in LMICs.

Of the estimated 202 million patients with PVD worldwide, 70% live in LMICs.[26, 32] Inopportunely, these healthcare systems are insufficiently equipped to care for patients with PVD.[11, 12, 14, 36, 37] Most LMICs have less than one general surgeon or physician anesthetist per 100,000 persons, no vascular surgeon, and severe deficiencies in infrastructure, equipment and supplies to care for even common surgical conditions.[2, 36] As described by this study, there is critically limited capacity to care for patients with PVD, whose number in the last decade has increased by more than 30% and which has become a more common cause of emergency surgery in LMICs than in HICs.[2, 32] Sub-Saharan Africa is one of the least affected regions by the dramatic epidemiological transition driving the global burden of PVD that is mainly occurring in South America and Southeast Asia.[2, 26, 32] Attention to the changing epidemiology of PVD in LMICs would benefit involved countries greatly. Specifically, national health systems could plan public health interventions to minimise the incidence of PVD risk factors and mechanisms for risk factor identification and management.[7, 38] In addition, healthcare systems could develop a surgical capacity improvement strategy, which might include vascular care.[7] While the greatest benefit to PVD burden reduction will be from public health initiatives, simultaneous investment in emergency, perioperative and critical care, and rehabilitation facilities required for vascular care would produce synergistic improvements in the capacity to manage a number of other

medical and surgical conditions (e.g. neonatal sepsis, myocardial infarction, stroke, trauma, obstructed labor) that require similar services.[39-42] Therefore, dedicated funding for surgical care should not be overlooked.[2, 43, 44]

Improvements in vascular care in LMICs must include training for clinicians, technologists and biomedical engineers in order to avoid wasteful mismatch in scarce physical and human resources. This study found that vascular care item non-availability, when not due to absence of equipment, was often the result of lack of training (i.e. duplex ultrasonography interpretation, vascular anastomosis, major surgery and amputation) and/or long periods of technology breakage (i.e. angiography). A similar study in India of trauma care capacity and causes of deficiency also reported item non-availability frequently due to prolonged breakage.[17] Attention to training clinicians (i.e. primary care providers, persons performing surgery, radiologists), technicians and biomedical engineers in LMICs will be increasingly important as the burden of PVD challenges the currently insufficient health system resources.

Though this is a comprehensive and novel study that incorporates data from several sources, there are notable limitations. The WHO SAGE data do not completely describe risk factors for or symptoms of PVD. For instance, hypercholesterolemia, inflammatory biomarkers and claudication were not evaluated. Further, ABI measurements were not performed as a part of the study. Nonetheless, the available assessment of population risk factors provides meaningful information that portends the growing burden of PVD in Ghana and other LMICs. Additionally, despite finding a substantial prevalence of PVD risk factors among Ghanaians, they are less likely to smoke or have hypertension compared to other LMIC populations.[9, 22, 45] Therefore, the data should be seen as a bare minimum estimate of LMIC population PVD risk.

There was also a limitation with the use of IHME GBD data. Death and DALY rates for each of the vascular conditions reported by the IHME GBD and described above (i.e. aortic aneurysm, mesenteric ischemia, lower extremity vascular disease) were added together to get a more robust estimate of PVD than available directly from the database. This approach assumes that the conditions were not co-morbid in the same individual. While this is not reflective of the epidemiology of vascular disease, the database does not allow for individual-level assessments. In addition, the goal of presenting the IHME GBD data was to demonstrate the trend of PVD in Ghana and not its prevalence as the latter was estimated more accurately by the WHO SAGE study.

Another limitation is the relatively subjective rating scheme used during capacity assessment (0 – 3). In an attempt to strengthen its validity, key informants from several departments that interact with the same item (i.e. X-ray – emergency room doctors, emergency room nurses, surgeons, nurse anesthetists, X-ray technicians, biomedical engineers) were asked about its availability to triangulate responses. To avoid bias, direct observation of equipment and supplies was also performed. One regional and one tertiary hospital in a highly populated area declined to participate in the study. Their resource availability remains undetermined in comparison to other facilities within the same healthcare level. Lastly, an attempt was made to understand the root causes of deficiencies, but there were many externalities beyond the

hospital level that could not be examined. Despite these limitations, this study provides a useful assessment of PVD risk among a LMIC population and vascular care capacity. These results may inform needed vascular care improvements to meet the projected marked increase in the prevalence of PVD in LMICs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographic characteristics of adults aged at least 50 years from World Health Organization's Study on Global Aging and Adult Health (SAGE), Ghana.

	%	(95% CI)	National estimate	(95% CI; 100,000s)
Age in years				
50-59	39.8	(37.2-42.3)	1,144,978	(10.7-12.2)
60-69	27.5	(26.3-28.7)	792,579	(7.6-8.3)
70-79	23.1	(21.5-24.7)	664,794	(6.2-7.1)
80-89	7.1	(6.1-8.2)	206,043	(1.8-2.4)
≥90	2.5	(1.2-3.7)	70,924	(0.3-10.7)
Sex				
Male	52.4	(49.1-55.7)	1,509,317	(14.1-16.0)
Female	47.6	(44.3-50.9)	1,370,001	(12.8-14.7)
Residence				
Rural	59	(42.9-75.1)	1,698,143	(12.3-21.6)
Urban	41	(24.9-57.1)	1,181,175	(7.2-16.5)
Education completed				
None	64.5	(53.5-75.5)	1,856,908	(15.4-21.7)
Primary	10.9	(7.5-14.3)	313,732	(2.2-4.1)
Secondary	21	(13.3-28.7)	605,187	(3.8-8.3)
More than secondary	3.6	(2.6-4.6)	103,491	(0.7-1.3)

CI – confidence interval

Table 2

Peripheral vascular disease risk factors among adults aged at least 50 years in Ghana.

	%	(95% CI)	National estimate	(95% CI; 100,000s)
Hypertension				
No	42.6	(36.0 - 49.3)	1,223,869	(4.4-14.2)
Yes	57.4	(50.7 - 64.0)	1,646,350	(14.6-18.4)
Diabetes				
No	96.2	(94.7 - 97.7)	2,758,828	(27.3-28.1)
Yes	3.8	(2.3 - 5.3)	108,959	(0.7-1.5)
Smoking				
Never smoked	75	(70.5 - 79.6)	2,160,572	(2.03-2.29)
Previously smoked	14.3	(11.3 - 17.2)	411,413	(3.3-4.9)
Current smoker	10.7	(4.2 - 17.1)	307,332	(1.2-4.9)
Body mass index				
<30 kg/m^2	90	(83.2 - 96.0)	2,501,835	(23.9-27.6)
≥30 kg/m^2	10.4	(4.0 - 16.8)	291,721	(1.2-4.8)
Cardiovascular disease				
No	75.3	(73.3 - 77.3)	2,158,486	(21.1-22.3)
Yes	24.7	(22.7 - 26.7)	709,300	(6.5-7.7)
Peripheral vascular disease risk*				
Very low	4.6	(3.7 - 5.4)	131,771	(1.1-1.6)
Low	38	(36.0 - 40.0)	1,092,989	(10.4-11.5)
Moderate	41.9	(40.8 - 43.1)	1,207,717	(11.8-12.4)
High	15.5	(13.3 - 17.7)	446,840	(3.8-5.1)

Conditions were defined as detailed in *Methods;* CI – confidence interval;

* peripheral disease risk was defined as: very low – no risk factors; low – 1-2 risk factors; moderate – 3-4 risk factors; high – ≥5 risk factors

Table 3

Vascular care item availability at district-level, regional and tertiary hospitals in Ghana.

	Median item availability rating (range)					
	District		Regional		Tertiary	
Number assessed	29		8		3	
Perioperative care						
Basic airway equipment*	2	(0-3)	2	(0-3)	2	(2-3)
Advanced airway equipment†	3	(0-3)	3	(0-3)	3	
Oxygen supply	3	(1-3)	3	(2-3)	3	(2-3)
Pulse oximetry	3	(0-3)	2	(2-3)	3	
Mechanical ventilator	2	(0-2)	1	(0-3)	3	(1-3)
Blood transfusion ability	2	(1-3)	2	(1-3)	2	(2-3)
Electronic cardiac monitoring	0	(0-2)	1	(0-2)	2	(1-2)
Hemoglobin	3	(1-3)	3	(2-3)	3	
Electrolytes	0	(0-3)	1	(0-2)	2	(0-2)
Arterial blood gas, lactate	-	-	0		1	(0-2)
Imaging						
X-rays	2	(0-3)	2	(0-3)	2	(2-3)
Duplex ultrasonography	0		0		1	(0-1)
CT scan	-	-	0		1	(0-3)
Angiography	-	-	0		0	
Surgery						
Basic surgery‡	3	(0-3)	3	(0-3)	3	
Major general surgery§	1	(0-3)	3	(0-3)	3	
Vascular repair or anastomosis	0	(0-2)	0	(0-2)	2	(0-2)
Vascular shunt or graft	0		0		0	
Skin grafting	0	(0-3)	0	(0-2)	2	(1-3)
Rehabilitation						
Prosthetics for amputees	0		0		0	(0-1)

CT – computed tomography;

*Basic airway equipment – oral and nasal airways, suction pump;

†Advanced airway equipment – endotracheal tubes, laryngoscope;

‡Basic surgery – wound debridement, digital amputation;

§Major surgery – neck exploration, exploratory laparotomy, major amputation

Table 4

Factors contributing to vascular care item non-availability (%) in Ghana.

	Equipment absence	Broken	Personnel shortage	Lack of training	Lack of supplies	User fees necessary
Duplex ultrasonography	3	5		92		
CT scan	95		3			2
Angiography	95	5				
Basic general surgery*	3		5	28		
Major general surgery†	8		5	48	3	
Vascular repair or anastomosis	32			68		
Vascular graft	100					
Skin grafting	60	13		24		3
Prosthetics for amputees	90					10

CT – computed tomography;

*Basic surgery – wound debridement, digital amputation;

†Major surgery – neck exploration, exploratory laparotomy, major amputation; Contributing factors were not considered mutually exclusive except when items had never been present at a facility. Therefore, some totals sum to more than 100%.