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SPECIAL ARTICLE

World Health Organization-World Federation of Societies of Anaesthesiologists (WHO-WFSA) International Standards for a Safe Practice of Anesthesia

Adrian W. Gelb, MBChB, FRCPC,* Wayne W. Morriss, MBChB, FANZCA,† Walter Johnson, MD,‡ Alan F. Merry, MBChB, FANZCA, FFPMANZCA, FRCA,§ on behalf of the International Standards for a Safe Practice of Anesthesia Workgroup

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The International Standards for a Safe Practice of Anesthesia were developed on behalf of the World Federation of Societies of Anaesthesiologists (WFSA), a nonprofit organization representing anesthesiologists in 150 countries, and the World Health Organization (WHO). The recommendations have been approved by WHO and the membership of WFSA. These Standards are applicable to all anesthesia providers throughout the world. They are intended to provide guidance and assistance to anesthesia providers, their professional organizations, hospital and facility administrators, and governments for maintaining and improving the quality and safety of anesthesia care. The Standards cover professional aspects; facilities and equipment; medications and intravenous fluids; monitoring; and the conduct of anesthesia. **HIGHLY RECOMMENDED** standards, the functional equivalent of mandatory standards, include (amongst other things): the continuous presence of a trained and vigilant anesthesia provider; continuous monitoring of tissue oxygenation and perfusion by clinical observation *and* a pulse oximeter; intermittent monitoring of blood pressure; confirmation of correct placement of an endotracheal tube (if used) by auscultation and carbon dioxide detection; the use of the WHO Safe Surgery Checklist; and a system for transfer of care at the end of an anesthetic. The International Standards represent minimum standards and the goal should always be to practice to the highest possible standards, preferably exceeding the standards outlined in this document. (Anesth Analg 2018;126:2047–55)

Hippocrates stated *primum non nocere*—first do no harm. This remains a fundamental principle in patient care. Leadership by anesthesiologists in many parts of the world resulted in the implementation, in high-income countries, of monitoring and other standards of care in the 1980s. The Institutes of Medicine (now the National Academies of Science) noted in their 1999 publication, *To Err is Human*, that anesthesia-related mortality had been reduced from two per 10,000 to one in 200,000 in healthy patients.[1] This, unfortunately, is not the case in low- and middle-income countries where anesthesia-related mortality can be as high as one in 300![2]

A detailed review of the history of the first International Standards for a Safe Practice of Anesthesia has been published.[3] Briefly, the World Federation of Societies of Anaesthesiologists (WFSA) first published such standards in 1992. As part of the World Health Organization (WHO)'s *Safe Surgery Saves Lives* initiative in 2008, a workgroup reviewed, revised, and updated the Standards. These were endorsed by all national anesthesia societies and published in 2010, with an expectation for periodic review.[3,4] This current document represents the first substantive outcome of that review process. The fundamental Standards are largely unchanged although an attempt has been made to make the document more accessible by increasing the number of tables. We have also attempted to reconcile recommendations with those that have come from other entities writing about safe surgery, such as The Lancet Commission on Global Surgery (LCoGS)[5] and Disease Control Priorities, third edition (DCP-3) (http://dcp-3.org/surgery).[6]

The intent of the 2018 International Standards, like its predecessor, is not to supersede the established national standards of any country. They are intended primarily as a resource for those countries that do not already have national standards and define minimum standards for any facility where anesthesia is administered. To facilitate evaluation of facilities against these standards, a parallel Anesthetic Capacity Checklist has been derived to allow anesthetic departments, regions, or countries to assess their compliance and their needs (available at https://www.wfsahq.org/our-work/safety-quality). The International Standards for a Safe Practice of Anesthesia were presented to the General Assembly of the WFSA in 2016 and unanimously endorsed by all national society members present. The document was also reviewed by the WHO Emergency & Essential Surgical Care Programme and the Policy, Access and Use, Essential Medicines & Health Products Department.

*Department of Anesthesia & Perioperative Care, University of California San Francisco, San Francisco, California; †Department of Anaesthesia, University of Otago, Christchurch Hospital, Christchurch, New Zealand; ‡Services Organization and Clinical Interventions Unit (SCI), Service Delivery and Safety Department (SDS), Health Systems and Innovation (HIS), World Health Organization, Geneva, Switzerland; §Department of Anaesthesiology, University of Auckland and Department of Anaesthesia, Auckland City Hospital, Auckland, New Zealand.

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Address correspondence to Adrian W. Gelb, Department of Anesthesia & Perioperative Care, University of California San Francisco, 500 Parnassus Ave, MUE 404, San Francisco, CA 94143. Address e-mail to adrian.gelb@ucsf.edu.

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Table 1. Anesthesia Providers

Provider/Term	Description
Anesthesia provider	Any healthcare worker who provides anesthesia care, irrespective of professional background or level of training
Anesthesia	Refers to the administration of general or regional anesthesia or moderate or deep sedation independent of who provides the care
Anesthesiologist	A graduate of a medical school who has completed a nationally recognized specialist anesthesia training program
Nurse anesthetist	A graduate of a nursing school who has completed a nationally recognized nurse anesthetist training program
Non-specialist physician anesthetist	A graduate of a medical school who has not completed a specialist training program in anesthesia but has undergone some anesthesia training
Non-anesthesiologist providers	Includes non-specialist physician anesthetists, nurse anesthetists, and other providers
Other anesthesia providers	In many countries, anesthesia is provided by other health workers (eg, anesthetic officers, technicians, or assistants) who have completed training recognized in their own countries

World Health Assembly resolution 68.15 recognizes access to emergency and essential anesthesia and surgical care as an integral part of universal health coverage.[7] There is also growing recognition that up to one third of the global burden of disease is surgically correctable, which is a greater burden than that of tuberculosis, human immunodeficiency virus, and malaria combined. Increasing access to surgical care depends on a parallel increase in access to safe anesthesia. It is the hope of the Working Group that the recommendations and standards herein contribute to ensuring that every patient in every country has access to safe anesthesia every time he or she needs it.

OVERVIEW

The following bullet points outline the main principles and tenets that inform these updated Standards.

- Access to safe anesthesia for essential surgery is a basic human right and should be available to all patients irrespective of their ability to pay.
- These International Standards have been developed by the WHO and the WFSA, a nonprofit organization representing anesthesiologists in 150 countries worldwide. The Standards apply to all anesthesia providers (Table 1) throughout the world.
- They are intended to provide guidance and assistance to anesthesia providers, their professional organizations, hospital and facility administrators, and governments for maintaining and improving the quality and safety of anesthesia care.
- We have used the standardized language of the WHO to denote three levels of standard:
  - **HIGHLY RECOMMENDED**
  - **RECOMMENDED**
  - **SUGGESTED**
- **HIGHLY RECOMMENDED** standards are the minimum expected standards. They are the functional equivalent of mandatory standards.
- **RECOMMENDED** standards and **SUGGESTED** standards should be practiced when resources allow and if appropriate for the healthcare being provided.
- In any setting, the goal should be to practice to the highest possible standards, preferably exceeding the standards outlined in this document.
- In some resource-poor settings, even **HIGHLY RECOMMENDED** (ie, minimum expected standards) may not currently be met. In these settings, the provision of anesthesia should be restricted to procedures that are absolutely essential for the immediate (emergency) saving of life or limb.
- If **HIGHLY RECOMMENDED** standards are not met, provision of anesthesia for elective surgical procedures is unsafe and unacceptable. Every effort must be made by those responsible for the provision of healthcare in these settings to ensure that **HIGHLY RECOMMENDED** standards are met, as a matter of urgency.

SCOPE OF STANDARDS

- These standards are relevant to any healthcare facility anywhere in the world, independent of level designated, in which general anesthesia, deep sedation, or moderate sedation (Table 2) is used or regional anesthesia (spinal, epidural, major limb blocks) is administered.
- Assessment of and titration to the exact level of sedation can be difficult and the same standards therefore apply to moderate and deep sedation as to general anesthesia. For example, ketamine administration for a surgical procedure usually results in general

Table 2. Definition of General Anesthesia and Levels of Sedation[a]

	General Anesthesia	Deep Sedation	Moderate Sedation ("Conscious Sedation")	Minimal Sedation (Anxiolysis)
Responsiveness	Unarousable even with painful stimulus	Purposeful response following painful stimulation	Purposeful response to voice or to tactile stimulation	Normal response to verbal stimulation
Airway	Intervention often required	Intervention may be required	No intervention required	Unaffected
Breathing	Frequently inadequate	May be inadequate	Adequate	Unaffected
Circulation	May be impaired	Usually maintained	Usually maintained	Unaffected

[a]Adapted from the American Society of Anesthesiologists definitions. Available from URL: http://www.asahq.org/quality-and-practice-management/standards-guidelines-and-related-resources/continuum-of-depth-of-sedation-definition-of-general-anesthesia-and-levels-of-sedation-analgesia (accessed February 2018).

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anesthesia or deep sedation and therefore the **HIGHLY RECOMMENDED** standards apply.
- The standards do not apply to locations where only superficial procedures involving local anesthesia (ie, infiltration of local anesthetics) and/or minimal sedation are performed. Minimal sedation is characterized by a normal response to verbal stimulation (Table 2).
- These International Standards should be reviewed and revised at regular intervals as anesthetic practice and technologies evolve.

LEVEL OF HEALTHCARE FACILITY

- The WHO uses three levels to categorize healthcare facilities (Table 3):
  - Level 1: Small hospital/health centre
  - Level 2: District/provincial hospital
  - Level 3: Referral hospital

Some minor surgical procedures requiring anesthesia may be performed in a WHO Level 1 facility.

- The LCoGS describes three levels of facility, approximately aligned with the WHO levels—primary health centre, first level (district) hospital, and higher-level (secondary or tertiary) hospital (Table 4). The LCoGS first-level hospital (equivalent to WHO Level 2) should be capable of providing Cesarean delivery, laparotomy, and treatment of open fracture (the so-called "Bellwether Procedures", taken to indicate a "system advanced enough to do most other surgical procedures").[5,8]
- The DCP-3 also describes three levels of facility for delivery of essential surgery—the primary health centre, first-level hospital, and second- and third-level hospitals (Table 4). Only minor surgical procedures not requiring general anesthesia or sedation should be performed at the primary health centre. The first-level hospital is aligned with WHO Level 2.
- It is difficult to exactly align the three levels of the International Standards with the levels of healthcare facility (Table 4). We recognize that, in some countries, especially those with limited access to healthcare facilities, surgery and anesthesia may be performed in a Level 1 facility. *The relevant standards are determined by the surgical cases done in the facility rather than the officially designated facility level.* **HIGHLY RECOMMENDED** standards apply to all levels of facility providing surgery and anesthesia, including the lowest.
- In general:
  - Level 1 facilities providing surgery and anesthesia: HIGHLY RECOMMENDED standards.
  - Level 2 facilities: HIGHLY RECOMMENDED standards for facilities providing the Bellwether Procedures and a limited range of other surgical procedures. HIGHLY RECOMMENDED + RECOMMENDED standards for larger facilities providing a wide range of emergency and elective procedures.
  - Level 3 facilities: HIGHLY RECOMMENDED + RECOMMENDED + SUGGESTED for facilities providing a full range of emergency and elective procedures as well as subspecialty procedures.
- In all facilities, the goal always should be to practice to the highest possible standards.

Table 3. WHO Health Care Facility Levels[a]

	Level 1 Facility Small Hospital/Health Centre	Level 2 Facility District/Provincial Hospital	Level 3 Facility Referral Hospital
Typical infrastructure	Small number of beds, sparsely equipped procedure or operating room (OR)	100–300 beds, adequately equipped major and minor ORs	300–1,000 or more beds, adequately equipped ORs and intensive care facilities
Treatment capability	Emergency treatment of 90–95% of trauma and obstetric cases (excluding Cesarean delivery) Referral of other patients (eg, obstructed labour, bowel obstruction) to a higher level	Short-term treatment of 95–99% of major life-threatening conditions	Same as Level 2, with the addition of intensive care treatment
Procedures	Normal vaginal delivery Uterine evacuation Circumcision Hydrocele reduction, incision and drainage Wound suturing Control of hemorrhage with pressure dressings Debridement and dressing of wounds Temporary reduction of fractures Cleaning and/or stabilization of open and closed fractures Chest drainage (possibly)	Same as Level 1 with the following additions: Cesarean delivery Laparotomy (usually not for bowel obstruction) Amputation Hernia repair Tubal ligation Closed fracture treatment and application of plaster of Paris Eye operations, including cataract extraction Removal of foreign bodies, eg, from the airway Emergency ventilation and airway management for referred patients such as those with chest and head injuries	Same as Level 2 with the following additions: Facial and intracranial surgery Bowel surgery Pediatric and neonatal surgery Thoracic surgery Major eye surgery Major gynecologic surgery, eg, vesico-vaginal repair

[a]Adapted from Guide to Infrastructure and Supplies at Various Levels of Health Care Facilities. Emergency and Essential Surgical Care, WHO. Available from URL: http://www.who.int/surgery/publications/immesc_equipt_needsmaneg/en/ (accessed February 2018).

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Table 4. Comparison of Levels of Health Care Facilities

	Level 1	Level 2	Level 3
WHO (see Table 3 for details)	Minor surgery, some cases requiring anesthesia (eg, uterine evacuation)	Cesarean delivery, laparotomy, and a range of emergency and simple elective procedures	Subspecialty and more complex surgery. Intensive care treatment
Lancet Commission on Global Surgery (LCoGS)	**Primary Health Centre** Minor procedures not requiring anesthesia. Referral to first level hospital	**First-Level (District) Hospital** The "core site for surgical and anesthesia care delivery". Provision of the Bellwether Procedures (laparotomy, Cesarean delivery, treatment of open fracture), indicative of a surgical system advanced enough to do most other surgical procedures	**Higher-Level (Secondary or Tertiary) Hospital** "Care specialization". Hub for system-wide clinical, education, and research support
Disease Control Priorities (DCP-3)	**Community Facility and Primary Health Centre** Minor procedures not requiring anesthesia (eg, dental extraction, drainage of superficial abscess)	**First-Level (District) Hospital** Similar to LCoGS. Bellwether procedures and a range of other emergency and elective surgery	**Second- and Third-Level Hospitals** Subspecialty surgery (eg, surgery for congenital abnormalities)

INTERNATIONAL STANDARDS FOR A SAFE PRACTICE OF ANESTHESIA

The standards are grouped under the following headings:

- Professional aspects
- Facilities and equipment
- Medications and intravenous fluids
- Monitoring
- Conduct of anesthesia

PROFESSIONAL ASPECTS

Safe surgical and anesthesia care requires effective communication and teamwork between all healthcare workers. The model of delivery of anesthesia care varies from country to country and all anesthesia providers should be trained to a nationally recognized standard. Anesthesiologists and non-anesthesiologist providers need to understand each other's scope of practice and skills.

Professional Status

Anesthesia is a vital component of basic healthcare and requires appropriate resources. Anesthesia is inherently complex and potentially very hazardous, and its safe provision requires a high level of expertise in medical diagnosis, pharmacology, physiology, and anatomy, as well as considerable practical skill. Therefore, the WFSA views anesthesiology as a medical practice. Wherever and whenever possible, anesthesia should be provided, led, or overseen by an anesthesiologist **(HIGHLY RECOMMENDED)**. When anesthesia is provided by non-anesthesiologists, these providers should be directed and supervised by anesthesiologists, in accordance with their level of training and skill. When there are no anesthesiologists at a local level, leadership should be provided by the most qualified individual. Policies and guidelines consistent with this document should be developed at a local, regional, or national level by a team of anesthesia providers led by an anesthesiologist.

Every patient should be cared for at the highest standard of safety possible, independent of whether the provider is an anesthesiologist or a non-anesthesiologist. This means that there is only one standard of safety and this does not vary among provider groups. Therefore, local and national standards should be consistent with the recommendations in this document (**HIGHLY RECOMMENDED**).

Professional Training

Sufficient time, facilities, and financial support should be available for professional training of all anesthesia providers, both initial and continuing, to ensure that an adequate standard of knowledge, expertise, and practice is attained and maintained. Formal training in a nationally accredited (postgraduate) education program and documentation of training is **HIGHLY RECOMMENDED**.

Number of Anesthesia Providers

The LCoGS goal of all countries achieving a specialist surgical workforce (surgeons, anesthesiologists, obstetricians) of at least 20 per 100,000 population by 2030 is **HIGHLY RECOMMENDED**.[4] The number of anesthesiologists within the specialist surgical workforce must be adequate to ensure effective leadership of anesthesia services and delivery of care. Currently, many countries fall below target (www.wfsahq.org/workforce-map). The number of non-anesthesiologist providers will be determined by local models of care, surgical demands, financial resources, and other factors.

Professional Organizations

Anesthesia providers should form appropriate organizations (eg, societies, colleges) at local, regional, and national levels for the setting of standards of practice, supervision of training, and continuing education with appropriate certification and accreditation (**RECOMMENDED**). These organizations should form links with appropriate groups within the region, the country, and internationally.

Quality Assurance

Institutional, regional, and/or national mechanisms should be instituted to provide an ongoing review of anesthetic practice. Regular confidential discussion of appropriate topics and cases with multidisciplinary professional colleagues should take place. Protocols and standard operating procedures should be developed to ensure that deficiencies in individual and collective practice are identified and rectified in a nonpunitive manner. An anonymous incident-reporting

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system with case analysis resulting in recommendations for alterations in practice is **RECOMMENDED**.

Workload

A sufficient number of trained anesthesia providers should be available so that individuals may practice to a high standard without undue fatigue or physical demands **(RECOMMENDED)** (www.wfsahq.org/our-work/safety-quality). Time should be allocated for education, professional development, administration, research, and teaching **(RECOMMENDED).**

FACILITIES AND EQUIPMENT

Standards for facilities and equipment are summarized in Table 5. This table includes monitoring equipment; additional standards for monitoring are summarized in Table 7.

Appropriate facilities and equipment meeting the standards in this document should be present wherever anesthesia and recovery are undertaken, including locations outside the operating room (eg, radiology suites, outpatient facilities, or offices).

Training in the use and safety of equipment is required **(HIGHLY RECOMMENDED).** Formal certification and documentation of this training are **SUGGESTED**. Anesthesia equipment should conform to relevant national and international standards—eg, the International Organization for Standardization (ISO) (www.iso.org/home.html).

MEDICATIONS AND INTRAVENOUS FLUIDS

Standards for medications and intravenous fluids are summarized in Table 6.

Adequate quantities of appropriate anesthetic, analgesic, resuscitative, and other (adjuvant) medications should

Table 5. Standards for Facilities and Equipment[a] (also see Table 7)

	HIGHLY RECOMMENDED	RECOMMENDED	SUGGESTED
Preoperative area			Dedicated space for preoperative assessment
Operating room	Adequate lighting Tilting operating table Supply of oxygen (eg, oxygen concentrator, cylinders or pipeline) Oropharyngeal airways Facemasks Laryngoscope and appropriate sized laryngoscope blades for both adult and pediatric patients Appropriate sized endotracheal tubes for adult and pediatric patients Intubation aids (eg, Magill forceps, bougie, stylet) Suction device and suction catheters Adult and pediatric self-inflating bags Equipment for IV infusions and injection of medications for adult and pediatric patients Equipment for spinal anesthesia or regional blocks Sterile gloves Access to a defibrillator Stethoscope Pulse oximeter Carbon dioxide detector Noninvasive blood pressure monitor with appropriate sized cuffs for adult and pediatric patients	Work surface and storage for equipment and medications System for delivering inhalational anesthesia (draw-over or plenum) For plenum systems: • Inspired oxygen concentration monitor • Anti-hypoxia device to prevent delivery of a hypoxic gas mixture • System to prevent misconnection of gas sources (eg, tank yokes, hose connectors) Automated ventilator with disconnect alarm IV pressure infusor bag Device for warming IV fluids, blood Examination (nonsterile) gloves Continuous waveform capnography Electrocardiogram Temperature monitor (intermittent) Peripheral neuromuscular transmission monitor (nerve stimulator)	System for delivering inhalational anesthesia (plenum) Adult and pediatric supraglottic airways Infusion pumps Warming blanket Overhead heater (for neonates) Infant incubator Intensive care ventilator Inhalational anesthetic concentration monitor Intra-arterial blood pressure monitor Temperature monitor (continuous electronic)
Postanesthesia recovery area	Adequate lighting Supply of oxygen (eg, oxygen concentrator, cylinders or pipeline) Suction device and suction catheters Facemasks Adult and pediatric self-inflating bags Electrocardiography Access to a defibrillator Pulse oximeter Noninvasive blood pressure monitor with appropriate sized cuffs for adult and pediatric patients	Dedicated space for recovering patients Examination gloves (nonsterile) Temperature monitor (intermittent)	

Abbreviation: IV, intravenous.

[a]Adapted from Guide to Infrastructure and Supplies at Various Levels of Health Care Facilities. Emergency and Essential Surgical Care, WHO. Available from URL: http://www.who.int/surgery/publications/immesc_equipt_needsmaneg/en (accessed February 2018).

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Table 6. Standards for Medications and Intravenous Fluids

	HIGHLY RECOMMENDED	RECOMMENDED	SUGGESTED
Intraoperative medications	Ketamine Diazepam or midazolam Morphine Local anesthetic (eg, lidocaine or bupivacaine) Dextrose (for neonates)	Thiopental or propofol Appropriate inhalational anesthetic (eg, halothane, isoflurane) Succinylcholine Appropriate non-depolarizing muscle relaxant (eg, pancuronium or atracurium) Neostigmine	Propofol Alternative inhalational anesthetics (eg, sevoflurane) Alternative non-depolarizing muscle relaxants (eg, rocuronium or cisatracurium)
IV fluids	Saline for injection Normal saline or Ringer's lactate	Mannitol, Plasmalyte	
Resuscitative medications	Oxygen Epinephrine (adrenaline) Atropine Dextrose	Amiodarone Ephedrine, metaraminol, norepinephrine, or phenylephrine Hydrocortisone	
Postoperative medications	Morphine Acetaminophen (paracetamol) Appropriate nonsteroidal anti-inflammatory medicine (eg, ibuprofen)		Tramadol Gabapentin Oxycodone
Other medications	Magnesium	Salbutamol Calcium gluconate (or chloride) Hydralazine Furosemide	Glyceryl trinitrate/nitroglycerine Heparin

Abbreviation: IV, intravenous.

be available in healthcare facilities. The medications listed in Table 6 are a minimum and should be readily available for individual patients, irrespective of the patient's ability to pay for them. The WHO Essential Medicines List serves as a guide to the minimum medications that should be available (http://www.who.int/medicines/publications/essentialmedicines/en/).

All medications should be clearly labelled and dated (**HIGHLY RECOMMENDED**). Use of the ISO standard-coloured medication labels is **SUGGESTED** (www.iso.org/standard/43811.html).

Supplemental oxygen is **HIGHLY RECOMMENDED** for all patients undergoing general anesthesia and deep sedation. Supplemental oxygen is **SUGGESTED** for

Table 7. Standards for Monitoring

	HIGHLY RECOMMENDED	RECOMMENDED	SUGGESTED
Intraoperative	Clinical observation by an appropriately trained anesthesia provider: • Pulse rate and quality • Tissue oxygenation and perfusion • Respiratory rate and quality • Breathing system bag movement • Breath sounds • Heart sounds (eg, use of precordial or esophageal stethoscope as appropriate) Audible signals and alarms at all times Continuous use of pulse oximetry Intermittent noninvasive blood pressure monitoring Carbon dioxide detector for patients undergoing intubation	Inspired oxygen concentration monitor Device to prevent delivery of a hypoxic gas mixture Disconnect alarm (when mechanical ventilator used) Continuous use of an electrocardiogram Intermittent temperature monitoring Peripheral neuromuscular transmission monitor (when muscle relaxants used) Continuous waveform capnography[a] for patients undergoing general anesthesia and deep sedation	Continuous measurement of inspired and expired gas volumes Continuous measurement of inspired and expired inhalational anesthetic concentrations Continuous measurement and display of arterial blood pressure (in appropriate cases) Continuous electronic temperature monitoring (in appropriate cases) Urine output monitoring (in appropriate cases) Processed EEG in appropriate cases
Postoperative	Clinical observation: • Tissue oxygenation and perfusion • Respiratory rate and quality • Pulse rate and quality Continuous use of pulse oximetry Intermittent noninvasive blood pressure monitoring Assessment of pain score using age appropriate scale	Intermittent temperature monitoring	Urine output monitoring (in appropriate cases)

Abbreviation: EEG, electroencephalography.
[a]Continuous waveform capnography will be **HIGHLY RECOMMENDED** when appropriately robust and suitably priced devices are available.

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patients receiving moderate sedation. The inspired oxygen should be guided by pulse oximetry.

MONITORING

Standards for intra- and postoperative monitoring are summarized in Table 7.

Trained Anesthesia Provider

The most important monitor is a trained and vigilant anesthesia provider. He/she should be continuously present in the operating or procedure room during the anesthetic until recovery of consciousness or until care is transferred to another trained healthcare worker—eg, postanesthesia nurse **(HIGHLY RECOMMENDED)**.

Clinical Observation

Continuous clinical observation (eg, a finger on the pulse, direct observation of the patient, precordial stethoscope) is an essential component of monitoring an anesthetized patient. Clinical observation may allow earlier detection of clinical deterioration than monitoring equipment.

Audible Alarms

Available audible signals, such as the variable pitch pulse tone of the pulse oximeter, with appropriately set alarm limits, should be activated at all times and loud enough to be heard throughout the operating room **(HIGHLY RECOMMENDED)**.

Intraoperative Monitoring

Oxygen Supply. It is **RECOMMENDED** that the inspired oxygen concentration be monitored throughout each anesthetic with an instrument fitted with a low oxygen concentration alarm. An oxygen supply failure alarm and a device protecting against the delivery of a hypoxic gas mixture are **RECOMMENDED**. Systems with interlocks (eg, tank yokes, hose connectors) are **RECOMMENDED** to prevent misconnection of gas sources.

Oxygenation of the Patient. Tissue oxygenation and perfusion should be monitored continuously by clinical observation AND a pulse oximeter (**HIGHLY RECOMMENDED**). Clinical observation of oxygenation requires exposure of part of the patient (eg, face or hand, with adequate lighting).

Airway and Breathing. The adequacy of the airway and ventilation should be monitored by auscultation and continuous clinical observation **(HIGHLY RECOMMENDED)**. Where a breathing circuit is used, the reservoir bag should be observed. In some environments, continuous use of a precordial or esophageal stethoscope may be appropriate.

If an endotracheal tube is used, correct placement must be verified by auscultation (**HIGHLY RECOMMENDED**). Confirmation of correct placement by carbon dioxide detection (ie, non-waveform capnography or colourimetry) is also **HIGHLY RECOMMENDED**.

Continuous waveform capnography is **RECOMMENDED** for monitoring the adequacy of ventilation in intubated and/or paralyzed patients and also other patients undergoing general anesthesia or deep sedation. This form of monitoring will be **HIGHLY RECOMMENDED** when appropriately robust and suitably priced devices are available. Equipment manufacturers are encouraged to urgently address this deficiency.

When mechanical ventilation is used, a ventilator disconnect alarm should be used (**RECOMMENDED**).

Continuous measurement of inspiratory and/or expiratory gas volumes is **SUGGESTED**.

Cardiac Rate and Rhythm. The circulation must be monitored continuously. Palpation or display of the pulse and/or auscultation of the heart sounds should be continuous. Continuous monitoring and display of the heart rate with a pulse oximeter are **HIGHLY RECOMMENDED**. Monitoring of cardiac rhythm with an electrocardiograph is **RECOMMENDED**.

Blood Pressure. Noninvasive arterial blood pressure (NIBP) should be monitored using an appropriately sized cuff at appropriate intervals (usually at least every five minutes and more frequently if a patient is unstable) **(HIGHLY RECOMMENDED)**. Automated NIBP devices may allow the anesthesia provider to concentrate on other anesthesia tasks during an anesthetic. Continuous direct measurement and display of arterial pressure using an intra-arterial cannula and measurement system are **SUGGESTED** in appropriate cases. This allows continuous beat-by-beat monitoring of blood pressure. It should be considered when hemodynamic instability from blood loss, fluid shifts, or significant cardiopulmonary disease is anticipated. It is also useful when multiple blood samples are needed (eg, blood glucose management of brittle insulin-dependent diabetics).

Urine Output. During prolonged procedures or when significant administration of intravenous fluids is anticipated, urine output should be monitored **(SUGGESTED)**.

Temperature. A means of measuring the temperature should be available and used at frequent intervals where clinically indicated (eg, prolonged or complex anesthetics and in young children). The availability and use of continuous electronic temperature measurement in appropriate patients are **SUGGESTED**.

Neuromuscular Function. When muscle relaxants are given, the use of a peripheral neuromuscular transmission monitor (nerve stimulator) is **RECOMMENDED**.

Depth of Anesthesia. The depth of anesthesia (degree of unconsciousness) should be regularly assessed by clinical observation. The continuous measurement of inspired and expired concentrations of inhalational anesthetic agents is **SUGGESTED**.

The use of an electronic device intended to measure brain function (processed electroencephalography, depth of anesthesia monitor), while not universally recommended or used, is **SUGGESTED**, particularly in cases at risk of awareness under general anesthesia or postoperative delirium.

Postoperative Monitoring

All patients should be monitored in the postanesthesia recovery area until recovery of consciousness. Patients with hemodynamic, respiratory, or neurologic instability should

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be transferred to a high-dependency nursing unit or intensive care unit. Postoperative monitoring should follow similar principles to intraoperative monitoring. Continuous clinical observation by a trained healthcare worker is **HIGHLY RECOMMENDED**. This includes observation of oxygenation, airway and breathing, and circulation and measurement of the patient's pain score. Use of a pulse oximeter and intermittent NIBP monitoring are **HIGHLY RECOMMENDED**.

Use of other monitoring (eg, monitoring of temperature and urine output) may also be indicated, depending on patient and surgical factors.

CONDUCT OF ANESTHESIA

Personnel

One anesthesia provider should be dedicated to each patient and be present in the anesthetizing location throughout each anesthetic (general anesthesia, moderate or deep sedation, regional anesthesia). A trained assistant (eg, operating room nurse or technician) should be available to assist the anesthesia provider (**RECOMMENDED**).

The anesthesia provider is responsible for the transport of the patient to a suitable postanesthesia recovery area and the detailed transfer of care to an appropriately trained healthcare worker (**HIGHLY RECOMMENDED)**.

Preanesthetic Assessment and Consent

The patient must be assessed by the anesthesia provider prior to administration of anesthesia, preferably prior to entry into the operating room, and an appropriate anesthetic plan formulated and documented in the patient's medical record **(HIGHLY RECOMMENDED)**. The assessment should include preoperative optimization of medical problems and a plan for intraoperative and postoperative management.

Consent consistent with hospital policy, preferably written, should be obtained **(HIGHLY RECOMMENDED)**.

Preanesthetic Checks

The anesthesia provider must ensure that the facilities and personnel are adequate for the delivery of safe anesthesia and all medications and equipment (including the anesthesia machine/delivery system) have been checked prior to commencing the anesthetic **(HIGHLY RECOMMENDED).**

WHO Safe Surgery Checklist

The WHO Surgical Safety Checklist (http://www.who.int/patientsafety/safesurgery/ss_checklist/en/) is a simple tool designed to improve the safety of surgical procedures by bringing together the whole operating team (surgeons, anesthesia providers, and nurses) to perform key safety checks during three vital phases of care: prior to the induction of anesthesia, prior to skin incision, and before the team leaves the operating room. The use of the checklist, appropriately modified for local conditions and priorities, is **HIGHLY RECOMMENDED**.

Record Keeping

A record of the details of each anesthetic should be made and preserved with the patient's medical record (**HIGHLY RECOMMENDED**). This should include details of the preoperative assessment, the anesthetic plan, and intra- and the postoperative management, including any complications that occurred.

Postanesthesia Care

All patients who have had an anesthetic (general anesthesia, moderate or deep sedation, regional anesthesia) should remain where anesthetized until recovered or be transported safely to a specifically designated recovery area for postanesthesia recovery **(HIGHLY RECOMMENDED)**.[9] The postanesthesia recovery area must be adequately staffed by healthcare workers trained to manage patients recovering from anesthesia and surgery (**RECOMMENDED**). Oxygen, suction, a means of ventilation (eg, self-inflating bag-mask system), and emergency resuscitation medications must be immediately available (**HIGHLY RECOMMENDED**).

Transfer of Care and Delegation of Care

When responsibility for care is transferred from one anesthesia provider to another, or to a nurse or other healthcare worker, all relevant information about the patient's history, medical condition, anesthetic status, and plan should be communicated to that person **(HIGHLY RECOMMENDED)** (http://www.who.int/patientsafety/solutions/patientsafety/PS-Solution3.pdf?ua=1). The anesthesia provider should retain overall responsibility for the patient during the recovery period and should be readily available for consultation until the patient has recovered fully.

If the anesthesia provider delegates aspects of pre-, intra-, or postoperative patient care to another healthcare worker, the anesthesia provider is responsible for ensuring that the other person is adequately qualified and conversant with relevant information regarding the anesthetic and the patient.

Pain Management

All patients are entitled to appropriate efforts to prevent and alleviate postoperative pain using appropriate medications and modalities; these efforts are therefore **HIGHLY RECOMMENDED**.

Anesthesia providers should ensure that appropriate analgesic medications are available for intra- and postoperative pain management. A strong opioid (eg, morphine) may be required for severe postoperative pain and appropriate healthcare workers (eg, postanesthesia recovery nurses) should be trained in assessment of pain and patient monitoring after opioid administration. Postoperative administration of opioids and other analgesics may be delegated to appropriately trained healthcare workers in the postanesthesia recovery area, but overall responsibility for patient care should remain with the anesthesia provider.

APPENDIX

WHO-WFSA International Standards Workgroup

Chair:
Adrian W. Gelb (USA) adrian.gelb@ucsf.edu

Deputy Chairs:
Alan F. Merry (New Zealand) a.merry@auckland.ac.nz
Wayne Morriss (New Zealand) w.morriss@me.com

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Anuja Abayadeera (Sri Lanka) anuja@srg.cmb.ac.lk
Natalia Belîi (Moldova) natalia.belii.med@gmail.com
Sorin J. Brull (USA) SJBrull@me.com
Aline Chibana (Brazil) alineychibana@gmail.com
Faye Evans (USA) faye.evans@childrens.harvard.edu
Cyril Goddia (Malawi) cyril.goddia@gmail.com
Carolina Haylock-Loor (Honduras) carolinahaylockloor@gmail.com
Fauzia Khan (Pakistan) fauzia.khan@aku.edu
Sandra Leal (El Salvador) leal_sandra@hotmail.com
Nan Lin (China) linnan127@163.com
Richard Merchant (Canada) richard.merchant@ubc.ca
Mark W. Newton (USA) mark.w.newton@vanderbilt.edu
Jackie S. Rowles (USA) jsrowles@earthlink.net
Arinola Sanusi (Nigeria) arinolasanusi@yahoo.com
Iain Wilson (UK) iainhwilson@me.com

WHO:
Adriana Velazquez Berumen (Mexico)
velazquezberumena@who.int
Walter Johnston (USA) wjohnson@llu.edu

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AUTHOR CONTRIBUTIONS

Adrian W. Gelb, *Wayne W. Morriss*, and *Alan F. Merry* contributed substantially to all aspects of this manuscript, including conception and design; acquisition, analysis, and interpretation of data; and drafting the article. *Walter Johnson* contributed to the analysis of data and contributed substantially to the interpretation of data. All the other members of the Working Group contributed to the analysis and interpretation of data.
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