Anesthesia and Its Allied Disciplines in the Developing World: A Nationwide Survey of the Republic of Zambia

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BACKGROUND: Many surgical interventions worldwide are performed in developing countries. To improve survival of acutely and critically ill patients in these countries, basic problems and demands of anesthesia care need to be identified. Using this survey, we evaluated the current status of anesthesia and its allied disciplines (intensive care medicine, emergency medicine, and pain therapy) in the Republic of Zambia.

METHODS: Questionnaires were sent to 87 hospitals registered at the Zambian Ministry of Health as performing minor or major surgery. The questionnaire consisted of 111 questions grouped into five sections: general hospital information, anesthesia, intensive care, emergency medicine, and pain therapy.

RESULTS: Sixty-eight questionnaires could be statistically evaluated (78%). The most common operations were obstetric/gynecological and abdominal surgical procedures. Dissociative ketamine anesthesia was the technique most often used for general anesthesia (50%). Endotracheal intubation was performed in 10% of patients undergoing general anesthesia. In most hospitals (78%), anesthesia was administered by nonphysicians. Only 5 of 68 hospitals (7%) reported having an intensive care unit, with 29 beds to serve the entire country. Anesthesiologists play almost no role in emergency medicine and pain therapy.

CONCLUSIONS: Anesthesia in the Republic of Zambia is a highly under-developed and under-resourced medical specialty.

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Many surgical interventions worldwide are performed in developing countries.[1] In the developed world, anesthesia has progressed to a comprehensive medical specialty in the past few decades with a well established presence in allied disciplines, including intensive care medicine, emergency medicine, and pain therapy.[2] However, in developing countries, anesthesia is mostly focused on intraoperative patient care for basic surgical procedures.[1] Compared with the situation in industrialized nations, perioperative morbidity and mortality in developing countries remain unacceptably high.[1,3] This is particularly alarming because relatively simple and inexpensive technology could readily decrease the burden of illness and injury in these countries.

To improve survival of acutely and critically ill patients in developing countries, it is important to identify basic problems and the resulting demands in anesthesia and its allied disciplines. Unfortunately, except for anecdotal reports[4] and regional evaluations,[5] there are few data on the status of anesthesia, intensive care, emergency medicine, and pain therapy in developing countries.[1] Such information is essential to guide the efforts of governmental and nongovernmental organizations to improve health care delivery in the developing world.

Using a nationwide, questionnaire-based survey, we evaluated the current status of anesthesia and its allied disciplines (intensive care medicine, emergency medicine, and pain therapy) in the Republic of Zambia, a typical sub-Saharan African developing country with a population of 11.7 million people.

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METHODS

The study was performed as a cross-sectional questionnaire survey. The protocol and questionnaire were approved by the IRB of the Medical University of Zambia and the Zambian Ministry of Health. In January 2006, questionnaires were sent via postal service from the country's capital, Lusaka, to the anesthesiologists in charge of 87 hospitals registered at the

Ministry of Health as performing minor or major surgery (A copy of the questionnaire is available as a supplement at www.anesthesia-analgesia.org). Hospitals that returned the questionnaire to the study center in Lusaka received a laryngoscope, stethoscope, intubation stylet, and a CD-based textbook of anesthesia. After 6 mo, questionnaires were sent again to hospitals which had not responded by that time. Returned questionnaires were collected at the University Teaching Hospital in Lusaka until January 2007 and then taken to the study center in Innsbruck, Austria, for statistical evaluation.

The questionnaire included 111 questions divided into five sections. The first section consisted of seven general questions about the hospital. The second section consisted of 38 questions about anesthesia and perioperative management. Sections 3, 4, and 5 asked questions about intensive care medicine (39 questions), emergency medicine (16 questions), and pain therapy (11 questions), respectively. Free text comments were requested to assess the five most common surgical interventions, anesthesia complications, admission diagnoses to the intensive care unit, emergency medicine diagnoses, drugs applied in emergency medicine, and causes of pain in hospitalized patients. Finally, anesthesiologists were asked to suggest how to improve anesthesia and intensive care services in their hospital. For statistical analysis, free text comments were grouped and transformed into a numerical code.

The SPSS 12.0.1. software program was used for statistical analysis (SPSS Inc., Chicago, IL). Descriptive statistical methods were applied to present results of single sections and questions. To accurately assess the percentage of categorical data, the number of completed single questions was used as the denominator (i.e., we did not use the number of returned questionnaires, as some returned questionnaires were incomplete). Distribution of normality of study variables was analyzed using the Lilliefors test. Bivariate correlations were used to test for relationships between relevant anesthesia-related parameters. Results are presented using the Spearman ρ correlation coefficient (SRCC) and P value. P values <0.05 were considered to indicate statistical significance. Data are given as median values and interquartile ranges, if not indicated otherwise.

RESULTS

Of 87 hospitals, 69 responded (79%). As one questionnaire was not completed, 68 questionnaires (78%) were used for the statistical analysis. The return rates of various provinces throughout Zambia are presented in Figure 1. Although there was no overall difference in return rates of questionnaires among provinces ($P = 0.341$, χ^2 test), fewer questionnaires were returned from the Lusaka Province (40%) when compared with all other provinces combined (82%) ($P = 0.058$). Eight of 9 referral hospitals in the provincial capitals (89%) returned the questionnaires.

Table 1 presents characteristics of the participating hospitals. Details of anesthesia practice are summarized in Tables 2 and 3. Aside from the complications presented in Table 3, five respondents noted tracheal aspiration, two respondents intraoperative cardiac arrest, and two respondents "cannot intubate" situations as among the five most common intraoperative complications of anesthesia. Cesarean delivery was more frequently performed using general anesthesia with endotracheal intubation (31 of 57, 54%) than using spinal anesthesia (26 of 57, 46%), general anesthesia via mask (14 of 57, 25%), or peridural anesthesia (1 of 57, 2%) (multiple answers possible).

There was a significant correlation between the distance of the hospital to the capital city of Lusaka and:

Figure 1. Return Rates of Questionnaires from Single Provinces. *Questionnaire received from referral hospital in the provincial capital. Return Rates: Western Province, 7 of 8 (87.5%); North-Western Province, 8 of 10 (80%); Southern Province, 9 of 13 (69.2%); Copperbelt, 11 of 13 (84.6%); Central Province, 7 of 8 (87.5%); Lusaka, 2 of 5 (40%); Luapula, 5 of 7 (71.4%); Eastern Province, 9 of 9 (100%); Northern Province, 11of 14 (78.6%).

Table 1. Characteristics of Participating Hospitals

No. of responding hospitals	68
Beds	114 (70–208)
Physicians/100 beds	2 (1–3)
Operation rooms	2 (1–2)
Five most common surgical interventions[a], $n = 61$	
Obstetric surgery incl. Cesarean delivery	54 (89)
Laparatomy	50 (82)
Gynecologic surgery	29 (48)
Herniorrhaphy	29 (48)
Incision and drainage of abscesses	27 (44)
Source of financial support[b], $n = 68$	
Government	65 (96)
Mission	18 (27)
Private	2 (3)
Industrial	1 (2)

Data are given as *n* (%) or median values and IQR.

n in the first column reflects the number of completed questions and is considered 100%.

[a] Open-ended question with free text comments.

[b] Multiple answers possible.

Table 2. Details of Anesthesia Practice: Part I

Anesthesia cases performed per year, $n = 64$	
<100 cases	9 (14)
100–250 cases	13 (20)
250–500 cases	14 (22)
>500 cases	28 (44)
No. of general anesthesia cases per year, $n = 55$	352 (126–551)
Techniques used for general anesthesia[a], $n = 55$	
General anesthesia with intubation	10 (0–40)
General anesthesia with laryngeal mask	0 (0–0)
General anesthesia with mask	13 (0–20)
Dissociative ketamine anesthesia	50 (16–79)
Combined general and regional anesthesia	1 (0–10)
No. of regional anesthesia cases per year, $n = 51$	60 (39–178)
Techniques used for regional anesthesia[a], $n = 51$	
Spinal anesthesia	30 (0–87)
Peridural anesthesia	0 (0–0)
Axillary plexus anesthesia	0 (0–0)
Peripheral nerve blocks	0 (0–9)
Local anesthesia	56 (11–100)
Intravenous hypnotic agent available, $n = 62$	
Ketamine	45 (73)
Thiopentone	14 (23)
None available	3 (5)
Volatile anesthetic agent available, $n = 63$	
Halothane	44 (70)
Trichlorethylene	1 (2)
Ether	1 (2)
None available	17 (27)
Analgesic agent available, $n = 60$	
Meperidine	49 (82)
Paracetamol	2 (3)
Others	3 (5)
None available	6 (10)
Muscle relaxant available, $n = 56$	
Suxamethonium	36 (64)
Pancuronium	4 (7)
Atracurium	1 (2)
None available	15 (27)
Local anesthetic available, $n = 59$	
Lidocaine	41 (70)
Bupivacaine or Marcaine	16 (27)
None available	2 (3)

Data are given as *n* (%) or median values and IQR.

n in the first column reflects the number of completed questions and is considered 100%.

[a] Multiple answers possible.

1. the frequency of endotracheal intubation (SRCC, −0.285; $P = 0.025$),
2. the frequency of mask ventilation (SRCC, −0.281; $P = 0.031$) during general anesthesia,
3. the availability of a volatile anesthetic (SRCC, −0.28; $P = 0.026$),
4. the availability of an intraoperative electrocardiogram monitor (SRCC, −0.445; $P < 0.001$),
5. the availability of a noninvasive arterial blood pressure monitor (SRCC, −0.27; $P = 0.037$),
6. the presence of a recovery room (SRCC, −0.38; $P = 0.002$), and
7. the presence of an intensive care unit (SRCC, −0.278; $P = 0.023$).

The number of hospital beds was significantly correlated with:

1. the frequency of endotracheal intubation (SRCC, 0.507; $P < 0.001$),
2. the use of a laryngeal mask (SRCC, 0.39; $P = 0.002$) during general anesthesia,
3. the availability of a volatile anesthetic (SRCC, 0.481; $P < 0.001$),
4. the availability of a muscle relaxant (SRCC, 0.304; $P = 0.023$),
5. the presence of a physician anesthesiologist (SRCC, 0.294; $P = 0.024$),
6. the presence of an aid nurse without medical training (SRCC, −0.315; $P = 0.015$),
7. the availability of an intraoperative oxygen saturation monitor (SRCC, 0.386; $P = 0.002$),
8. a vaporizer for volatile anesthetics (SRCC, 0.49; $P < 0.001$),
9. the availability of oxygen during anesthesia (SRCC, 0.272; $P = 0.012$),
10. the presence of a blood bank (SRCC, 0.313; $P = 0.012$),
11. the presence of a recovery room (SRCC, 0.274; $P = 0.027$), and
12. the presence of an intensive care unit (SRCC, 0.289; $P = 0.001$).

Physician anesthesiologists were less frequently present in hospitals supported by the government than in hospitals with other sources of funding (SRCC, −0.436; $P < 0.001$). The presence of a physician anesthesiologist had no influence on the technique of general anesthesia, but the presence of an aid nurse without medical training was associated with a significantly lower incidence of endotracheal intubation

Table 3. Details of Anesthesia Practice: Part II

Type of intravenous fluids available, $n = 62$	
Crystalloids	62 (100)
Colloids	35 (57)
Qualification of individual performing anesthesia[a], $n = 60$	
Physician anesthetist	13 (22)
Anesthetic officer (3 yr medical college and 2 yr anesthesia school)	44 (73)
State registered nurse (3 yr training in state-registered nursing school)	11 (18)
Nonregistered Nurse (2–3 yr training in nonregistered nursing school)	6 (10)
Aid nurse without medical training	3 (5)
External training during last 5 yr, $n = 63$	18 (29)
Contemporate anesthesia textbook available, $n = 64$	15 (23)
Availability of evaporator for volatile anesthesia, $n = 60$	42 (75)
Availability of oxygen during anesthesia, $n = 60$	55 (92)
Type of oxygen supply[a], $n = 60$	
Oxygen cylinder	45 (75)
Oxygen concentrator	23 (38)
Compressed gas/oxygen system	2 (3)
Monitoring equipment for anesthesia, $n = 60$	
Stethoscope	58 (97)
Sphygomanometer	57 (95)
Electrocardiogram	13 (22)
Oscillatory noninvasive blood pressure monitor	12 (20)
Oxygen saturation monitor	24 (40)
Capnography/capnometry	3 (5)
Protocolling during anesthesia, $n = 63$	52 (83)
Preanesthetic examination, $n = 62$	49 (79)
Written informed consent, $n = 64$	61 (95)
Blood bank in the hospital, $n = 65$	55 (85)
Types of blood recruitment[a], $n = 55$	
Blood from relatives	28 (43)
Blood from self donation	1 (2)
Blood from regularly tested donors	50 (77)
Recovery room, $n = 66$	23 (35)
Patients treated at recovery room, $n = 23$	53 (0–62)
Five most frequent anesthesia complications[b], $n = 53$	
Cardiovascular complications	28 (53)
Vomiting	22 (42)
Laryngospasm	19 (36)
Respiratory complications	17 (32)
Acute delirium	9 (17)
In-hospital mortality for elective surgery, $n = 56$	0.5 (0–0.8)
In-hospital mortality for emergency surgery, $n = 53$	2.4 (1–3)

Data are given as *n* (%) or median values and IQR.

n in the first column reflects the number of completed questions and is considered 100%.

[a] Multiple answers possible.

[b] Open-ended question with free text comments.

Table 4. Anesthesia Assessment of Intensive Care Medicine

Availability of an intensive care unit, $n = 68$	5 (7)
No. of ICU beds, $n = 5$	5 (4–8)
Physician present during 24 h, $n = 5$	1
External training during last 5 yr, $n = 63$	2
Availability of a contemporate critical care textbook, $n = 63$	0
Total no. of nurses per intensive care unit, $n = 5$	6 (5–17.5)
No. of patients treated per year, $n = 5$	160 (56–249)
Average age of patients, $n = 5$	
Children (<15 yr)	1
Adults (>15 yr)	4
Five most common admission diagnoses[a], $n = 5$	
Intensive care after major surgery	5
Isolated traumatic brain injury	4
Malaria	3
Pre/eclampsia	3
Severe Trauma	3
Availability of monitoring equipment, $n = 5$	
Electrocardiogram	4
Oscillatory noninvasive blood pressure monitor	2
Oxygen saturation monitor	4
Capnography/capnometry	1
Availability of a mechanical ventilator, $n = 4$	2
Oxygen Supply, $n = 5$	5
Oxygen cylinders	5
Oxygen concentrator	2
Compressed gas/oxygen system	1
Percentage of beds supplied with oxygen, $n = 5$	50 (25–75)
Compressed air supply, $n = 5$	3
Basic laboratory available during 24 h, $n = 5$	5
X-ray available in the intensive care unit, $n = 5$	3
Sonography available in the intensive care unit, $n = 5$	1
Average length of stay (d) in the intensive care unit, $n = 5$	3 (2.5–4)
Intensive care unit mortality, $n = 5$	20.5 (8.2–41)
Most common causes of death in the intensive care unit[a], $n = 5$	
Infection/sepsis	4
Malaria	3
Traumatic brain injury	2
Severe trauma	2
Hemorrhage	1

Data are given as *n* or median values and IQR.

n in the first column reflects the number of completed questions and is considered 100%.

[a] Open-ended question with free text comments.

(SRCC, −0.414; $P = 0.001$) and a trend towards more frequent use of ketamine (SRCC, 0.258; $P = 0.053$) during general anesthesia.

Only five hospitals (7%) reported having an intensive care unit (Table 4). All of these were referral hospitals in provincial capitals ($n = 4$) or the University Teaching Hospital in Lusaka. Summarizing data from these five hospitals, 29 intensive care beds were available in all study hospitals. Four of these intensive care units were headed by an anesthesiologist and one by an internist. All intensive care units had access to running water and electricity, and reported power cuts to occur with a median frequency of three per month (range, 1–4).

Data on the practice of emergency medicine and pain therapy are given in Tables 5 and 6, respectively. Table 7 shows the five most common suggestions to

Table 5. Anesthesia Assessment of Emergency Medicine

Availability of a local ambulance-based EMS, $n = 68$	38 (59)
Availability of an EMS based on a telephone dispatcher system, $n = 64$	23 (36)
Five most common emergency diagnoses[a], $n = 56$	
Obstetric emergencies	32 (57)
Trauma	30 (54)
Malaria	10 (18)
Acute abdomen	8 (14)
Anemia	6 (11)
EMS staff[b], $n = 40$	
Driver without emergency medical training	34 (85)
Driver with emergency medical training	3 (8)
Nurse without emergency medical training	32 (80)
Nurse with emergency medical training	2 (5)
Physician	9 (23)
Ambulance equipment, $n = 38$	
Stretcher	33 (87)
Wound dressings	17 (45)
Sprains	3 (8)
Oxygen	9 (24)
Vital data monitor	3 (8)
Defibrillator	1 (3)
Drugs	15 (40)
Five most frequently applied drugs[a], $n = 15$	
Analgesics	8 (53)
Corticosteroids	8 (53)
Intravenous fluids	6 (40)
Epinephrine	5 (33)
Antibiotics/antimalarial medications	4 (27)
Time (mins) from emergency to hospital admission, $n = 46$	140 (113–360)
Modes of transport in patients not served by the EMS[b], $n = 58$	
By foot	20 (35)
Bicycle	35 (60)
On stretcher	22 (38)
Private car	41 (71)
Taxi	21 (36)

Data are given as *n* (%) or median values and IQR.

n in the first column reflects the number of completed questions and is considered 100%.

EMS = emergency medical system.

[a] Open-ended question with free text comments.

[b] Multiple answers possible.

Table 6. Anesthesia Assessment of Pain Medicine

Patients suffering from pain in the hospital, $n = 51$	73 (50–80)
Patients receiving analgesics, $n = 51$	70 (50–90)
Five most common causes of pain in the hospital[a], $n = 62$	
Trauma	52 (84)
Surgery	39 (63)
Infections	18 (29)
Gynecologic/obstetric diseases	15 (24)
Cancer	12 (19)
Responsible person for pain therapy in the hospital, $n = 64$	
Physician in charge	60 (94)
Nurse	24 (38)
Anesthetist	18 (28)
Physician specially trained in pain medicine	2 (3)
Five most frequently applied analgesics[a], $n = 64$	
Paracetamol	41 (64)
Meperidine	27 (42)
NSAID	19 (30)
Acetylsalecylic acid	12 (19)
Metamizole	2 (3)
Experience of the anesthetist in chronic pain treatment, $n = 62$	52 (84)
Availability of oral opioids, $n = 63$	10 (16)

Data are given as *n* (%) or median values and IQR.

n in first column reflects the number of completed questions and is considered 100%.

NSAID = nonsteroid antiinflammatory drugs.

[a] Open-ended question with free text comments.

Table 7. Suggestions to Improve Anesthesia and Intensive Care Services[a,b]

Anesthesia, $n = 59$	
Monitors, e.g., oxygen saturation monitors	39 (66)
Anesthesia machine	32 (54)
Theoretical and practical training	23 (39)
Increase in qualified staff	20 (34)
Resuscitation equipment, e.g., laryngoscopes	12 (20)
Intensive care medicine, $n = 5$	
Medical apparatus, e.g. monitors and ventilators	5 (100)
Theoretical and practical training	2 (40)
Renovation and enlargement of intensive care unit	2 (40)
Increase in qualified staff	1 (20)

n in the first column reflects the number of completed questions and is considered 100%.

[a] Open-ended questions with free text comments.

[a] Multiple requirements and suggestions possible.

improve anesthesia and intensive care medicine. All respondents (68 of 68, 100%) indicated a willingness cooperate with industrial countries to improve their anesthesia care and related services.

DISCUSSION

The Republic of Zambia is a sub-Saharan African developing country ranking on the basis of population 166 of 177 nations on the Human Development Index.[6] With 464% of the 212 million inhabitants living on <1 US dollar per day, the country is one of the poorest in the world. In 2006, the life expectancy was 40 yr. Sixty-eight percent and 32% of the urban and rural population, respectively, have access to improved sanitation. Human immunodeficiency virus/acquired immunodeficiency syndrome, lower respiratory tract infections (e.g., pneumonia), and malaria are the leading causes of death in the country. Approximately 6% of the annual gross domestic product is spent on health care (353% general government, 47% private expenditure) amounting to a per capita total expenditure on health of 21 US dollars in 2003.[7]

In contrast to industrialized countries, anesthesia in Zambia is an under-developed and under-resourced medical specialty focused almost exclusively on intraoperative patient care. In most hospitals, anesthesia is

given by nonphysicians with little or no formal training in anesthesia. Small hospitals and hospitals in remote areas lack adequate staff, equipment, drugs, and supply materials to perform safe anesthesia. Intensive care units are rarely available. Anesthesiologists have almost no involvement in emergency medicine and pain therapy.

Similar to other tropical countries, the spectrum of surgical interventions reported in this survey is predominated by obstetric/gynecological surgery and abdominal surgery (Table 1).[8,9] The most common anesthetic technique performed is general anesthesia, which is different from other sub-Saharan African countries, which primarily use regional anesthesia (Table 2).[10] Half of the general anesthesia cases used dissociative anesthesia with ketamine, consistent with other tropical[11] and developing[12] countries. The reliance on ketamine may be a result of the inadequate training of anesthesia providers (Table 3), as well as experience with, and access to, more advanced equipment such as laryngoscopes and endotracheal tubes.[1] This is consistent with our finding that 80% of anesthesia cases were performed by nonphysicians, and the presence of a physician anesthesiologist strongly increased the likelihood of endotracheal intubation for general anesthesia. Our study suggests that a lack of adequately trained anesthesiologists, as well as inadequate monitoring equipment and a lack of anesthesia drugs, are the main problems in perioperative anesthesia care in the Republic of Zambia.

Cardiovascular complications were the most common complication reported in our survey (Table 3). The cause is unclear, but inadequate airway control, inadequate patient monitoring, undetected hypoxia, and the lack of resuscitation drugs and colloid fluids may be contributory. Perioperative hemodynamic instability may contribute to poor overall outcome.[13]

Widespread use of ketamine-based dissociative anesthesia without airway protection may have contributed to the high incidence of laryngospasm, respiratory complications, and delirium reported in the survey (Table 3). No cause for the frequent intraoperative and postoperative vomiting can be drawn from our data. However, considering inadequate airway protection in approximately 75% of patients undergoing general surgery, there is clearly a high risk for aspiration. Even though aspiration was reported to be a frequent complication by only five respondents, its incidence may be under-estimated given the lack of diagnostic options including radiograph and oxygen saturation monitors.

Reported in-hospital mortality rates were astonishingly (and unbelievably) low. Zero in-hospital morality was reported by 22% of the respondents for elective surgery, and 42% of the respondents for emergency surgery. This may be partly explained by respondents reporting intraoperative mortality, instead of in-hospital mortality. However, it may also reflect selective censoring of reported data. Implementation of quality control measures (e.g., documentation of anesthesia-related perioperative morbidity and mortality rates) could significantly increase the ability of health care providers and governmental agencies to assess the quality of anesthetic care.[14]

Only one other study has examined the status of anesthesia in a developing country on a larger scale.[15] Hodges et al. used a questionnaire-based survey including approximately one-third of Ugandan anesthesiologists (48% of Ugandan hospitals). In accordance with our findings, the authors identified significant shortages of adequately trained personnel, anesthetic drugs, and equipment. Merely 23% of the anesthesiologists had the facilities to deliver safe anesthesia to an adult, 13% to deliver safe anesthesia to a child, and 6% to deliver safe anesthesia for cesarean delivery.

Although critical care medicine has become an integral part of anesthesia in industrialized countries,[16] it plays a negligible role in most Zambian hospitals. Because there are only 29 critical care beds in 78% of Zambian hospitals performing surgery, it is obvious that most critically ill patients are cared for in ordinary hospital wards. This is even more remarkable when considering the high number of life-threatening complications of tropical diseases in sub-Saharan Africa.[1,17] When compared with intensive care units in industrialized countries,[18] patients treated in Zambian intensive care units are mostly children or young adults. Similar to anesthesia care, clinical practice of critical care medicine is characterized by shortages in adequately trained personnel and basic supplies such as oxygen and fundamental equipment such as ventilators and radiograph. Infection and sepsis were the most frequent causes of death in Zambian intensive care units, and may have resulted from low standards of hygiene,[19] inadequate diagnostic resources,[15] limited drug supply, and antibiotic resistance.[20]

Zambian anesthesiologists play almost no role in emergency medicine (Table 5). Only approximately 50% of the hospitals were served by an emergency medical system. Comparable findings have been reported from other sub-Saharan nations.[21] If there is an emergency medical system at all, the care is primarily based on rapid transport rather than on medical treatment at the scene. Emergency service vehicles are inadequately equipped and lack basic medical supplies.

Zambian anesthesiologists play almost no role in pain therapy (Table 6). Our study confirms a dramatic lack of oral opioids for pain treatment in sub-Saharan Africa.[22,23]

Only nationwide structural changes will result in consistent improvements of the Zambian health care system. The situation is even worse in developing countries shaken by war, economic instability, and poverty. These fundamental problems must be solved to provide adequate medical treatment for the world's

poorest people. The respondents to this questionnaire indicated that both theoretical and practical training, as well as anesthetic drugs and devices, are needed to improve anesthesia care in Zambia (Table 7). In accordance with suggestions of other authors,[15,24] oxygen concentrators and oxygen saturation monitors may enhance intraoperative and postoperative patient safety in Zambia, as it has been shown for industrialized countries.[25] However, donated medical devices will only improve patient care if they can be used locally (e.g., most hospitals do not have a compressed air supply, and thus cannot use modern anesthesia machines), if health care personnel are adequately trained, and if basic maintenance can be guaranteed for a reasonable period of time. Suggestions on how to transfer knowledge and material to less developed countries are summarized in Table 1 of the supplementary material (available at www.anesthesia-analgesia.org).

There are important limitations to our survey results. First, despite the high return rate of questionnaires, our data cannot be taken as absolute figures for the entire country of Zambia. Although unlikely, it is possible that overall anesthesia care is significantly better in the nonresponding hospitals. Second, we only investigated intensive care units in hospitals offering surgical and anesthesiology services. Third, the results of this study cannot be extrapolated to other developing countries, particularly not to those outside of sub-Sahara Africa. Fourth, the statements on complications and mortality rates may be based on personal impressions rather than on objective data. Fifth, data on medical disciplines with which the responding anesthesiologist is not involved (e.g., emergency medicine) may not be valid.

In conclusion, anesthesia in the Republic of Zambia is highly under-developed and under-resourced. Indeed, it bears little resemblance to anesthesia practiced in developed countries.

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