Costing a National Emergency Care System for Uganda

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Prepared by the African Federation for Emergency Medicine

ABBREVIATIONS & ACRONYMS

AFEM	African Federation for Emergency Medicine
ALS	Advanced Life Support
BEC	Basic Emergency Care
BLS	Basic Life Support
CAD	Computer Aided Dispatch
DCP2	Disease Control Priorities, Second Edition
DCP3	Disease Control Priorities, Third Edition
ECS	Emergency Care System
EFAR	Emergency First Aid Responder
EM	Emergency Medicine
EMS	Emergency Medical Services
EU	Emergency Unit
GH	General Hospital
IFT	Inter-facility Transfer
HCIV	Health Centre IV
HMIS	Health Management Information System
IUSS	Infrastructure Unit System Support
MoH	Ministry of Health
NRH	National Referral Hospital
RRH	Regional Referral Hospital
UNAS	Uganda National Ambulance Service
WHO	World Health Organization

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EXECUTIVE SUMMARY

Emergency care is an essential part of an effective health care system. Delivery of this vital element requires several integrated services, which together function to provide prompt, safe and effective access to health care in times of urgent need. The dilemma of resource scarcity plagues health care systems. Health care priority setting depends on cost implication inputs. Ability to implement sound planning and organisation is often inhibited by a lack of context specific cost analyses. Our work aims to fill this gap and act as a resource to support planning for dedicated emergency care services in the Ugandan context.

The main purpose of this report is to estimate the cost of resources necessary to perform the essential functions of a coordinated national emergency care system. Wherever possible, figures are specific to the Ugandan environment and informed by extensive discussions with current administrators and policymakers. Where data were sparse, expertise was provided for by the African Federation for Emergency Medicine and appropriate assumptions undertaken.

This report uses guidance from the forthcoming article, *Costing facility-based emergency care*[1]*.* Extensions of the model are used to frame the development of this piece. Principles applied throughout that model were expanded to cover all elements of emergency care service delivery, and have been adapted to the context, aims and needs of Uganda. We employed various approaches in developing this report: top-down costing from hospital expenditure, and bottom-up costing for new activities such as scene care. Primary data were collected during visits to the Ministry of Health in Kampala during March 2018 and through extensive dialogue with the leadership of the Department of Emergency Medical Services. All costs were derived from expenditure within the past 3 years and were not inflated. Online currency exchange rates were used throughout this report at a rate of 3,571 Ugandan Shillings to the US Dollars.[2] All costs are reported in US dollars.

The report adheres to the following structure. First, we share our final results. Then, we discuss broadly the assumptions and inputs undertaken in each domain of care from Scene to Transport and finally, Facility. There are many considerations that fall beyond the scope of this report. Therefore, we then outline the items excluded from our calculations and consider the limitations of our findings. Finally, we discuss our results and draw conclusions. We finish by offering a proposed 5-year cost staging plan based off of the findings.

The total cost of implementing a dedicated emergency care system, covering elements of scene care, patient transport and facility care for Uganda is approximately $225,553,907 over the first 5 years of implementation (including a projected 2% annual increase due to inflation). This reflects substantial new areas of spending (e.g. training,

personnel, dedicated physical spaces and essential equipment) as well as growth in the use of medicines, lab tests and radiology at facilities.

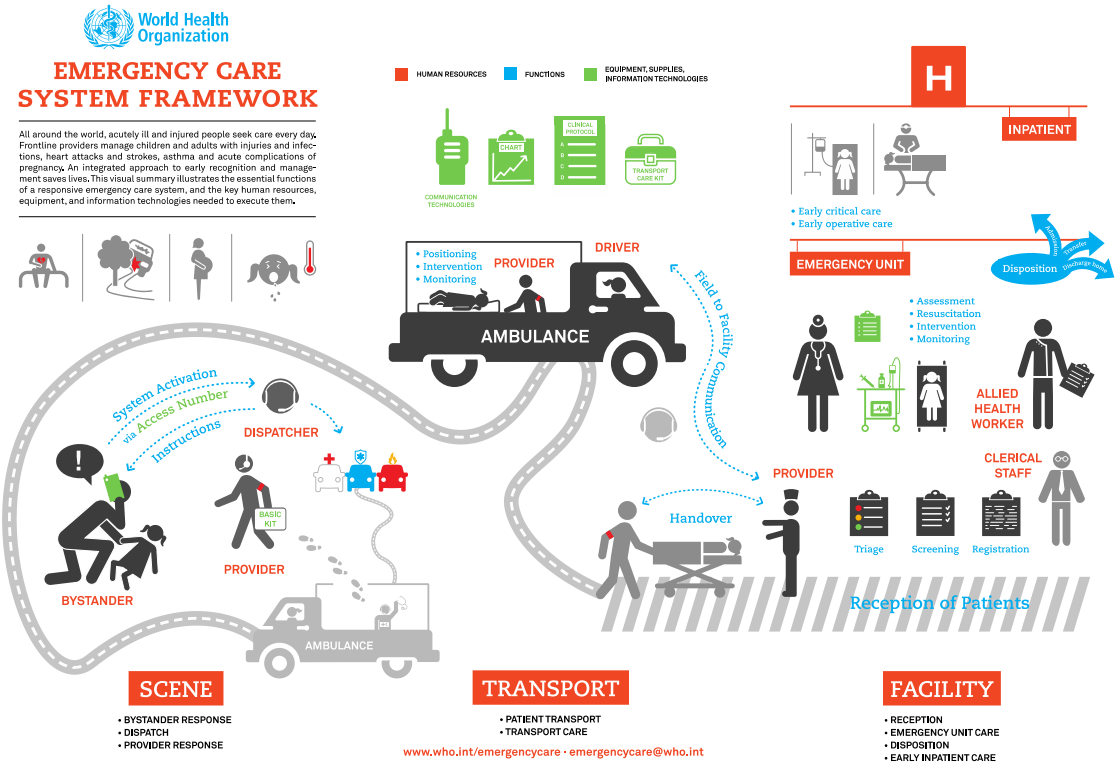
Note that this report is limited in several ways. Firstly, many of the data inputs available to us are old, restricted in scope, or based on untested assumptions. In addition, we have had to make many assumptions about the scope of services, incremental increases in service provision, and speed of acquisition of resources. Furthermore, we have had to stage the cost over time, given that staff need to be employed and trained, buildings built, and vehicles acquired and equipped country-wide. We had no evidence on which to make this staging decision and so had to use best judgement. Costs range from around $18.5 million in year 1 to $72 million in year 5.

Despite the multiple limitations, we believe that this report contains a reasonable estimate of the likely annual cost of providing comprehensive emergency care across Uganda, in line with recommendations from WHO and Disease Control Priorities.

BACKGROUND

Organized emergency care matches patients rapidly with necessary clinical services. The Disease Control Priorities project estimates that over half of deaths in low and middle-income countries could be addressed the implementation of effective emergency care.[3] However, what "effective emergency care" means from a health system perspective had not previously been defined. The approach of this costing was derived from the new model of emergency care delivery from WHO: the essential functions of the WHO Emergency Care System (ECS) Framework.[4]

Figure 1: WHO Emergency Care System Framework Infographic



The WHO ECS Framework details essential functional components of emergency care at the *scene*, during *transport*, and in *facilities*. In each of these three domains critical functions are specified. In addition, the Disease Control Priorities project (DCP3) now contains an emergency care package that identifies specific essential clinical services for each level of the health system. Elements of specific services as identified in the Essential Package of Emergency Care from DCP3 were included based on appropriateness to level of care.[5] We used these guides, as well as input from the Ugandan Ministry of Health Department of Emergency Medical Services, to inform decisions about what resources were needed to specify this report.

This assessment provides a conceptual structure and initial cost basis of a functional and integrated ECS in Uganda. Where available and appropriate, current consumption of medicines and services in Uganda are integrated into the model. Panel 1 presents our preliminary findings regarding the incremental cost of developing the emergency care system from the existing available services, assuming all activities could be undertaken immediately and simultaneously. This includes inputs for full coverage, including all National Referral Hospitals (NRH), Regional Referral Hospitals (RRH), General or District Hospitals (GH), and Health Centre IVs (HCIV). As a result of additional costs incurred due to recurring expenditures throughout implementation, true costs will be higher. We account for this in a more realistic 5-year implementation scenario in our final section.

Panel 1: Incremental cost of activities for the establishment of an Emergency Care System for Uganda, un-inflated

		Training	Staffing	Medicines & Consumables	Physical Infrastructure	TOTALS
Scene		$275,175	$49,365	$15,829	$89,347	**$429,716**
Transport		$625,137	$20,199,206	$30,171,960	$23,720,857	**$74,717,160**
Facilities	**NRHs**	$34,545	$290,992	$114,806	$186,659	**$627,003**
	RRHs	$73,155	$635,328	$403,478	$667,150	**$1,779,111**
	GHs	$463,990	$2,459,150	$2,329,412	$4,395,322	**$9,647,875**
	HCIVs	$457,555	$2,227,799	$672,360	$1,916,810	**$5,274,525**
TOTAL						**$92,475,389**

The hope is that this information will provide transparency of the National Emergency Medical Services Policy and act as a guide for further implementation costing. Within each domain of care, panels are used to illustrate the cost each input has on the total financial burden. This may be used to help set priorities.

SCENE

In the WHO Emergency Care System Framework, scene care assumes responsibilities for bystander response, dispatch, and provider response. This includes essential emergency care functions such as: system activation via a universal access number, delivery of instructions to bystanders, resource management of ambulance fleet, and dispatch of clinical personnel.

Under the framework, scene care also encompasses functions of provider response, including hazard management, field-to-facility communication, and destination triage. There are significant overlaps of functions between provider response at scene and transport care; to simplify the report we chose to include all cost inputs for uniformed provider response under *transport* rather than *scene*. This allowed us to avoid cost duplication.

For essential functions provided at the scene of injury or illness, the elements costed in this report include:

- training of Emergency First Aid Responders (EFARs),
- first aid kits provided to EFARs,
- computer aided dispatch system,
- dispatch centre physical infrastructure and equipment, and
- dispatch centre staffing.

Panel 2: Categories costed for establishment of national emergency scene response

Category	Minimal requirement	Costed items
Bystander response	Lay community members equipped with patient care knowledge and first aid skills	Training and equipment
Initiation of Dispatch	Use of context-adapted protocols to initiate dispatch of clinical response	Training, staffing and equipment
Physical Infrastructure	Dedicated centre with areas and equipment for operating dispatch platform	Construction, general equipment, maintenance

In alignment with the proposed ambulance dispatch management framework provided through discussion with the Department of Emergency Medical Services, this report specifies scene care as administered at a health region level. Throughout this report, it is assumed that each of the health regions should have the capacity to manage resources and dispatch of emergency medical response for their regional jurisdiction.

There are important policy activities that fall outside of the scope of this report but should be further explored for financial impact. These include the development of a universal access number, emergency number community sensitisation and outreach, and bystander first aid training (bystanders are lay-people who happen to be in the immediate vicinity when illness or injury occur: they are not dispatched by the emergency care system). Bystander first aid training really means having a proportion of the general public who have attended short course training in first aid. Such courses are typically offered by organisations like St Johns or Red Cross, and should be regulated by the Department of EMS.

Our assumptions and sources for costing data included in this report are discussed broadly below and further details are provided in Appendix A.

Training

Under guidance from the Department of Emergency Medical Services, a national two-tier EMS system is proposed. In such a system, Tier 1 refers to the organised dispatch of trained community members, and Tier 2 refers to uniformed, employed professional provider response. The Tier 1 system is known locally as the Emergency First Aid Responder program. Training EFARs was costed. This report includes implementation of a national training program.

The following guidelines were used to cost for training activities. The EFAR training curriculum utilizes a train-the-trainer model. Under this model, stakeholders, customarily health care professionals from the region, are trained first. During these sessions, they hone lecturing and teaching skills to be able to effectively deliver Emergency First Aid Training to the wider public. These professionals utilize the skills developed during their course to host trainings within the health regions for interested lay community members.

We assumed a centrally run training program, initiated with one 5-day long train-the-trainer session for 10 participants. Thereafter, we costed for a single facility with the capacity to conduct a 5-day training for 40 weeks of the year. This allows for thousands of lay individuals to be trained in Emergency First Aid Response, in the first year of implementation. For the purpose of this model and under the guidance of the Ministry, we assumed the cost of EFAR to be undertaken by the MoH. We assumed a once off training for the CAD System platform to be conducted in each region.

Medical Supplies

Emergency First Aid Responder training attendees are provided with a small basic first aid response kit to support in scene management. The items for this kit were determined upon advice from experts. Each kit costs $4.12 and holds supplies for up to 5 uses. We assume there to be one re-stocking of kit items per year, requiring the

provision of 3,840 kits annually and allowing first aid responders to attend to several thousand cases per year.

Dispatch

Dispatch system technology costs were collected from the RapidDeploy cloud-based Computer Aided Dispatch (CAD) platform. Costs were sourced directly from the provider and include the provision of the dispatch platform, training and on-boarding staff to the software. A list of all equipment required to run the CAD system were also provided by RapidDeploy and used to guide costing of equipment.

Human Resources

Dispatch call centre staffing needs were based on a 24-hour-a-day, 7-day-a-week response availability. To assist in estimating emergency call volume, we used guidance of service data from dispatch centres in South Africa and assumed that once the community is fully sensitized and aware of the universal access number, call volumes could represent approximately 20% of emergency care patient volume at facilities. We assume this increasing steadily over a 5-year window: in the first year 4% of emergency unit patient volume will arrive by ambulance, increasing to 20% over time. Given one dispatch centre per region, and using Emergency Unit patient volumes provided by the Ministry, this amounts to an average of six calls per day to begin with, increasing over a 5-year period to an average of 31 calls per day. This call volume requires one dispatch caller staffed for each 12-hour shift. Following this standard, the staffing minimum of one dispatch centre was assumed at five dispatchers (one on shift during day, one off shift during day, one on shift during night, one off shift during night, and one for covering leave).

Dispatch requires the function of “Medical Control”, clinical guidance and instruction delivered to those at the scene of incident by a more experienced provider. Assuming the use of the RapidDeploy CAD dispatch system, we costed for one Medical Control Officer at the local Emergency Unit to field calls and provide clinical assistance when needed. We assumed this individual to be part of the dedicated emergency unit staff, and therefore any costs for their salary are already included in the overall staffing structure of the emergency unit and not repeated here. One clinical officer should be accessible by phone at all times to ensure readiness of clinical instruction.

Physical Infrastructure

The Department of Emergency Medical Services provided us with guidance on the health regions structure. Under this direction, we assumed each of the fourteen health regions will establish one EMS call and dispatch centre. These centres are expected to stand alone and run independently of existing structures. Therefore, our model assumes establishing a dispatch centre requires construction of a new physical space, furniture for administration (two desks and two phones), a restroom for staff, and key technical equipment for CAD software (including a computer and phones).

The size of dispatch centres (50 m^2) was informed by the Infrastructure Unit System Support Project (IUSS) guidelines for standard administrative rooms[6]. This accounts for an open plan office space capable of seating a maximum of four individuals with a small staff break room and toilet. Average costs per square meter for construction were provided by the Ministry of Health Department of Infrastructure. We assumed the lower end of the provided range was used ($700 per m^2) as dispatch centres do not require advanced clinical space. The cost estimates for both renovation and maintenance were based on expenditure from the same region[7]**.** Renovation costs were set at 30% of construction capital and maintenance costs were set at 10% of construction capital. Water was assumed to annually cost 1% of construction costs, and electricity was assumed to cost 3% of construction costs, based off similar data from Kenya.

Provider Response

We presume a two-tiered system for care response. Tier 1 involves EFARs who are contacted through the RapidDeploy dispatch system via SMS. EFARs are unsalaried and therefore their response incurs no additional cost beyond initial training and basic first aid kits. The proportion of responses relying on EFARs is set to reduce over time as more professional EMS responders are added to the system: Tier 2 response.

Tier 2 personnel are the same individuals staffing ambulances. Therefore, to avoid duplication of costs, expenses for their employment, medical supplies, and response equipment were excluded from *scene* and instead can be found under our analysis of the costs for *transport*.

Results

The estimated annual cost of implementing a scene care system in each health region is presented in Panel 3.

Panel 3: Estimated annual incremental cost of implementing emergency scene care nationally

	Training	Staffing	Consumables	Capital	TOTALS
Bystander Response	$274,175		$15,829		$290,004
Dispatch	$1,000	$49,365			$50,365
Physical Infrastructure				$89,347	$89,347
TOTAL	$275,175	$49,365	$15,829	$89,347	**$429,716**

The greatest single cost is associated with the input of emergency first aid response training, at $274,175. Equipping EFARs with first aid kits adds $15,829. The amortized cost of physical space and general equipment is $89,347. The total annual cost is estimated at approximately $429,716.

TRANSPORT

In the WHO Emergency Care System Framework, the element of *transport* assumes responsibilities for patient transport and all care delivered throughout transportation until arrival at an appropriate health facility. This includes essential emergency care functions such as: transportation of patient from scene of incident to facility, and patient positioning, intervention and monitoring during transport.

For care delivered through transport, the components costed in this report include:

- staffing for the management of accreditation and fleets,
- training of Ambulance Providers,
- basic provider kits,
- computer aided dispatch system equipment for vehicle
- procurement of ambulances, ambulance equipment,
- ambulance staffing, and
- ambulance garages.

Notably, the component of transport occasionally encompasses the use of ambulances for inter-facility transfer (IFTs). For the purpose of this report, costs for transportation are predominantly identified in the "primary response" of moving patients from location of acute event to a hospital facility. Upon direction from the department of EMS, an additional 194 IFT vehicles were added, covering a ratio of one vehicle per 200,000 population.

Panel 4 outlines the categories costed for establishment of a dedicated national ambulance service.

Panel 4: Categories costed for establishment of dedicated national ambulance service

Category	Minimal requirement	Costed items
Patient transport	Vehicle with ambulance functionality and space to give care	Vehicle, general equipment, and maintenance
Transport Care	Use of appropriate positioning, monitoring and intervention protocols	Training, supplies and equipment, and staffing
Physical Infrastructure	Dedicated ambulance posts with areas for employee rest	Construction, general equipment, and maintenance

In alignment with the proposed ambulance dispatch management framework as provided, we specify patient transport and transport care as administrated by each health region. Each region should have the capacity to attend to emergencies and transfer patients to facilities. Therefore, the process of costing accounts for expenses required for a regional level implementation, but findings are presented as expenditure implications of developing a nationwide ambulance response.

We used the DCP3 recommended ratio of 1 ambulance per 50,000 people as the benchmark for estimating the number of ambulances required for each health region[8]. Rural and urban settings can incur different coverage needs but are unspecified in this report: we have taken an average of 1:50000 across all geographies but this will need local refinement, depending on road network, terrain and health facility proximity to population centres. Target response times may influence the suitability of this ratio. For the purposes of this report we assumed the DCP3 vehicle to population ratio regardless of target response time. Table 1 demonstrates the vehicle and staffing requirements per region needed to meet our assumed minimum ratio of care.

Under recommendation from the Department of EMS, one additional Advanced Life Support (ALS) capacity ambulance was costed per health region, for a total of 14. ALS ambulances were equipped with all of the equipment included in BLS ambulances, with the addition of a nebulizer, warming blankets and cardiac monitor to match capacities as defined by the Equipment Required for Emergency Care WHO draft document. Furthermore, one additional inter-facility (IFT) transfer vehicle, equipped to BLS standards, was costed per 200,000 population, culminating in an additional 194 ambulances. This indicates a total of 971 BLS equipped vehicles and 14 ALS equipped vehicles.

Table 1: Vehicle and clinical requirements per health region, based on population

Health Region	Population	Vehicles (1/50000)	Ambulance Providers (7 per vehicle)
Kampala Metro EMS	7,136,300	143	999
Masaka EMS	2,050,200	41	287
Mubende EMS	2,077,700	42	291
Mbarara EMS	3,140,700	63	440
Kabale EMS	1,442,100	29	202
Fort Portal EMS	2,542,000	51	356
Hoima EMS	2,250,800	45	315
Jinja EMS	3,972,200	79	556
Sororit EMS	2,339,700	47	328
Mbale EMS	3,816,000	76	534
Lira EMS	2,167,700	43	303
Moroto EMS	1,094,700	22	153
Gulu EMS	2,036,000	41	285
Arua EMS	2,757,000	55	386
TOTALS	***38,823,100***	***776***	***5,435***

Assumptions and sources used to cost transport care are discussed below, and further details are provided in Appendix B.

Human Resources

Under guidance from the Ministry, and aligned with South African Emergency Medical Services Minimum Norms and Standards for Ambulance Services, we costed for the bulk of ambulances at Basic Life Support level[9]. This indicates the ability for transfer and treatment for ill or injured patients requiring limited non-invasive medical interventions and basic support medical care. Specific requirements include a minimum staffing of two Basic Life Support (BLS) qualified Ambulance Providers per vehicle per shift. These staff are able to offer basic prehospital trauma care, rescue, stabilization and transport of injured patients. We followed expert guided staff minimums of staff members per ambulance, in which a rotation of 2 Ambulance Providers on each shift e.g. 2 on day shift, 2 off day shift, 2 on night shift, 2 off night shift and 2 are available to cover vacation and sick leave.

Our costing included capacity for a portion of ALS ambulances. ALS equipped ambulances indicate the ability to provide transport for patients in critical conditions. Staffing of these vehicles requires that, each shift be covered by one ALS trained provider and one BLS trained provider, for a total of 5 ALS providers and 5 BLS providers per 24-hour ALS Ambulance.

Management of the fleet is essential for timely and appropriate response, therefore costs for fleet supervisors are included in our report. DCP2 recommends one supervisor per 3 ambulances, but we believe the regionalized management of ambulance fleets as proposed by the Department of EMS appeals to an adequate staffing of 1 fleet supervisor per region[10]. Therefore 14 fleet supervisors were costed for full national coverage. The Ministry can increase this if vehicle maintenance becomes overwhelming for one staff member. To reflect guidance from DCP2, fleet managers were projected at a salary level equivalent to Ambulance Providers.

Certification, accreditation, licensing and registration are essential components of promoting coordinated quality transport care. Functions include certification process and a register of certified ambulance providers, accreditation process and registration of all training sites, accreditation for and register of all emergency care services, and required licensing processes for EMS provider services. These functions necessitate the development of a formal accreditation system. We did not cost for activities undertaken in developing this policy, and we envision the budget impact of these activities to be minimal. In this report, we cost for two full time staff members who sit within the Department of EMS to coordinate certification, accreditation and registration of emergency vehicles, providers and services across the country. We costed salaries for one ambulance officer and one secretary. We assumed staff would share office

space with the existing EMS team and therefore did not include these costs into our analysis. We anticipated their equipment needs at two computers, one desk, two chairs, and one telephone.

Training

Currently providers in the Uganda National Ambulance Service (UNAS) are qualified nurses who have undertaken supplementary Basic Emergency Care (BEC) Training. Under proposals by the Department of EMS, dedicated Ambulance Providers will now be expected to undergo a three-month-long Basic Life Support course to receive qualification. Training of this length requires the construction of a training centre, and we therefore costed construction of 5 venues including skills area, toilet and office space for each to house 72 participants at a time. Following guidance from the IUSS Health Facility Guides for Nursing Education Institutions, we used the recommended 2.5m^2 per seat for a demonstration and anatomy room, providing room for all participants[11]. This cost can be reduced if appropriate existing space is already available. To conduct these trainings, we costed for 2 full time trainers and 1 administrator per session, for a total of 30 trainers, 15 administrators and 5 coordinators. We assume 24 students per course and that each facility has the capacity to conduct 3-month long courses, 3 times a year with 3 courses occurring concurrently, providing for 9 courses in a year. We included costs for 3 sets of equipment found in ambulances for training purposes, consumables for basic provider kits, general equipment and stationary. Consumables were priced at the annual cost for a fully functioning ambulance to account for replacements.

We calculate an anticipated 9,776 BLS Ambulance Providers will be needed to adequately staff all ambulances necessary for care. The capacity of these the training centres outlined here will fall short of the target of 1,955 Ambulance Providers necessary to fully staff vehicles the first year. Therefore, we recommend a continuation of the current staffing mechanisms of BEC trained nursing cadres to provide coverage where BLS training cannot be scaled up in time. We propose that the proportion of BEC trained nurses staffing ambulances be reduced over time as BLS trained Ambulance Provider cadres grow. To account for this, we included BEC training costs for the remaining 875 providers needed to fully staff ambulances annually.

Similar calculations were conducted for Advanced Life Support ambulance provider training. ALS provider training is comprised of a one year long course. We assumed construction of one training centre, with space capable of hosting 24 students and 2 trainers at a time. Salaries of trainers as well as one administrator were costed. Costs for one set of equipment found in ambulances for training purpose and consumables for basic provider kits, general equipment and stationary were also included. Consumables were priced at the annual cost for a fully functioning ambulance to account for necessary replacements. We costed for training of all 70 ALS providers required to outfit ALS ambulances. Training was therefore assumed to be completed over a 3-year period.

Medications and supplies

Basic ambulance equipment should include the items necessary for emergency procedures such as airway support, haemorrhage control, fracture immobilization, and childbirth. On board supplies should also be adequate for provider personal protection, patient movement and basic rescue procedures. Our approach regarding which items were costed in basic provider kits was guided by the AFEM Handbook.[12] This was further refined through analysis of current UNAS monthly consumption estimates provided by colleagues at the Ministry. Price for items were sourced from Joint Medical Stores, Uganda. Where cost data was unavailable through JMS inventory, local expertise was used to advise estimated prices.

Quantities of consumables were informed by monthly stock replenishment records for UNAS ambulances. Currently ambulances are conducting a fraction of the services they are likely to undertake when the EM system is at full capacity. To account for this, and under expert guidance, we assumed a threefold increase from current utilization in consumables for a fully functioning ambulance. Thus, this report costs for ambulances normative service.

Equipment

All ambulances should fit to the type and specifications established by the MoH. Therefore, the items costed for equipment in ambulances were informed by the Ugandan Ministry of Health, National Ambulance Services Compliance Sheet [13]. Uganda MoH guidelines specify ambulance vehicles to be a Toyota Land Cruiser Hard top 4WD. According to MoH policy, after 5 years vehicles are assumed to have concluded their useful life and are set to be disposed. Vehicles which have reached this stage are assessed and undergo evaluation to determine resale cost under current mechanical conditions. We gathered historical data from the Department of EMS of previous end sales prices and used the average buy back price of $2,240. This sales price was reduced from the total cost of ambulance procurement to ensure accurate annualized cost. Maintenance and fuel records were derived from 2017 UNAS expenditure reports provided to us by colleagues at the Department of EMS. We assumed the following essential equipment to be included in the procurement cost of the vehicle: radio system, labelling, linoleum floor, light bar and siren, seats for clinicians and frosted glass film. Any additional equipment necessary for transport care, including items from the AFEM Basic Provider Kit Guidelines and UNAS compliance sheet, were price separately and included in the final costs of a fully equipped ambulance. In alignment with the assumptions made in our scene care analysis regarding the CAD platform, the cost of one smartphone per ambulance was included to fulfil equipment requirements for the RapidDeploy dispatch platform.

Procurement costs include ambulances which are already outfitted with radio communication capability. Under guidance from the MoH, further costs for implementing a radio-based communication system were omitted. In lieu,

communication via cellular mobile network and in coordination with the RapidDeploy dispatch platform were considered to be adequate for communication. Telecommunications cost, such as cellular airtime, were not included in this report.

Physical Infrastructure

Ambulances require a small carport garage style shelter from which to dispatch. To establish the number of sites needed, we targeted a clustered approach based on factors of population density and road network, but given a lack of sub-district data available we instead assumed an estimated average of ten garages per region under the guidance of the MoH. Placement and number of dispatch posts contributes to the ability to achieve response time targets.

We assumed costs to be comprised of the construction of new structure which includes space for a small break room for staff, a toilet, a desk and four chairs. Under IUSS guidance we assumed shelters to be 72m^2.[14] We used the lower end of the MoH Department of Infrastructure averages ($700/m^2) to account the less intensive and complex structure. Although we costed this using an estimate from the MoH Department of Infrastructure cost of construction per m^2, it is very likely that the true cost of constructing what is basically a warehouse for storing ambulances is much less.

Results

The estimated average annual cost of implementing a dedicated national ambulance service per health region is presented in Panel 5.

Panel 5: Estimated annual cost of implementing dedicated national transport care

	Training	Staffing	Consumables	Capital	TOTALS
Patient Transport		$2,745		$21,181,362	$21,184,107
Transport Care	$625,137	$20,196,461	$30,171,960		$50,993,558
Physical Infrastructure				$2,539,495	$2,539,495
TOTAL	$625,137	$20,199,206	$30,171,960	$23,720,857	**$74,717,160**

The greatest single cost increase is associated with the cost of consumable medicines used on board to supply the basic provider kit at $30,171,960. Secondly, the procurement of ambulances and their general equipment and maintenance at $21,185,107. Staffing required for ambulances costs $20,196,461. The amortized cost

of new physical space is $2,539,495. The total annual cost is estimated at approximately $74,717,160.

FACILITY

Under WHO Emergency Care System Framework facility care assumes responsibilities for reception (registration, screening, triage and handover), emergency unit care (assessment, monitoring, diagnostic studies and treatment) and disposition (admission, discharge or transfer).

The DCP3 emergency care package identifies specific essential clinical services that should be provided at each level of care centre. We used this information to guide our decision regarding resources to specify within this model.

Facilities are the point in the emergency care system where patients are expected to receive definitive care. This relies heavily on appropriate triage, adequate supplies and staff, and physical infrastructure. These principles informed the elements costed for this report. Panel 6 outlines the categories costed for establishment of dedicated hospital emergency units.

Panel 6: Categories costed for establishment of dedicated hospital emergency units

Category	Minimal requirement	Costed items
Triage	Full time triage clinicians	Training and staffing
Initial resuscitation	Use of context-adapted protocols for resuscitation	Training, supplies and equipment, staffing
Clinical assessment and monitoring	Vital sign and cardiac measurement and monitoring	Equipment and staffing
Quality Assurance	Systematic monitoring and improvement of clinical processes	Staffing
Medications	N/A	Incremental fraction of cost reported in EDs
Lab	N/A	Incremental fraction of cost reported in EDs
Radiology	N/A	Incremental fraction of cost reported in EDs
Physical Infrastructure	Dedicated ED space with areas & equipment for triage, waiting, trauma, minor operating theatre, nurses.	Construction, general equipment, maintenance

Unlike scene or transport care, a portion of the activities outlined under facility-based emergency care are already being executed to some degree within the health system. Therefore, our approach in costing for facility-based care was to define the incremental cost associated with upgrading the existing level of care to a dedicated emergency unit meeting the functional criteria of the WHO framework and capable of delivering the essential services as established per hospital level in the DCP3 Essential Package of Emergency Care. The size and capacity of each health facility was informed by the

anticipated volume of patients and expected, and the essential resources for delivery of emergency care in hospitals as outlined in DCP3.

For essential functions provided at dedicated emergency units, the elements costed in this report include:

- salaries of all unit staff,
- Basic Emergency Care training for all staff in unit,
- equipment for resuscitation kits,
- construction and maintenance cost of new physical space,
- equipment for clinical assessment and monitoring, and
- incremental increase of medication, lab and radiology cost as a result of a dedicated EU.

Our costing was guided by the following assumptions. Further details costing sources is provided in Appendix C.

Capacity

Capacity of care delivered at each level of facility was determined using Ugandan government facility functions as well as was derived from the DCP3 Essential Emergency Services.[3] Generally, Health Centre IVs should have the capacity to provide out-patient services, some inpatient services, simple diagnostics, maternal health services and perform some emergency surgical operations. HCIVs have provisions for an operating theatre, in-patient and laboratory services, and act as a referral facility for 20-30 level II and II primary care facilities.[15]

General hospitals should have the capacity to perform all essential emergency unit function and provide preventive, medical and surgical services with limited specialist services.[15] In addition to the capacities of HCIV, General Hospitals should have prompt access to radiological services, and provide onsite lab tests.

Regional Referral Hospitals should have the capacity to provide referral services and supportive supervision to the general hospitals within their zone. They are expected to provide specialized medical and surgical care, basic research, and training of nurses and paramedical officers.

National Referral Hospitals should have the capacity to provide all services delivered by regional hospitals but more comprehensive and advanced. Advanced diagnostics may include services such as MRI and CT scans.

Physical Infrastructure

We costed for the 361 total existing health facilities of which are distributed as follows: two National Referral Hospitals, 19 Regional Referral Hospitals, 147 District Hospitals and 193 Health Centre IVs. While differentiation between public, private and NGO did

not factor into our costing, it is worth noting that of the 361 total facilities 249 are public facilities, and 112 which are NGO or private. This information comes from the latest hospital census to be published in March 2018, provided to us by the Department of Emergency Medicine.

The Department also provided us with an understanding of readiness and fit of current facility structures. 10 Regional Referral Hospitals and 10 General Hospitals were noted to be fit with emergency units. We therefore costed for construction of the remaining:

- 2 NRHs,
- 9 RRHs,
- 137 GHs and
- 193 HCIVs.

We assumed staffing, training, maintenance, equipment and medical consumable costs for the 10 regional referral hospitals and 10 general hospitals recently renovated were included in existing budgets, and did not include those costs in our model.

We assume establishing an emergency unit requires construction of new physical space, and furniture for clinical assessment, management, and administration. The measurement of these areas varied depending on the capacity of the facility, but all included space for dedicated areas for triage, treatment and resuscitation. The cost of all equipment was amortized based under guidance from UNFPA Fixed Asset Policies.[16] The following assumptions were made regarding physical space and general equipment for each level of service. Costs for HCIV and General Hospital were guided by the recommended number of beds from the Department of EMS and calculated based on the guidelines developed in the Infrastructure Unit System Support Project (IUSS) Report on Emergency Units.[14] Table 2 illustrates the estimated minimum space for each level of service based on the IUSS supported minimum of 50 m^2 per 1000 patients, and quantities of equipment assumed for this costing.

Table 2: Physical space and equipment assumptions per facility level

	NRH	RRH	GH	HCIV
Physical space	802 m2	639 m2	260 m2	54 m2
Equipment				
Examination couch, metal/wooden	5	3	2	1
Emergency lamp	5	3	2	1
Refrigerator	1	1	1	1
Trolley, patient	5	3	2	1
Wheel chair	5	3	2	1
Autoclave	1	1	1	1
Gynecological examination table	1	1	1	1
Delivery bed	1	1	1	1
Transport incubator	1	1	1	1
Patient bed with mattress	60	40	10	4
Office chair	30	22	15	7
Stool	20	15	10	5
Bedside locker	60	40	10	4

We expected the existing basic hospital structures to include some capacity such as central laboratory equipment and existing staff toilet and break rooms. Therefore, we did not include the costs of these elements. Under recommendation from the Ministry Infrastructure department, we accounted for increased water and electricity consumption of this new structure. Due to a paucity of data regarding the degree of incremental cost incurred by hospitals due to new construction, we based costs used in this model on reports from a comparable East African setting, Kenya. These reports indicate annual water bills account for approximately 1% of construction cost and electricity bills approximately 3% of construction costs.

Initial estimates were developed based off patient volumes. The following steps were taken to reach this estimate. Using number of patients per level appropriate area was determined based on IUSS guidance. We then utilised construction costs provided by the infrastructure department, quoting the average building cost for Ministry projects within a range of $700USD-$1,200USD per meter square. The mean of the range ($950 per m^2) was presumed appropriate for the purpose of this analysis. We then analysed costs for the construction derived from bills of recently constructed regional referral hospital casualty units. We observed the relationship between the bill and the estimated costs of construction for a regional referral hospital based on physical space guidance from IUSS to develop an adjustment factor (1.6332) to amend construction costs at each level. This adjustment hopes to give a more accurate picture of costs based on limited data available.

Patient Volumes

Annual numbers of patient visits to facilities for emergency care was derived from routine data collected through the Uganda Health Management Information System (HMIS). Figures were derived from monthly reports dated January 2017 to February 2018. The following routine indicators were combined to estimate the total number of emergency unit patients per level of facility: admissions to emergency ward, admissions to acute care unit, road traffic accident (cases), injuries: motor cycle (boda-boda accidents) cases, injuries: (trauma due to other causes), medical emergencies (cerebro-vascular events, cardiac arrest, gastro-intestinal bleeding, respiratory distress, acute renal failure, all others), outpatient department- stroke/cardiovascular accident, outpatient department injuries (trauma due to other causes), outpatient department obstructed labour, and outpatient department haemorrhage related to pregnancy.

These figures were used to estimate patient volumes at each level of service and cross checked against data collected on emergency admissions at Kawolo and Masaka hospitals. It should be noted that there were some substantial gaps in the data, especially for National Referral Hospitals from August 2017- February 2018. Therefore, it is probable that the true figures of service for National Referral Hospitals are higher than we estimate here.

Medications, supplies, equipment and diagnostics

Cost estimates for medications were acquired from budget records from Mubende and Kawolo hospitals. We used the fixed cost per patient findings from each of these facilities to guide our analysis of facilities of similar sizes. Therefore, figures from Mubende Regional Referral Hospital are used for National Referral Hospital level facilities, and figures from Kawolo General Hospital are used for Health Centre IV facilities. Quantities for items in the resuscitation equipment were derived from regionally comparative consumption figures from a district level facility in Tanzania. Prices for these items were collected from Joint Medical Stores Uganda. We assume the same cost per patient regarding supply consumption across the four facility levels.

Cost estimates for assessment and monitoring equipment were provided by Joint Medical Stores Uganda. Resuscitation kit supplies were also provided by JMS. To account for a lack of laboratory expenditures data in Uganda we utilized lab costs collected from South African emergency units with similar functionalities to our target scenario and adjusted them based on geographic variation in prices for lab tests across regions. Figures were reduced by the medical cost variation between Uganda and South Africa. We estimate approximately prices at 73% cheaper in Uganda than South Africa.

Costs for x-ray film was provided from the Joint Medical Stores. We assumed one-hour procedures for labour costs of x-rays, dividing the radiographer's salary by 2000 work hours in one year. Radiographer salaries from Masaka Hospital were used to inform this labour cost. Data regarding the number of films per patient were not available for Uganda. In its place, we applied data provided by colleagues conducting a study in Tanzania in which findings show 8% of general hospitals EU visits resulted in an x-ray. We assumed a 50% increase or decrease from this figure depending on the level of facility Therefore we assumed the following percentage of patient at each level of service: National Referral Hospital (18%), Regional Referral Hospital (12%), General Hospital (8%) and HCIV (4%).

Human Resources

Both salary and training cost of additional personnel were costed. Under guidance from the Department of Emergency Medical Services for the Ugandan Ministry of Health we assumed the following staffing structure for varying tiers of service.

Table 3: Proposed staffing structure matrix per level of facility

	NRH	RRH	GH	HCIV
Senior Consultant	1			
Consultant	1	1		
EM Specialist	3	1	1	
Medical Officer	4	2		
Senior Clinical Officer		2		
Clinical Officer	5	4	2	1
EC Principal Nursing Officer	1			
Senior Nursing Officer	2	1		
Nursing Officer	4	1	1	
Enrolled nurses/midwives	30	12	1	6

In addition to these staffing structures, radiographers were costed in regional referral and national referral hospitals to reflect minimum essential resources outlined in DCP3. We included costs for salaries of all dedicated emergency unit staff and basic in-service training in emergency care for all unit staff. For salary estimates we used data on actual provider salaries from the Masaka Regional Referral Hospital FY 2017/18 Staff List. For training costs, expense reports from recent Basic Emergency Care training programs in Uganda were used.

Currently dispersed interventions

After describing the specific services expected to be provided through dedicated emergency units, we asked local experts to estimate the proportion of costs incurred by services currently dispersed elsewhere in the health system in the following three categories: clinical interventions, laboratory testing and radiologic investigations. Utilizing information provided by the MoH we assumed that only 30% of clinical interventions, labs, and radiology are currently fulfilled. This indicates a 70% increase due to the presence of dedicated emergency care units. This figure was then used to discount our estimates.

Results

To implement dedicated emergency units, at an appropriate capacity to facility type and patient load, at all facilities incurs an estimated annual cost of $17,328,513. If we analyse this from the population served rather than patients treated this yields a cost of $1.95 per person with access to emergency unit services.

Constructing adequate physical infrastructure for emergency units is the greatest cost at $7,165,942. Across all levels of care one of the most significant costs are salaries for adequate staff which come to $5,613,269 for all facilities. Medical consumables require $3,520,057 to secure. Of the four levels of facilities, General Hospitals incur the highest cost ($9,647,875), then Health Centre IVs ($5,274,525), followed by Regional Referral Hospitals ($1,779,111) and finally National Referral Hospitals ($627,003). This is likely a result of the volume of lower level facilities relative to higher level facilities.

Details of the costs of each input, stratified by level of facility, are displayed in the proceeding Panels 7-10.

Panel 7: Estimated annual incremental cost of a dedicated emergency unit at National Referral Hospital Level

	Training	Staffing	Consumables Higher Use Rate	Capital	TOTALS
Triage					$0
Initial resuscitation	$17,273		$29,662		$46,935
Clinical assessment				$3,531	$3,531
Shared staffing for triage, resuscitation, assessment, and quality assurance		$145,496			$145,496
Medications			$10,842		$10,842
Lab			$13,555		$13,555
Radiology			$3,343		$3,343
Physical Infrastructure				$89,799	$89,799
TOTAL	$17,273	$145,496	$57,403	$93,330	**$313,501**

Panel 8: Estimated annual incremental cost of a dedicated emergency unit at Regional Referral Level

	Training	Staffing	Consumables Higher Use Rate	Capital	TOTALS
Triage					$0
Initial resuscitation	$8,128		$23,624		$31,753
Clinical assessment				$3,127	$3,127
Shared staffing for triage, resuscitation, assessment, and quality assurance		$70,592			$70,592
Medications			$8,635		$8,635
Lab			$10,796		$10,796
Radiology			$1,775		$1,775
Physical Infrastructure				$71,001	$71,001
TOTAL	$8,128	$70,592	$44,831	$74,128	**$197,679**

Panel 9: Estimated annual incremental cost of a dedicated emergency unit at General Hospital Level

	Training	Staffing	Consumables Higher Use Rate	Capital	TOTALS
Triage					$0
Initial resuscitation	$3,387		$9,611		$12,998
Clinical assessment				$2,790	$2,790
Shared staffing for triage, resuscitation, assessment, and quality assurance		$17,950			$17,950
Medications			$2,518		$2,518
Lab			$4,392		$4,392
Radiology			$481		$481
Physical Infrastructure				$29,293	$29,293
TOTAL	$3,387	$17,950	$17,003	$32,083	**$70,422**

Panel 10: Estimated annual incremental cost of a dedicated emergency unit at Health Centre IV Level

	Training	Staffing	Consumables Higher Use Rate	Capital	TOTALS
Triage					$0
Initial resuscitation	$2,371		$1,997		$4,368
Clinical assessment				$2,463	$2,463
Shared staffing for resuscitation, assessment, and quality assurance		$11,543			$11,543
Medications			$523		$523
Lab			$913		$913
Radiology			$50		$50
Physical Infrastructure				$7,469	$7,469
TOTAL	$2,371	$11,543	$3,484	$9,932	**$27,329**

5-YEAR COST STAGING

Clearly, so many staff cannot be trained all at once; buildings cannot all be built in the same month, and ambulances cannot all be procured and deployed immediately. Some form of staging over time is required as the system develops from its current state to the proposed future emergency care system. Implementation of the activities outlined in this report has to be staggered, to spread the costs involved in the establishment and implementation of a national emergency care system.

For the propose of this report we have provided staging costs of implementing the Emergency Care System **over a 5-year period**. Here we present a simple amortized staging to distribute cost of implementation across a 5-year window. One fifth of activities are implemented in the first year and an additional fifth every remaining year after until completion.

Alongside these costs, we ensured recurring costs for existing structures and activities, such as staff salaries, water and electricity were appropriate accounted for on an annual basis. We factored inflation costs, adding 2% annually.[17] The final cost for the 5-year period is **$225,553,907**.

Details of inputs and their staging percentages are provided in Appendix E.

Table 4: Cost per year over 5-year staging period

Year 1	Year 2	Year 3	Year 4	Year 5
$18,631,514	$31,543,252	$45,047,279	$58,502,761	$71,829,101

LIMITATIONS AND EXCLUSIONS

The estimates reached in this report have important limitations.

In many instances, we had to rely on a number of assumptions which may not be robust. We used expert advice to guide us in areas where data were especially sparse. Specifically, current systems are not established with aims of capturing data from emergency services separately from other care. This makes some of the assumptions based on routine data vulnerable to improper association for emergency care. We believe that the use of regional data from comparable context was appropriate under these circumstances.

Many of the findings of this report also rest upon assumptions taken regarding how essential functions will be structured and implemented. As the EMS policy is still in early stages, appropriateness of some of our assumptions may change under further specification of the policy scope.

This report only surveys items and activities which incur costs and fall within the scope of the WHO ECS Framework. There are other sources of increased or offset costs which ought to be considered further. For example, improved clinical outcomes may add costs not previously borne by the existing system. On the other hand, more rational treatment and testing as a result of better trained and organised staff may reduce costs. Either way, better emergency care will result in reduced referrals, decreased length of stay, and better outcomes for many patients, allowing quicker return to the productive economy of the country and having more far reaching societal and economic impact that can be covered in this report. A more complex model capable of considering the fiscal impact of increased health utilization of expanding health coverage and projected changes in utilization rates as services improve should be considered.

There are also important activities which may reveal financial implications which have been omitted from this report. The following activities, which comprise important elements to the overall delivery of emergency medical care, were excluded from our analysis, but should be further assessed for additional cost implications. These include:

Universal access number and community sensitization

This element will include costs of development of a universal emergency call number, and sensitization of the general public to a national health number. This may include media outreach, community events.

Monitoring and evaluation

Cross cutting elements such as monitoring and evaluation were not considered in this model. All emergency care indicators should be aligned and integrated into existing

data capturing tools, therefore cost implications may include approaches such as the training of current data collectors nationwide to the integration of new HMIS indicators.

Pre-service and Specialist training

This costing excludes pre-service and specialist training at all levels of care. This activity is essential to scaling up human resources to match the proposed EM system and should be costed in coordination with the Ministry of Education.

Using the proposed staffing structure provided by the Department of Emergency Medical Service, our calculations indicate that 2,644 specialists and pre-service individuals will need to be trained to meet demand across all 361 facilities. 1,943 are needed to meet demand in government facilities alone. This includes: 2 Senior Consultants, 21 consultants, 172 EM Specialists, 46 Medical Officers, 38 Senior Clinical Officers, 573 Clinical Officers, 2 EC Principal Nursing Officers, 23 Senior Nursing Officers, 174 Nursing Officers and 1,593 Enrolled nurses/ midwives. The development of dedicated degree programs in educational institutions is necessary to meet this demand. Cost to consider may include training facilities, training staff, bursaries and student hostels, administrative staff, costs of teaching equipment, medical consumables, and simulation materials.

Leadership and Governance:

All elements of policy development were omitted from this report. As this report's primary purpose is to identify the costs of delivering service across an emergency care system, the activities conducted to establish governance fall outside of the scope. Leadership and governance activities are likely smaller budget items.

CONCLUSION

Through this preliminary exercise we estimated the cost of establishing and maintaining an Emergency Medical Services system in Uganda to be **$255,553,907 over a 5-year period**. The most significant financial burden arises in establishing essential functions of transport care. The details in this report may guide a more definitive implementation strategy for future use.

Emergency care systems have the potential for major reductions in morbidity and mortality. The findings of our costing study intend to provide key stakeholders and decision makers with a clearer understanding of the cost implications of fulfilling a dedicated national emergency medical system. Although this report is not exhaustive, it provides a strong basis for understanding costs of undertaking a comprehensive emergency care system. We believe this provides a strong case to prioritize the implementation of a coordinated national emergency system for Uganda.

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APPENDICES

Appendix A. Costing Details and Source for Scene Care

Cost Category	Detailed Items	No of Units	Sources
Training (Emergency First Aid Responders)	Venue rent	N/A	Expenditure records of emergency training programs (a)
	Participants allowance	N/A	
	Catering	N/A	
	Administrative costs	N/A	
	Supplies and equipment	N/A	
	Trainers per diem	N/A	
	Transportation	N/A	
First Aid Kit	Disposable gloves	N/A	Quantities based on expert estimates. Prices from Joint Medical Stores Uganda (b)
	Disposable mask	N/A	
	Gauze padding	N/A	
	Clear bandages	N/A	
	Scissors	N/A	

Personnel	Dispatch Centre Call Operators	5	Quantities based on expert estimates. Salaries from Masaka Regional Referral Hospital (c) and Uganda Public Service Salary Structure(d)
IT / Equipment	Dispatch platform	1	Prices from RapidDeploy CAD software (e)
Physical Infrastructure	Construction	N/A	Size from IUSS (g), cost from record of casualty unit construction provided by MoH (h)
	Maintenance	N/A	Kenya national costing study of government functions (i)
	Renovation	N/A	
	General Equipment	N/A	Equipment prices from Joint Medical Stores (b) and expert estimates.

(a) Expenditure records of Basic Emergency Care trainings conducted in Uganda. 2017.
(b) Joint Medical Stores Uganda. 2018.
(c) Masaka Regional Referral Hospital Staff List FY 2017/2018.
(d) Uganda Public Service Salary Structure. 2018.
(e) RapidDeploy Technical Overview. 2018.
(f) Ugandan National Ambulance Service procurement plan for goods, works and non consultancy services for the financial year 2016/2017.
(g) Infrastructure Unit System Support Project Health Facility Guide, Emergency Centres. 2014.
(h) Bill of Quantities for the Construction of a Casualty Unit, Ministry of Health, Department of Infrastructure. 2018.
(i) MAKORI SK. COSTING OF GOVERNMENT FUNCTIONS, Kenya.2015

Appendix B. Costing Details and Source for Transport Care

Cost Category	Detailed Items	No of Units	Sources
Training	National Coordinator	1	Quantities based on expert estimates, cost derived from Masaka Regional Referral Hospital (a) and Uganda Public Service Salary Structure(b)
	Administrative Support	16	
	Trainer salary	35	
	Stationary	N/A	Expenditure records of emergency training programs (c)
	Equipment	N/A	Costs from current expense reports from UNAS (i)
	Construction	N/A	Size determined by IUSS guidelines (o), construction costs based on average building costs from MoH (m)
	Maintenance	N/A	Kenya national costing study of government functions (n)
	Electricity	N/A	
	Water	N/A	
Basic Provider Kit	Fluids	N/A	Quantities based on UNAS monthly consumables (d) increased upon expert advice to demonstrated increased capacity, Prices from Joint Medical Stores in Uganda (e)
	Cannula IV Set	N/A	
	Cannulae	N/A	
	Disposable Gloves	N/A	
	Cotton	N/A	
	Gauze	N/A	
	Oxygen	N/A	
	Tape	N/A	
	Crepe Bandage	N/A	
	Triangular Bandage	N/A	
	Paracetamol	N/A	
	Diclofenac	N/A	

Personnel	Driver (Ambulance Officer)	N/A	Number of units based on DCP3 and DCP2 guidelines (f), salaries from UNAS salary structure (g) and Uganda Public Service Salary Structure (b)
	Ambulance Officer (BLS trained)	9,776	
	Ambulance Officer (ALS trained)	70	
	Accreditation Officer	1	
	Accreditation Administrator	1	
	Fleet Director	14	
Equipment	BLS Ambulance	971	Number of units determined from Uganda Bureau of Standards district population projection (h), costs from current expense reports from UNAS (i)
	ALS Ambulance	14	
	Repair	N/A	
	Service	N/A	
	Fuel	N/A	
	Smart phones	N/A	Quantities based on CAD software requirements (j), prices from UNAS Procurement plan for goods 2016/17 (k)
Physical Infrastructure	Construction		Size determined by DCP-2 guidelines (l), construction costs based on average building costs from MoH (m)
	Maintenance		Kenya national costing study of government functions (n)
	Equipment		Equipment prices from Joint Medical Stores (e) and expert estimates.

(a) Masaka Regional Referral Hospital Staff List FY 2017/2018.
(b) Uganda Public Service Salary Structure. 2018.
(c) Expenditure records of Basic Emergency Care trainings conducted in Uganda. 2017.
(d) AFEM Handbook, First Edition. 2013.
(e) Joint Medical Stores, Uganda. 2018.
(f) Disease Control Priorities: Improving Health and Reducing Poverty, Third Edition, Volume 9. 2018.
(g) Ugandan National Ambulance Service Salary Structure. 2018.
(h) Uganda Bureau of Standards, District single year projection 2015-2020.
(i) Ministry of Health, Department of Emergency Medical Service, Ambulance Operational Costs. 2017/2018.
(j) RapidDeploy Technical Overview. 2018.
(k) Ugandan National Ambulance Service procurement plan for goods, works and non consultancy services for the financial year 2016/2017.
(l) Disease Control Priorities In Developing Countries (DCP2). 2006.
(m) Ministry of Health, Department of Infrastructure. 2018.
(n) MAKORI SK. COSTING OF GOVERNMENT FUNCTIONS, Kenya.2015
(o) Infrastructure Unit System Support Project Health Facility Guide, Nursing Education Centres. 2014.

Appendix C. Costing Details and Source for Facility Care

Cost Category	Detailed Items	No of Units	Sources
Training	Venue rent	N/A	Expenditure records of training programs (a)
	Participants allowance	N/A	
	Catering	N/A	
	Administrative costs	N/A	
	Supplies and equipment	N/A	
	Trainers per diem	N/A	
	Transportation	N/A	
	First aid kit	N/A	
Resuscitation equipment	Defibrillator		Quantities from budget records of Ugandan hospitals (b), Prices from Joint Medical Stores in Uganda (c)
	Nebuliser		
	Laryngoscope for adults		
	Laryngoscope for babies		
	Oxygen concentrator		
	Neonatal resuscitation bag with mask		
	Suction machine		
	Instrument Trolley		
	Dressing Trolley		
	Medications Trolley		
	Oxygen gas cylinder		
	Oxygen regulator with flow meter		
	Infusion stand		
	Emergency Tray		
Clinical Monitoring Equipment	Binaural stethoscope	3	Quantities based on national costing from Kenya(d), adjusted to fit varying service levels. Prices from JMS Uganda (c)
	Foetal Stethoscope	3	
	Blood pressure (BP) cuff (adult)	3	
	Digital Thermometer	3	
	Glucometer plus test strips	3	

	Fingertip Pulse Oximeter	1	
	ECG Machine	1	
	Child weighing scale	1	
	Adult weighing scale	1	
	Ultrasound machine + supplies	1	
	Infant weighing scale	2	
	Mobile Examination lamp	1	
	Spotlight	2	
	Portable light	2	
	X-ray developer	1	
	X-ray fixer	1	
	X-ray machine	1	
Personnel	Senior Consultant	N/A	Number of units based on Uganda MoH Division of Emergency Medical Services proposed staffing structure (e), Salaries based on Masaka Regional Referral Hospital (f)
	Consultant	N/A	
	Senior Clinical Officer	N/A	
	Clinical Officer	N/A	
	Principal Nursing Officer	N/A	
	Senior Nursing Officer	N/A	
	Enrolled Nurses/ midwives	N/A	
	Radiographer	N/A	
Medications	fraction of observed in emergency units	N/A	Budget records of Ugandan hospitals (b)
Lab	fraction of observed in emergency units	N/A	Expenditure records of South African hospitals (g)
Radiology	X-ray films	1	Film prices from JMS (c),
	Labour	N/A	Masaka Regional Hospital salary records (f)
	Frequency	8% of EU patients	Quantity from analysis of emergency practice in Tanzania (h), adjusted to match service level.

Physical Infrastructure	Construction Maintenance Renovation General Equipment	Record of casualty unit construction provided by MoH infrastructure department(i), Square meter size from IUSS recommendations (j)

(a) Expenditure records of Basic Emergency Care trainings conducted in Uganda. 2017.

(b) Ugandan Gov. Hospitals 2016-2017 budget records. 2017

(c)Joint Medical Stores, Uganda. 2018

(d) MAKORI SK. COSTING OF GOVERNMENT FUNCTIONS, Kenya.2015

(e) Republic of Uganda Ministry of Health, Department of Emergency Medical Services. 2018

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(g) Republic of South Africa, Western Cape District hospitals' emergency departments 2016-2017 expenditure records. 2017.

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Appendix D. Details of 5-year cost staging approach and figures

		Year 1	Year 2	Year 3	Year 4	Year 5
	EFAR Train the Trainer	100% EFAR Train the Trainer				
SCENE	*EFAR Training*	20% EFAR Training	20% EFAR Training	20% EFAR Training	20% EFAR Training	20% EFAR Training
SCENE	*First Aid Kits*	20% First aid kits	40% First Aid kits	60%First Aid kits	80% First aid kits	100% first aid kits
SCENE	*Construction*	20% Dispatch center construct	20% Dispatch center constr	20% Dispatch center cost	20% Dispatch center cost	20% Dispatch center cost
SCENE	*Centre running costs*		20% Recurrent cost	40% Recurrent cost	60% Recurrent costs	80% Recurrent costs
SCENE	*Dispatch Centre Staff*	20% Dispatch staff	40% dispatch staff	60% dispatch staff	80% Dispatch Staff	100% Dispatch staff
TRANSPORT	*Vehicle Procurement*	20% BLS Vehicles	20% BLS Vehilces + 33.33% ALS Vehicles	20% BLS vehicles+ 33.33% ALS vehicles	20% Vehicles + 33.33% Vehicles	20% Vehicles
TRANSPORT	*Vehicle Running Costs*		20% BLS running costs	40% BLS Running costs + 33.33% ALS Running Costs	60% Running costs + 66.66% ALS Running Costs	80% Running Costs +100% ALS Running costs
TRANSPORT	*Staff- BLS Ambulance Providers + Fleet managers*	20% Staff	40% Staff	60% Staff	80% Staff	100% Staff
TRANSPORT	*Staff-BLS and ALS Training*	100% Staff	100% Staff	100% Staff	100% Staff	100% Staff
TRANSPORT	*Staff ALS Ambulance Providers*		33.33% Staff	66.66% Staff	100% Staff	
TRANSPORT	*BLS and ALS Training Venue*	100% Construction				
TRANSPORT	*BLS Training*	20% Training	20% Training	20% Training	20% Training	20% Training
TRANSPORT	*ALS Training*	33.33% Training	33.33% Training	33.33% Training		
TRANSPORT	*Basic Provider Kits*	20% Basic Provider kit	40% Basic Provider Kit	60% Basic Provider Kit	80% Basic Provider Kit	100% Basic Provider kit
TRANSPORT	*Garage Construction*	20% Garages	20% Garages	20% Garages	20% Garages	20% Garages
TRANSPORT	*Garage running Cost*		20% Running Cost	40% Running Cost	60% Running Cost	80% Running Cost
TRANSPORT	Accreditation	Accreditation officers + Equipment 100%	100% Accreditation officers	100% Accreditation officers	100% Accreditation officers	100% Accreditation officers
			NRH			
FACILITY	*Facility Construction*	50% Construction	50% construction			
FACILITY	*Facility Running Costs*		50% Running Cost	100% Running Cost	100% Running Cost	100% Running Cost
FACILITY	*BEC Training*	50% BEC Training	50% BEC Training			
FACILITY	*Staff*	50% Staff	50% Staff			
FACILITY	*Medical Supplies*	50% Med supplies	100% Med Supplies	100% Med Supplies	100% Med Supplies	100% Med Supplies
FACILITY	*Laboratory Costs*	50% Lab costs	100% Lab Costs	100% Lab Costs	100% Lab Costs	100% Lab Costs
FACILITY	*Radiology Costs*	50% Radiology costs	100% Radiology costs	100% Radiology costs	100% Radiology costs	100% Radiology costs
			RRH			
FACILITY	*Facility Construction*	20% Construction	20% Construction	20% Construction	20% Construction	20% Construction
FACILITY	*Facility Running Costs*		20% Running costs	40% Running Cost	60% Running Cost	80% Running Costs
FACILITY	*BEC Training*	20% BEC Training	20% BEC Training	20% BEC Training	20% BEC Training	20% BEC Training
FACILITY	*Staff*	20% Staff	40% Staff	60% Staff	80% Staff	100% Staff
FACILITY	*Medical Supplies*	20% Med Supplies	40% Med supplies	60% Med supplies	80% Med Supplies	100% Med Supplies
FACILITY	*Laboratory Costs*	20% Lab costs	40% Lab costs	60% lab costs	80% lab costs	100% lab costs
FACILITY	*Radiology Costs*	20% Radiology costs	40% Radiology costs	60% radiology costs	80% radiology costs	100% radiology costs
			GH			
FACILITY	*Facility Construction*	20% Construction	20% Construction	20% Construction	20% Construction	20% Construction
FACILITY	*Facility Running Costs*		20% Running costs	40% Running Cost	60% Running Cost	80% Running Costs
FACILITY	*BEC Training*	20% BEC Training	20% BEC Training	20% BEC Training	20% BEC Training	20% BEC Training
FACILITY	*Staff*	20% Staff	40% Staff	60% Staff	80% Staff	100% Staff
FACILITY	*Medical Supplies*	20% Med Supplies	40% Med supplies	60% Med supplies	80% Med Supplies	100% Med Supplies
FACILITY	*Laboratory Costs*	20% Lab costs	40% Lab costs	60% lab costs	80% lab costs	100% lab costs
FACILITY	*Radiology Costs*	20% Radiology costs	40% Radiology costs	60% radiology costs	80% radiology costs	100% radiology costs
			HCIV			
FACILITY	*Facility Construction*	20% Construction	20% Construction	20% Construction	20% Construction	20% Construction
FACILITY	*Facility Running Costs*		20% Running costs	40% Running Cost	60% Running Cost	80% Running Costs
FACILITY	*BEC Training*	20% BEC Training	20% BEC Training	20% BEC Training	20% BEC Training	20% BEC Training
FACILITY	*Staff*	20% Staff	40% Staff	60% Staff	80% Staff	100% Staff
FACILITY	*Medical Supplies*	20% Med Supplies	40% Med supplies	60% Med supplies	80% Med Supplies	100% Med Supplies
FACILITY	*Laboratory Costs*	20% Lab costs	40% Lab costs	60% lab costs	80% lab costs	100% lab costs
FACILITY	*Radiology Costs*	20% Radiology costs	40% Radiology costs	60% radiology costs	80% radiology costs	100% radiology costs

		Year 1	Year 2	Year 3	Year 4	Year 5	Totals
SCENE	*EFAR Train the Trainer*	3,954					
	EFAR Training	54,044	54,044	54,044	54,044	54,044	
	First Aid Kits	3,164	6,328	9,492	12,657	15,821	
	Construction	17,870	17,870	17,870	17,870	17,870	
	Centre running costs		14,285	28,569	42,854	57,138	
	Dispatch Centre Staff	9,870	19,740	29,610	39,480	49,350	
	SUBTOTAL	***88,902***	***112,267***	***139,585***	***166,904***	***194,223***	***701,881***
TRANSPORT	*Vehicle Procurement*	4,175,619	4,276,708	4,276,708	4,276,708	4,175,619	
	Vehicle Running Costs		1,564,730.75	3,167,282.22	4,769,833.69	6,372,385.16	
	Staff-Ambulance Providers + Fleet Managers	3,994,228	7,988,456	11,982,685	15,976,913	19,971,141	
	Staff ALS Ambulance Providers		70,000	140,000	210,000	210,000	
	Staff-BLS Training	3,064	3,064	3,064	3,064	3,064	
	BLS +ALS Training Venue	1,311,870					
	Training venue running cost		41,650	41,650	41,650	41,650	
	ALS Training	44,479	44,479	44,479			
	BLS+ BEC Training	580,657	580,657	580,657	580,657	580,657	
	Basic Provider Kits	4,756,038.20	9,512,076.40	14,268,114.60	19,024,152.80	23,780,191.00	
	Garage Construction	245,492	245,492	245,492	245,492	245,492	
	Garage running Cost		197,568	395,136	592,704	790,272	
	Accreditation	2,908	2,745	2,745	2,745	2,745	
	SUBTOTAL	***15,114,357***	***24,527,627***	***35,148,013***	***45,723,920***	***56,173,217***	***176,687,134***

FACILITY

		NRH			
Facility Construction	44,900	44,900			
Facility Running Costs		65,286	130,573	130,573	130,573
BEC Training	17,273	17,273			
Staff	145,496	290,992	290,992	290,992	290,992
Medical Supplies	40,505	81,009	81,009	81,009	81,009
Laboratory Costs	13,555	27,110	27,110	27,110	27,110
Radiology Costs	3,343	6,687	6,687	6,687	6,687
		RRH			
Facility Construction	127,802	127,802	127,802	127,802	127,802
Facility Running Costs		93,595	187,190	280,785	374,380
BEC Training	14,630	14,630	14,630	14,630	14,630
Staff	127,066	254,131	381,197	508,262	635,328
Medical Supplies	58,068	116,135	174,203	232,271	290,338
Laboratory Costs	19,433	38,865	58,298	77,730	97,163
Radiology Costs	3,195	6,391	9,586	12,782	15,977
		GH			
Facility Construction	802,623	802,623	802,623	802,623	802,623
Facility Running Costs		579,619	1,159,238	1,738,857	2,318,477
BEC Training	92,804	92,804	92,804	92,804	92,804
Staff	491,830	983,660	1,475,490	1,967,320	2,459,150
Medical Supplies	332,347	664,694	997,041	1,329,388	1,661,736
Laboratory Costs	120,343	240,686	361,029	481,372	601,715
Radiology Costs	13,192	26,385	39,577	52,770	65,962
		HCIV			
Facility Construction	288,297	288,297	288,297	288,297	288,297
Facility Running Costs		169,704	339,407	509,111	678,815
BEC Training	91,521	91,521	91,521	91,521	91,521
Staff	445,560	891,120	1,336,679	1,782,239	2,227,799
Medical Supplies	97,306	194,612	291,919	389,225	486,531

Laboratory Costs	35,235	70,469	105,704	140,938	176,173	
Radiology Costs	1,931	3,863	5,794	7,725	9,656	
SUBTOTAL	***3,428,255***	***6,284,863***	***8,876,401***	***11,464,824***	***14,053,247***	**44,107,590**
TOTAL	**18,631,514**	**30,924,757**	**44,163,999**	**57,355,648**	**70,420,687**	**221,496,605**
Including inflation	***18,631,514***	***31,543,252***	***45,047,279***	***58,502,761***	***71,829,101***	***225,553,907***

ANNEXES

Annex A. Excel Workbooks Table of Contents

WORKBOOK: **SCENE.xls**

WORKSHEET	DESCRIPTION
Overall Results_Scene	Main costing inputs and outputs
Panel	Summary panel for estimated annual incremental cost of implementing regional emergency scene care
Salaries	Dispatch caller salary
Training	Training costs for train- the trainer first aid responder session and EFAR training—based on data from historical Uganda BEC courses.
Dispatch Centres	Structural, equipment and supplies costs for one dispatch centre.
Medical Supplies	Supplies for lay responder kit.
Call volume	Data used to predict the number of dispatch call centre staff required.

WORKBOOK: **TRANSPORT.xls**

WORKSHEET	DESCRIPTION
Overall Results_Transport	Main costing inputs and outputs
Panel	Summary panel for estimated annual cost of implementing dedicated national transport care
Training	Training costs for Basic Life Support training to Ambulance Providers, based on comparable Basic Emergency Care Training budgets.
Salaries	Salaries of all applicable positions, data from Masaka Regional Referral Hospital
Medical Supplies	Medical supplies (sundries, injectables and medicines) needed to stock basic provider kit annual for each ambulance. Items from AFEM handbook and UNAS procurement records.
Ambulance + Equipment	Costs for procurement of fully equipped ambulance and basic provider kit equipment.
Physical Infrastructure	Structure and equipment costs for development of ambulance garage for deployment.
Health Regions Population	Vehicle and Ambulance Officer needs based on population of each health region. Population data from Uganda Bureau of Standards.

WORKBOOK: **FACILITY.xls**

WORKSHEET	DESCRIPTION
Overall Results_NRH	Main costing inputs and outputs for National Referral Hospitals
Overall Results_RRH	Main costing inputs and outputs for Regional Referral Hospitals
Overall Results_GH	Main costing inputs and outputs for General Hospitals
Overall Results_HCIV	Main costing inputs and outputs for Health Centre IVs
Facility Panels (National)	Summary panels detailing cost inputs and outputs for the total number of facilities required for national coverage.
Facility Panels	Summary panels detailing estimated annual incremental cost of implementing a dedicated emergency unit at each level of care
Training	Training costs of Basic Emergency Care Course
Salaries and Staffing	Total staffing costs for each level of service, as based on proposed staffing structures from MoH and salary structures from Masaka Hospital FY 2017/18
Staffing Expectations	Proposed Staffing needs presented in a matrix, detailing each facility level of service
Monitoring Equipment	Cost of monitoring equipment
Cost of Resuc Kit—JMS Prices	List of items from DCP3, populated with cost data from Joint Medical Stores
Medicines & Supplies	Total medications costs, based on inputs of Joint Medical Stores prices and units consumed currently at each level of facility.
Annual # of patients	Patient volumes at each level of facility as derived from HMIS routine data.
Construc + Renov	Construction, maintenance and general equipment costs for each level of facility.
X-rays	Average costs for x-ray films, from JMS.
Labs	Main cost source we are currently using for lab and medications costs.

Annex B. Excel Documents

SCENE.xlsx

TRANSPORT_FINAL_V2.xlsx

FACILITY_FINAL.xlsx