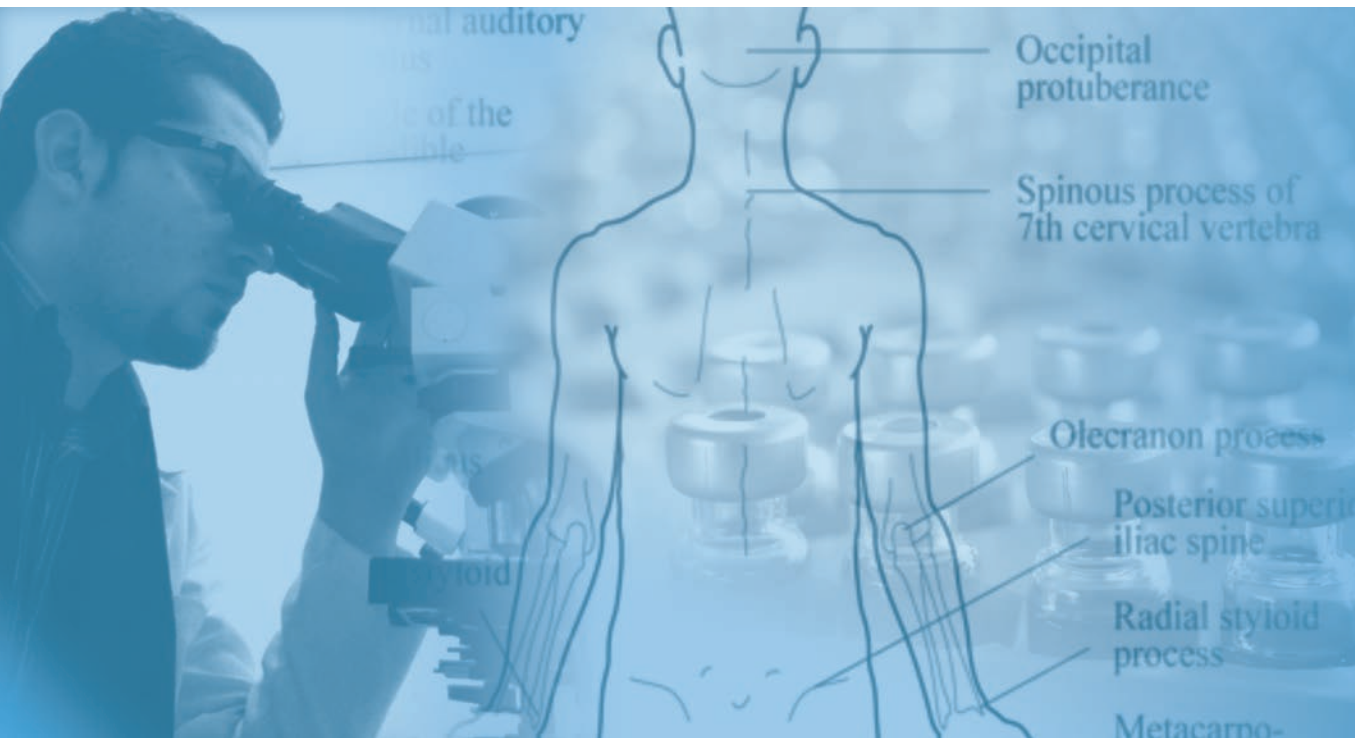




# UNODC

United Nations Office on Drugs and Crime



# Forensic autopsy Manual for forensic pathologists



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Development Canada

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et Développement Canada



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وزارة العدل

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This publication has not been formally edited.

# **FORENSIC AUTOPSY MANUAL**

August 2015



## FOREWORD

The United Nations Office on Drugs and Crime (UNODC) seeks to achieve security and justice for all by promoting effective strategies and action designed to fight crime, drugs and terrorism based upon the rule of law. UNODC aims to strengthen the rule of law through the promotion of effective, humane, fair and accountable criminal justice systems. UNODC's support is increasingly focused on assisting States to build the capacity of criminal justice institutions, improve governance structures and foster adherence to the rule of law as key cornerstones of development, human rights, peace and security.

Enhanced scientific and forensic capacity of States based upon a sound knowledge of drug, crime and terrorism issues is essential to an effective and transparent criminal justice system consistent with international norms.

Sharing forensic expertise is crucial in ensuring all States can benefit equally from forensic science tools and techniques. To respond to emerging threats and trends the UNODC has developed a wide range of technical assistance programs and tools to assist States in strengthening their forensic and scientific capacity and to assist inter-agency and inter-regional cooperation.

This manual was developed through a consultative process, in which regional and national ownership and the needs of criminal justice stakeholders were guiding principles. This manual contains a range of practical tools to assist the forensic pathologist in the task of performing an autopsy, documenting evidence and findings and overseeing the management of the mortuary.

Forensic evidence provides reliable information as long as the recognition, collection, analysis and interpretation is conducted at a standard that preserves the integrity and probative value of the evidence. We trust this manual will be a valuable resource for both medical practitioners and criminal justice system stakeholders who have a need for a detailed understanding of forensic autopsy.



Masood Karimipour  
Regional Representative for the Middle East and North Africa  
United Nations Office on Drugs and Crime

STATE OF PALESTINE  
MINISTRY OF JUSTICE  
Minister's Office



دَوْلَةُ فَالِستِطِينِ  
وَزَارَةُ العَدْلِ  
مَكْتَبُ الوَزِيرِ

Technical evidence and forensic medical reports can have a significant effect on the outcome of criminal cases, as they can prove that a crime occurred and can either incriminate or exonerate defendants. Forensic medicine plays a central and important role in achieving justice in a criminal investigation by providing information about the crime, how it occurred, and who may have committed it. This information allows the public prosecutor to build a strong case with a solid, evidence-based foundation, which is particularly important in cases of crimes that result in death.

Autopsy reports can provide judges with the date and time of the death, allowing them to make better judgments about convictions in criminal cases and rights and reparations in civil cases. Thus forensic medicine is important in achieving justice between disputants or for anyone who seeks or claims a right.

The Ministry of Justice, as the institution entrusted with achieving justice by scientific means and reliable evidence, is intent on guaranteeing a free and fair trial for all Palestinian citizens. This scientific and technical guide will help achieve this goal by acting as a compass for doctors and staff conducting autopsies. It was prepared by international, Arab and local experts with an advanced level of expertise and will help the integrity and efficiency of forensic medical services.

This manual outlines the importance of autopsies and the cultural and social obstacles faced in conducting them and includes the legal framework for autopsies as well as protocols to be followed regarding visiting the place of death, exhumation, and transporting a body to the morgue. It also provides information about how to operate a morgue, including safety regulations and the steps taken in storing a body. In a highly professional manner, it also deals with the smallest medical details of autopsies for different parts of the body, protocols for dealing with different liquids and tissues of the body, clarification of the medical certificate, preparing the judicial medical reports and submitting them to the competent authorities independently and impartially and in accordance with the laws and ethics of the profession.

I highly appreciate all the experts' efforts who participated in preparing this guide. I also thank the sponsors of this great achievement hoping that this guide will act as a constitution in the work of forensic medicine.

Saleem Al-Saqqa  
Minister of Justice

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## PREFACE

This manual has been developed as part of the project '*Forensic Human Resource and Governance Development Assistance for the Palestinian Authority*'. The project aims to strengthen the Palestinian criminal justice system by providing reliable and credible forensic evidence and improved capacity to manage forensic services. The project is implemented by UNODC in partnership with the Palestinian Ministries of Justice and Interior.

Amongst a number of initiatives to strengthen forensic medicine structures and to improve knowledge and competencies, the project provides for:

- the provision of a four-year post-graduate training in forensic medicine;
- a continuing professional development programme;
- a training programme in forensic nursing; and
- two manuals of forensic medicine covering sexual assault and the forensic autopsy.

A panel of forensic medicine experts, which included forensic doctors from the State of Palestine, Jordan and further afield, recommended that the manuals should meet the following objectives. Of relevance to this manual, it should:

- Be useful to forensic medicine services in the State of Palestine
- Be useful to doctors as well as to others (e.g. mortuary staff)
- Complement the four-year training programme for forensic doctors
- Be able to be translated into multiple languages (and thus useful internationally)
- Contain practical tools
- Emphasise gender issues
- Avoid duplication of material that already exists

We leave the reader to assess whether we have met these objectives. Chapter 2 sets out in brief a factual account of how the autopsy system works in the State of Palestine. This is not an evaluation of the strengths and weaknesses of the system, but serves as context for what follows.

There is necessarily some repetition of existing published material, but we believe this is justified on the grounds of the format of this manual, its forensic emphasis, and to render the work useful by not referring the reader to other texts, many of which are old and difficult to obtain.



## GLOSSARY

*The following terms and definitions should not be considered as official United Nations definitions.*

<b>Abortion</b>	Miscarriage of a pregnancy, either spontaneously or induced.
<b>Abrasion</b>	Superficial injury involving the epidermis resulting from a scratch, scrape, compression or friction. Also used to refer to such injuries extending to involve the dermis (and thus can bleed).
<b>Accountability</b>	A system or process designed to assure the proper discharge of responsibility by a person or institution.
<b>Accreditation</b>	A formal audit by independent external auditors of institutional processes against agreed industry wide standards. Passing the audit means the institutions is accredited.
<b>Anatomical pathology</b>	A sub-discipline of pathology comprising morbid anatomy (the macroscopic or naked-eye evaluation or diagnosis of diseased tissue and organs) and histopathology, which is the microscopic evaluation or diagnosis of diseased tissue. Sometimes referred to as surgical pathology.
<b>Anatomical planes</b>	Planes of the body used to help describe the location and course of body structures. There are three planes: 1. Coronal; 2. Sagittal, midline, median or longitudinal; 3. Horizontal or transverse.
<b>Anterior (or ventral)</b>	The front of the body or limbs; term used to help describe the relationship of one thing to another in or on the body. In relation to the palm of the hand, the term palmar is used, while plantar is used in descriptions of the sole of the foot.
<b>Artefact (artifact)</b>	Artificial product. In relation to autopsy, it is a sign (for example resulting from resuscitation or post-mortem damage) imitating pathology, disease, or injury occurring in life.
<b>Audit</b>	Evaluation of compliance with a standard.
<b>Autolysis</b>	A form of post-mortem decomposition mediated by enzymes and chemicals already present in organs and tissues
<b>Autonomy</b>	Literally, self-rule. The right of an individual to make decisions about matters affecting themselves.
<b>Autopsy (necropsy)</b>	A post-mortem examination of a body involving its external and internal examination and incorporating the results of special tests. In a full autopsy, the internal examination involves, but is not limited to, examining the contents of the cranium, chest, and abdomen. Further dissection can and should occur in particular circumstances.
<b>Autopsy room</b>	Part of the mortuary; the place in the mortuary where the external and internal examination of the body occurs.

<b>Bias</b>	An unjustified preference.
<b>Blanket (mattress) stitch</b>	A stitch used in reconstructing the body following autopsy.
<b>Bruise(contusion, ecchymosis)</b>	An injury characterized by extravasation of blood into the surrounding tissues.
<b>Cadaver</b>	Dead body; corpse; deceased person; human remains.
<b>Cause of death and related terms</b>	These four terms have been included together because they are important, are related to each other and are used inconsistently.
<b>1. Cause of death</b>	The underlying cause (the disease, condition or circumstance initiating the chain of events resulting in death), possibly proceeding through intermediate and immediate (or proximate) causes, ends the logically linked statements which constitute the cause of death. In recording the cause of death according to the WHO format, which is the conventional and internationally understood format, the most immediate cause is stated first, and the underlying cause stated last. Thus, the cause of death of a young man who was driving a car that crashed into a tree was: I(a) Haemorrhagic shock(due to) I(b)Multiple fractures and a ruptured liver (due to) I(c) Being the driver of a car which crashed into a tree.
<b>2. Mechanism of death</b>	<p>The phrase ‘mechanism of death’ is confusingly used in two different ways. First, it is used to describe the physical or other means by which the manner of death (in the example above: accident) or underlying cause of death (in the example above: being the driver of a car which crashed into a tree) led to the immediate and intermediate cause of death (for example: Haemorrhagic shock due to multiple fractures and a ruptured liver). Used in this way, the mechanism of death in the above example is blunt trauma.</p> <p>The second way the phrase is used is to represent the pathophysiological or biochemical means by which the underlying cause of death leads to death. Used in this way, the mechanism of death in the above example is haemorrhagic shock. Used in this way, the mechanism of death is the same as the mode of death – see below.</p>
<b>3. Manner of death</b>	The manner of death is the summary of the circumstances of the death; thus: homicide, suicide, accident or natural. In the example above, it was most likely an accident.
<b>4. Mode of death</b>	The mode of death is the word or phrase that best describes the pathophysiological events preceding death – in the example above, haemorrhage or haemorrhagic shock. Other modes include cardiogenic shock, respiratory failure, renal failure etc.
<b>Chain of custody (of exhibits)</b>	A process enabling the complete history of the custody of an exhibit to be tracked and recreated; that is, who has had care and control of the exhibit from the time it was first secured to the present.



<b>Clients and stakeholders</b>	Respectively, those who are directly served by the organization, and those who have an interest in the proper functioning of the organization.
<b>Clinical forensic medicine</b>	The medical discipline at the interface of clinical medicine and the law.
<b>Clinical pathology</b>	Hospital- or laboratory-based pathology consisting mainly of anatomical (surgical) pathology including cytopathology, haematology, microbiology, chemical pathology (biochemistry), immunology, cytogenetics, molecular biology, and others.
<b>Code of conduct (e.g. for mortuary staff)</b>	A document setting out the expected ethical behaviour and attitude of the group; usually intended as guidance for the group, and as a statement for clients and stakeholders.
<b>Confidentiality</b>	The obligation to safeguard entrusted information.
<b>Consent (informed consent)</b>	An agreement, freely given, to something; the agreement is not induced by fraud, and is based on the required information that has been provided. (Note: consent from next of kin is not necessary for autopsy in the context of this manual).
<b>Contamination</b>	The location on a person or object of material, whether obvious or not, from another source. Such contamination can be useful forensically (see Locard's Principle) or confusing and damaging to justice (e.g. DNA contamination).
<b>Contextual bias</b>	An unjustified preference for a particular professional opinion induced by circumstantial or other contextual information that is not relevant for forming that opinion.
<b>Continuity</b>	See: Chain of custody.
<b>Contusion</b>	See: Bruise.
<b>Coronal plane</b>	See: Anatomical plane. A vertical plane of the body, at right angles to the sagittal or median plane, which passes through or parallel to the central part of the coronal suture of the skull.
<b>Coronary atherosclerosis</b>	Colloquially, hardening of the arteries of the heart. Narrowing of the arteries of the heart (the coronary arteries) by fatty material (atheroma, comprised of cholesterol and related material). The common form of heart disease in the developed world. When the narrowing of the arteries is severe (greater than 75%) it is regarded as capable of causing sudden death.
<b>Coroner</b>	In some jurisdictions, the official responsible for death investigation. In the U.K. and Australia, coroners tend to have legal backgrounds. In Ontario, Canada, coroners are doctors (including, in some cases, forensic pathologists). This system of death investigation is often contrasted with the medical examiner system.

<b>Credibility</b>	A personal or institutional characteristic of providing reliable, correct advice and opinion; believability.
<b>Death certification system</b>	Better described as the 'cause of death' certification system. The vast bulk of deaths are dealt with by doctors who certify the natural cause from which the patient died. This is sufficient information for the deceased to then be buried.
<b>Death investigation system</b>	The system that deals with those deaths not certified as natural causes deaths by doctors.
<b>Death in custody</b>	Deaths that occur in police or prison custody; in some jurisdictions this extends to deaths in other forms of state supervised custody e.g. psychiatric hospitals, children's homes and foster care.
<b>Decomposition (post mortem)</b>	The process after death of decomposition comprises one or more of: autolysis, putrefaction, mummification, adipocere formation, skeletalization. In utero, the process is called maceration, a sterile form of autolysis.
<b>Disaster victim identification</b>	The scene, mortuary based and related processes (e.g. ante-mortem data collection, reconciliation) of dealing with a multiple fatality event to ensure that individuals are correctly identified. Undertaken in accordance with Interpol guidelines.
<b>Distal</b>	Term used in preference to superior/inferior in describing the location of things on or in the limbs.
<b>Document control</b>	The process of creating, and keeping up to date, documents setting out the institution's policies and procedures. This process underpins the institution's quality system.
<b>Ecchymosis</b>	See: Bruise, Contusion, Petechial haemorrhage.
<b>Effectiveness</b>	A measure of whether the output achieved matched what was expected or required.
<b>Efficiency</b>	A measure of output achieved for the resources used.
<b>Embolism</b>	The presence in the vascular system of material, often formed from the constituents of blood itself (thrombo-embolism), that can block blood flow with a variety of consequences; also fat embolism, bullet embolism, air embolism.
<b>Entomology (forensic)</b>	The study of insects in a forensic setting, most often in forensic pathology as an indicator of the minimum time since death.
<b>Ethics</b>	The study of what is right and wrong. Professional ethics concentrates on analyzing desirable behaviour and attitudes by members of that profession.
<b>Exhibits</b>	Physical evidence thought to be relevant to the investigation of a crime or death which are labelled and recorded as exhibits, and kept securely

so that they cannot be interfered with or contaminated.

<b>Forensic</b>	Relating to the courts, or more generally, the law.
<b>Forensic anthropology</b>	The examination of human skeletal material to answer medico-legal questions including those of identification.
<b>Forensic medicine</b>	The principles and practice of medicine as applied to the needs of the law and the courts.
<b>Forensic medicine practitioner, forensic doctor (State of Palestine)</b>	Certified medical doctor who is authorized to perform forensic post-mortem examinations, clinical medico-legal examinations and provide expert medico-legal advice.
<b>Forensic pathologist</b>	In this manual, the medical practitioner who undertakes the forensic autopsy; also referred to in this manual as a forensic doctor.
<b>Forensic odontology</b>	The study of dentistry in relation to the law, in particular to the investigation of death, especially the identification of human remains.
<b>Forensic pathology</b>	Part of pathology; the study of pathology in relation to the law, in particular to the investigation of sudden and unexpected deaths from all causes; the discipline of pathology concerned with the investigation of deaths where there are medico-legal implications.
<b>Fracture</b>	Break; a discontinuity in the cortex of a bone; sometimes used in relation to a cartilaginous structure such as a costal cartilage, or thyroid cartilage.
<b>Governance</b>	A system of oversight within an organization to assure the proper discharge of responsibility.
<b>Histology, histopathology</b>	The study of the microscopic structure of tissues (histology) in a diseased state (histopathology).
<b>Homicide</b>	The death of a person at the hands of another person. Generally a homicide is culpable (murder or manslaughter) or justifiable (for example in self-defence).
<b>Horizontal (or transverse) plane</b>	An anatomical plane of the body, at right angles to both the sagittal and coronal plane, parallel to the ground in a standing body.
<b>Human identification</b>	The attachment of the correct name to a person or human remains.
<b>Human remains</b>	In this document, synonymous with deceased person, dead body, cadaver. Sometimes used to specifically refer to skeletal remains.
<b>Hypostasis</b>	See: Lividity (post mortem); livor mortis.
<b>Immediate cause of death</b>	The disease, condition or complication, resulting from the underlying or intermediate cause, which immediately precedes death.
<b>Incised wounds</b>	Wounds caused by a sharp edged implement that are longer on the

	skin than they are deep.
<b>Infant, infancy</b>	In this document, a baby up to the age of 12 months. Sometimes refers to the period following the neonatal (qv) period and up to 12 months of age.
<b>Infanticide</b>	In some jurisdictions, a form of homicide; the killing of an infant (usually up to the age of 12 months) by his/her mother when the mother is still suffering the effects of giving birth.
<b>Inferior</b>	A term used to describe a vertical level of one thing below another on or in the body.
<b>Key performance indicator (KPI)</b>	A measure of performance that incorporates elements such as quality or timeliness (e.g. autopsy quality; time taken for body to be available for return to families, or to produce autopsy reports) as opposed to an output measure, which is simply a number of particular outputs (e.g. number of autopsies).
<b>Laceration</b>	A tear or split in the skin or other organ or soft tissue due to blunt force.
<b>Lateral</b>	Further away from the median, midline or sagittal plane.
<b>Lividity (post-mortem); livor mortis</b>	The post-mortem phenomenon of blood settling under the influence of gravity.
<b>Locard's principle</b>	The underlying principle of much of forensic science whereby any contact between two objects will leave a trace of each on the other.
<b>Maceration</b>	Sterile process of decomposition in utero which has a characteristic appearance.
<b>Manner of death</b>	The way, or circumstances, in which the death occurred; broadly, whether accidental, suicidal, homicidal, or natural.
<b>Mechanism of death</b>	See: Cause of death.
<b>Medial</b>	Closer to the median, midline or sagittal plane.
<b>Medical examiner system</b>	A form of death investigation system presided over by a forensic pathologist (usually) who carries responsibilities often divided between a coroner and a forensic pathologist in a coronial system, or by a prosecutor/judge and forensic doctor in other systems. This system often lacks the emphasis on public hearings inherent in a judicial coroners' system.
<b>Medico-legal death investigation</b>	Term used in this manual to indicate the totality of the forensic pathology investigation. It may include an autopsy and many other investigative modalities, which when combined produce the final result. Other modalities include: evaluating the deceased's medical record; consulting the deceased's doctors; information from police; attending the scene; evaluating scene photographs; considering witness

	statements and discussions with subspecialty pathologists or clinicians, etc.
<b>Midline</b>	An imaginary line dividing the body in half in the sagittal plane often used as a reference point to describe the anatomical location of a finding at autopsy.
<b>Midline plane</b>	See: Anatomical plane. This is the same as the sagittal or median plane, being the plane dividing the body into two symmetrical halves, reflecting the orientation of the sagittal sinus.
<b>Mission (mission statement)</b>	A statement setting out what the organization exists to do.
<b>Mode of dying/death</b>	The pathophysiological process by which the person died (e.g. haemorrhage, respiratory failure, cardiac failure, multi-organ failure, septicaemia). Its use alone is not sufficient to properly complete the WHO Medical Certificate of Cause of Death. See: Cause of death.
<b>Morgue</b>	See: Mortuary.
<b>Mortuary</b>	The place for storing, keeping and looking after the dead until final disposal or interment; includes the autopsy room; hospital for the dead.
<b>Mummification</b>	A particular form of post-mortem change where there is good preservation especially of skin, usually, but not always, associated with a hot, dry environment.
<b>Necropsy</b>	See: Autopsy.
<b>Needle stick injury</b>	A significant hazard in autopsy practice; a puncturing or penetrating injury usually from a needle.
<b>Negative autopsy</b>	No positive findings or specific pathological changes seen during the autopsy that allows a conclusion about the cause of death to be made.
<b>Neonate, neonatal</b>	The period from birth to 28 days postpartum; sometimes the period from birth to 7 days postpartum.
<b>Non-conforming testing or procedures</b>	Identified process, test or procedure in a particular case that was not performed in accordance with the requirements set out in the Work Instruction or the Policy and Procedure Manual.
<b>Paediatrics</b>	That branch of medicine involving the diagnosis and treatment of illness in children. It has long been recognized as a separate medical specialty because of the different medical issues that children and adults face.
<b>Pathology</b>	The study of disease (which includes injury), and the ways in which disease processes affect our bodies; recognizing the pattern that disease takes allows an understanding of the root of a problem, enabling accurate diagnosis, treatment, prognosis and prevention.

<b>Peer review</b>	Review by a person of material generated by another person of the same kind. For example, review by one forensic pathologist of the report and findings of another forensic pathologist for the purpose of assuring and/or controlling the quality of the report and its findings.
<b>Personal protective equipment (PPE)</b>	The special clothing, headwear, footwear and gloves worn, which together with safe autopsy practices, reduces to a minimum the risk of disease transmission at autopsy.
<b>Petechiae; petechial haemorrhages</b>	Pin point or 'dot like' haemorrhages. Some forms occur in life, others can occur after death.
<b>Planes (anatomical) of the body</b>	See: Anatomical planes.
<b>Pneumothorax</b>	Air in the pleural space; air in the chest between the lungs and the chest wall.
<b>Policies and procedures</b>	Formal written documents setting out the requirements of the organization. Policies are the broader statements of principle; procedures are the actions necessary to implement the policies.
<b>Post-mortem examination</b>	Examination of the body after death, which may or may not include an autopsy. Often, the phrase is used interchangeably with autopsy.
<b>Post-mortem lividity</b>	See: Lividity (post-mortem); livor mortis; Hypostasis.
<b>Posterior (or dorsal)</b>	Back of the body or limbs; term used to describe the relationship of one thing to another in or on the body.
<b>Privacy</b>	The ethical, and increasingly legal, right of individuals to have the information about them respected (for example, kept confidential) – note change to accommodate notion of physical privacy. Refers to the individual's right to be free from intrusion of interference by others.
<b>Prone</b>	Lying on the front (e.g. the body was prone).
<b>Prosector</b>	The authorized medical practitioner/pathologist undertaking the autopsy or the technician assisting at or undertaking dissection.
<b>Proximal/Distal</b>	Terms used in preference to superior/inferior to describe the location of things on or in the limbs. Proximal means closer to a notional centre of the body somewhere in the middle of the chest, and distal means further away from this notional centre.
<b>Purging (of body fluids after death)</b>	This is not a technical medical term. Purging is most often used to refer to dark red or black fluid issuing from the nose and mouth after the onset of putrefaction, the associated post-mortem development of gas compressing organs, including the lungs, resulting in dark red or black altered blood being expressed.
<b>Putrefaction</b>	One of the forms of post-mortem decomposition whereby bacteria from the intestines spread around the body via the vascular system

	altering the colour and consistency of tissues. It is associated with an intense and characteristic odour.
<b>Quality assurance</b>	A step or activity designed to improve the probability that the results of the individual and/or organization are reliable. For example, a system of audit of autopsy reports; review of the performance of staff in a quality assurance programme and educational programmes (e.g. lectures) to address any deficiencies identified.
<b>Quality control</b>	A step or activity designed to improve the probability that the particular result is correct. For example, review of a particular type of autopsy report, such as a homicide, before the report is issued to identify gaps, errors or even disagreements that can be corrected or discussed before the report is issued.
<b>Quality management system</b>	The overall system within an organization designed to improve the probability that its results are reliable.
<b>Redistribution (of drugs post-mortem)</b>	Following death, the ability of drugs to traverse different biological compartments to artificially raise blood levels.
<b>Reliability</b>	The reliability of a result is its stability when the test is undertaken by different observers in different places at different times.
<b>Responsibility</b>	The duty to perform a task or function properly.
<b>Reviewability</b>	One of the aims of the autopsy is that it (and indeed the whole medico-legal death investigation) is conducted in such a way that another forensic pathologist at another time can independently come to his/her own conclusions about the death.
<b>Rigor mortis (breaking of)</b>	Post-mortem stiffening. Sometimes the rigor mortis may be broken deliberately, for example to help with removing clothes. Breaking the rigor can cause artefactual internal bruising and disruption of muscles.
<b>Rule of law</b>	Rule according to or under the law. No individual, government official or government agency is above the law; no person or agency can act outside the law and if they do, they are subject to the law as administered by impartial courts that are independent of the government and that must apply the law transparently and fairly.
<b>Sagittal plane</b>	A vertical anatomical plane of the body that passes through the centre of the trunk dividing the body into equal left and right halves. The plane cuts the anterior surface of the body along the anterior midline (or the anterior median line), and the posterior surface along the posterior midline, or posterior median line. Also called the midline, median or longitudinal plane.
<b>Security (of exhibits)</b>	Process whereby an exhibit is secured such that it is evident whether or not it has been accessed, when and by whom.
<b>Stab wounds</b>	Wounds caused by sharp edged implements which are deeper in the body than their length on the skin.

<b>Standard</b>	A required or anticipated level of performance or achievement of a system, part of a system, measurement or test.
<b>Standard operating procedures</b>	Document setting out the standard procedures to be followed.
<b>Still birth</b>	The delivery of an infant that shows no signs of having lived a separate existence.
<b>Superior</b>	Term used to describe a vertical level of one thing above another on or in the body.
<b>Supine</b>	Lying on the back (e.g. the body was supine).
<b>Suspicious death</b>	A death where there is suspicion of homicide.
<b>Toxicology</b>	The science of drugs and poisons. Capacity to detect drugs and poisons in fluids and tissues sampled at autopsy is a critical component of a comprehensive forensic pathology service.
<b>Transparency</b>	When this term is used in relation to institutional processes, it means that these processes can be evaluated externally because the details of the processes are available to be examined.
<b>Underlying cause of death</b>	The disease or condition initiating the chain of events leading to death (often with intervening intermediate and immediate – or proximate – causes of death).
<b>Validity</b>	In relation to a measure or a result, the extent to which the measure or result reflects the truth of the phenomenon.
<b>Universal precautions</b>	The combination of Personal Protective Equipment (PPE) and safe practice that minimizes the risk of transmission of disease from the body to the prosector.
<b>Wound</b>	A significant discontinuity in the surface of a structure, most often in the skin (e.g. incised wound, stab wound, gunshot wound, laceration). It does not include a bruise or an abrasion.
<b>Work instructions</b>	Detailed standard operating procedures.



## 1. INTRODUCTION

### 1.1 The importance of forensic medicine

Forensic medicine is the application of the principles and practice of medicine to the needs of the law and the courts. It is one of the smallest recognisable specialty disciplines in medicine with far fewer practitioners than the public realise. Yet the performance of this small number of doctors has a disproportionate impact on criminal justice systems. Forensic doctors are involved in assessing most, if not all, serious violent crimes including murder, rape and serious bodily harm. How these crimes are handled is a very visible test of the effectiveness of the criminal justice system. If the forensic medicine components are handled well, it is likely that over time the law will come to handle these cases better. The public's confidence in the criminal justice system, and thus the rule of law, will improve.

### 1.2 The role of mortuaries and forensic autopsies

Mortuaries are at the centre of the medico-legal investigation of deaths, especially when they involve autopsy. The importance of such investigations for justice and for the health and safety of the community is well recognised. Such investigations are important for families of the deceased so they have an understanding of how the death occurred; indeed they have a right to know such information. Such knowledge is valuable in itself, may possibly have direct health benefits for the family (for example, if genetic or transmissible disease is discovered) and can also be of great help in the proper process of grieving, especially when the death has been sudden or unexpected. The information also has profound significance for matters of justice. This is most obvious in deaths resulting from crime, but also includes civil matters.

The community and families also expect that their loved one will be well cared for and treated in a dignified and respectful way. A mortuary motivated by an attitude of respect towards the deceased is likely to be a mortuary where the technical procedures are performed well.

An autopsy is a procedure of profound ethical significance, as it interferes with the body. It is a truism that if an autopsy is to be performed, it should be undertaken properly. For the interference to be justified, it has to achieve the purposes for which it was initially authorised. To miss important findings, or to misinterpret findings because of technical defects in the autopsy procedure, is more than a technical failing; it is also an ethical breach of obligations to the family and to justice. In relation to justice, what is a natural death, accident or suicide might mistakenly be concluded to be a homicide. Conversely, what is a homicide might mistakenly be thought to be a natural death, accident or suicide. A person might be wrongly accused of a serious crime, or a person might wrongly escape justice because of failures in the mortuary. Both these things probably happen regularly around the world, even today.

The autopsy is the first and only opportunity to evaluate and gather all the evidence pertaining to the deceased in order to answer questions about the death. All observations need to be made not only to answer the questions that appear at the autopsy, but also those that might arise later. When the circumstances surrounding the death have been further clarified in the weeks or months following the death, the questions for forensic pathology are correspondingly refined or, in some cases, completely different. They can only be answered if the necessary observations have been made and recorded. Generally speaking, all physical exhibits in a death investigation can be stored and looked at later. Leaving aside the increasingly undesirable option of retaining organs and tissues, apart from imaging (photography and radiology) and histology, no such luxury is available in forensic pathology and the examination of the body.

### 1.3 The purpose of this manual

This manual has been written to support forensic medicine capacity development in the State of Palestine in two ways:

- i) by setting out in brief, supported by some illustrations, the main autopsy procedures that are undertaken in a forensic context; and
- ii) by describing the requirements of a reliable system within the mortuary to support the undertaking of good quality forensic autopsies and the provision of good mortuary services generally.

Diagrams rather than photographs have been used, not only because it was thought there might be aesthetic advantages, but also to allow more focus on the key elements of the procedure than might be possible with photographs. Furthermore, this work has been produced not only with future pathologists in mind, but also as a resource for others, especially mortuary staff, police, lawyers and forensic scientists. Diagrams are more suitable for such readers.

While the emphasis is on the technical autopsy procedures in modern medicine and science, such work is undertaken within institutional frameworks and systems, especially quality systems. Accordingly, some of the important elements of these arrangements have been included. Even if resources preclude their full implementation, it is important that those involved understand and implement these arrangements to the greatest extent possible.

This manual assumes that all the legal, administrative and other procedures required prior to autopsy have been legally and ethically undertaken. For example:

- permission or authority for the autopsy has been properly obtained in writing and verified by the medical practitioner/pathologist responsible for the autopsy;
- the permission or authorisation covers the extent of the autopsy that will be undertaken;
- background information as to the medical history and the supposed circumstances of the death has been obtained and provided; and
- consideration has been given to the needs of the family, including their wish to view the body before and/or after the autopsy, whether they would like to wash the deceased and how they may wish to dispose of the body locally or even across international borders.

If there are well understood local customs about the extent to which the autopsy will go, these should not be exceeded without justification and, if necessary, consultation with those providing the permission or authority.

Familiarity with the medical history might include discussion with involved clinicians, access to the actual written medical record, or even the attendance by the clinician at the autopsy.

The reader will soon become aware that this is *not* a forensic pathology text book. It is a technical 'how to undertake an autopsy and manage a mortuary' book. Please note that it does not deal with the scene of death. It is focused on a full adult autopsy. There are distinct and separate issues relating to paediatric and neonatal autopsies, and references to those have been provided.

It is not a physical forensic anthropology manual, but some material about this has been included to assist with the basic approach to skeletal remains, and to help readers access the relevant literature in this, often poorly handled, field. There are a range of practical tools including some which may assist the forensic doctor in the considerable administrative task of recording all the findings.

The editorial group believe that the contents of this manual represent much of the theoretical technical knowledge a forensic doctor should have to competently undertake forensic autopsies and to competently oversee the management of a mortuary. We leave it to the trainees, under proper supervision, to put this knowledge into practice.

In this manual, ‘the deceased person,’ ‘the deceased,’ ‘human remains,’ ‘the body,’ ‘the dead person,’ ‘the cadaver,’ and on occasion, ‘the corpse’ are all words used interchangeably. ‘Human remains’ for some people is the term for skeletal remains. In this manual we refer to skeletal remains where the context requires it.



## 2. THE CONTEXT OF THE MEDICO-LEGAL DEATH INVESTIGATION

This chapter is included to provide a general overview of the medico-legal death investigation internationally and a specific introduction to the context in the State of Palestine. The latter is intended to be factual and not evaluative and has been provided by the Palestinian members of the editorial group.

### 2.1 General overview

Deaths subject to medico-legal death investigation entail the deceased person formally being taken out of family control. The state has declared an interest in understanding the deaths of its citizens that occur in particular circumstances or from particular causes. These circumstances and causes vary between jurisdictions. In general terms, the deaths of interest can be summarised according to the local system of medico-legal death investigation: police or prosecutor run systems, or medical examiner/coroner systems.

Police/Prosecutor authorised death investigation systems  (The ‘Continental’ systems)	Medical Examiner/Coroner authorised death investigation systems  (The ‘Anglo-Saxon’ systems)
<ul style="list-style-type: none"> <li>• Homicides and suspicious deaths</li> <li>• Deaths in custody (prison, juvenile detention, police operations, public disorder, psychiatric detention)</li> <li>• Other deaths where criminal offences may have been committed (e.g. some road traffic deaths);</li> <li>• Suicide (where there is suspicion about the death);</li> <li>• Some medical related or other deaths where the negligence of a person or agency may be an issue</li> <li>• Maternal deaths related to abortion</li> <li>• Post-partum infant or neonatal deaths where infanticide is considered possible</li> </ul>	<ul style="list-style-type: none"> <li>• All those mentioned opposite;</li> <li>• All suicides</li> <li>• All accidents</li> <li>• All sudden and unexpected deaths including natural deaths where the cause is uncertain</li> <li>• All deaths where the doctor is not able to certify the cause</li> </ul>

All systems of medico-legal death investigation rely on medical practitioners to undertake whatever form of post-mortem examination takes place. In many countries these doctors are specialised forensic doctors. For the purposes of this document, the medical practitioner undertaking the forensic autopsy is called either a forensic doctor or a forensic pathologist.

The duties of the forensic pathologist involve an understanding of the aims of the medico-legal death investigation, including the forensic autopsy, and together these have been described as follows:

The forensic pathologist’s broad duty is to make sure that the cause and circumstances of the death are revealed, and not to collude in wrongly hiding or obscuring these. As with other health professionals, the more specific content of the forensic pathologist’s duty is to exercise at least a reasonable degree of care and skill in his or her work, that is, in the production of valid and useful observations and conclusions. In assessing what is a reasonable degree of care and skill, reference can be made to the practice of colleagues of similar training and expertise. However, such practice is sub-standard if it

does not produce reliable and valid results. What this means in practical terms requires an understanding of the basic aims of the forensic autopsy. These are:

- to discover, describe and record all the pathological processes present in the deceased, and where necessary, the identifying characteristics of the deceased
- with knowledge of the medical history and circumstances of the death, to come to conclusions about the cause of death and factors contributing to death, and where necessary, the identity of the deceased
- in situations where the circumstances of death are unknown or in question, to apply the autopsy findings and conclusions to the reconstruction of those circumstances. This will, on occasions, involve attendance at the scene of death preferably with the body in situ
- to record the positive and relevant negative observations and findings in such a way as to enable another forensic pathologist at another time to independently come to his or her own conclusions about the case. As forensic pathology is essentially a visual exercise, this involves a dependence on good quality, and preferably, colour photography. (El Nageh M et al, 1999)

The last of these aims has in more recent times been termed the ‘reviewability’ of the autopsy. In cases where forensic pathology is particularly central to the resolution of the issues (especially homicides, suspicious deaths, deaths in custody), the ability of the case to be independently reviewed by another forensic pathologist at another time becomes crucial. It will be possible in some circumstances, where this aim is not met, for doubt to be cast over the original findings.

As these aims demonstrate, the responsibility of the forensic pathologist is for much more than the conduct of the autopsy. The autopsy is a subset, some would say the foundation, of the overall medico-legal death investigation, and all of this falls within the responsibility of the forensic pathologist.

The traditional autopsy has long been considered the gold standard of diagnosis. Imaging techniques, as valuable as they are, are some distance from being able to distinguish normal post-mortem phenomena from pathology, or to make histological diagnoses and perform toxicological, biochemical and microbiological tests, for example. CT and MRI scans, as well as plain X-rays, will assist in answering some questions in relation to the death, and these answers may be sufficient, together with other information, to complete the death investigation in some cases without requiring autopsy. But they are not, and probably never will be, a replacement for the autopsy in the remaining cases.

## **2.2 Cultural, religious and legal context in the State of Palestine.**

The authority to require a post-mortem examination lies with the Public Prosecutor. It must however be understood that family members frequently object to post-mortem examinations. Forensic doctors must deal with the family in an empathetic way to help them understand the reasons for requiring a post-mortem examination and to address their concerns about what will happen to the body and the burial arrangements.

The two most common concerns raised by family members with regards to their objections to post-mortem examinations are violation of the sanctity of the body and delay in burial of the body.

### **2.2.1 Family concern at the violation of the sanctity of the body**

In a Hadith, the Prophet SAW said: ‘Verily the act of breaking the bones of the deceased is the same as breaking the person’s bones while he is alive’ (Musnad al-Imam Ahmad ibn Hanbal, 2001). In effect, the Hadith prohibits any kind of humiliation of the deceased. Islam is very strict in giving due respect to the deceased, whether Muslim or not. The act of breaking the deceased’s bones is thus

regarded as an act of torture as mentioned in the Hadith. This is because such an act is generally a malevolent one and does not produce any benefit.

The post-mortem examination is carried out under legal authority. It is a medical and scientific examination of the dead body by an authorised medical practitioner with its aims directed towards justice and the public good. It is therefore not a malicious desecration or mutilation of a body.

It is important that the forensic doctor patiently explains the above to the family and helps to allay their fears and objections. Family members must be assured that the body will be treated with respect at all times.

### **2.2.2 Family concern about delay in the burial of the body**

It is expected that after the death of a Muslim, her/his body should be buried as soon as possible. Unfortunately, the performance of an autopsy will delay the burial. Every effort should be made by the Public Prosecutor and the forensic doctors to minimise delays including, if sufficient resources are available, performing autopsies outside ordinary working hours.

## **2.3 Summary of the law relating to deaths to be investigated in the State of Palestine**

For the purposes of death investigation, the State of Palestine has adopted the Jordanian Penal Code. Article (40) of the 'Rules of Penal Trials Code No. 9 for the year 1961' states the following:

If someone has died by murder or for unknown and suspicious reasons, then the public prosecutor may ask for the help of a physician or more to organise a report of the reasons of the death and the condition of the corpse of the dead.

This requires all homicides and suspicious deaths (including deaths in prison or police custody and following illegal abortions) to be reported to the Public Prosecutor who will then inform the forensic doctor. Furthermore, certain categories of death may also be reported to the Public Prosecutor who may inform the forensic doctor. These categories include:

- Sudden, unexpected and unexplained natural death
- Intentional or unintentional harm including, for example, suicides and road traffic or other accidents
- Intoxication or poisoning
- Possible failures of responsibility (e.g. in medical care)
- Unknown identity of the deceased

Occasionally, even though an autopsy has already been performed, the Public Prosecutor may require a second autopsy. In all these cases, the body is under the control of the Public Prosecutor. The Public Prosecutor is the only entity entitled to appoint the doctor deemed appropriate for the task. Doctors involved with the treatment of the deceased prior to his death, or who are related to the deceased will be excluded from appointment. When the post-mortem examination is complete the Public Prosecutor issues a ruling to deliver the body to the family to allow the burial to proceed.

## **2.4 Summary of the procedures for attending the scene of death, autopsy and exhumation in the State of Palestine.**

### **2.4.1 General**

The appointed doctor must be informed of the identity of the deceased and the apparent circumstances of the death. The doctor, especially in cases of deaths in custody, suspicious deaths and homicides, should attend the scene of the death/crime scene to perform a preliminary review of the body prior to the movement and transfer of the body to the mortuary. The doctor should express his/her condolences to the family for the loss of their loved one and acknowledge their shock and pain. While the examination of the scene is not discussed elsewhere, the following is a summary of the functions of the forensic doctor at the scene of death in the State of Palestine:

- Confirm the fact of death.
- Assess the time since death (note: this can only be approximate).
- Perform a preliminary assessment of any injuries and their possible relationship to death: the number of injuries, their locations, severity, age and their possible cause.
- Undertake a preliminary assessment of the scene which might provide a clue as to the circumstances and cause of death, such as the existence of poison/poisoning, an exposed wire leading to electrical shock, the presence of blood stained knives or blunt weapons.
- Assess the clothing on the body and any physical evidence or other clues carried on the clothing.
- If warranted, form an early hypothesis about how the death may have occurred suggested by the position of the deceased person when found, where the deceased was when receiving injuries, how blood was splattered, and the relationship of any injuries to their surroundings, such as the possibility of falling down stairs or colliding into furniture which could have caused injury.
- If necessary, make observations to help identify the deceased.
- Meet with the family of the deceased and discuss and explain preliminary conclusions and thoughts with them. The family must be allowed to make inquiries and their questions carefully answered, since it is early in the investigation, while maintaining the appropriate independence and respecting privacy and confidentiality.

Due care is taken to ensure there are no delays relating to the external examination of the body at the scene. The forensic doctor should also advise on the necessity of involving forensic science experts to take necessary photographs and to take control of any physical evidence based on a ruling by the Public Prosecutor.

If the Public Prosecutor has authorised an autopsy, the forensic doctor must inform the family about the procedures he/she will undertake and the goal of these procedures. If the family refuses an autopsy or does not desire one, the necessity of the autopsy should be explained, and they must be allowed to meet with the Public Prosecutor in charge of the case if they so request. The Public Prosecutor along with the forensic doctor, the forensic science experts, the police and anyone else involved or present at the crime scene, must co-operate to ensure that there will be no addition, removal, change or distortion of any physical or other conditions within the location of the death or crime scene.

The formal examination and autopsy of the body shall be undertaken by the appointed doctor at the facility designated for this purpose. When the body is admitted to the mortuary, the allocated sequential case number for the State of Palestine will be attached to the body

Family members shall not be permitted to attend the autopsy. However, the family can request approval from the public prosecutor for a doctor (preferably one with some knowledge of autopsy and pathology) to represent the family at the autopsy. Where there is no need to preserve the clothes and



personal belongings and send them to the crime laboratory, they are placed in a special bag to be returned to the family. A list of these belongings should be recorded and retained with the record of the case.

In relation to exhumation, preparation must be undertaken to identify the grave or tomb, the position of body placement therein and any items situated on or near the body in the grave. The forensic doctor shall organise the examination along with the Public Prosecutor, ensure proper identification of the remains, receive and control samples and physical evidence and deliver these to the competent entities for the necessary examinations to be conducted. The body/skeletal remains should not be delivered to the family for burial until the Public Prosecutor has issued a ruling after completion of the required examination. Any procedures meeting the needs of the family, such as allowing them to conduct the washing procedures (ghusl), and any other actions in preparation for burial, should be facilitated.

### **2.4.2 Identification**

At the scene, an inquiry is made regarding the person who is the closest relative to the person who is presumed to be the deceased. The identification of that person is verified and his/her personal information recorded in the relevant registry. This person certifies that he/she knows the identity of the deceased.

At the hospital, if the body is regarded as visually identifiable, the relative/s is/are then accompanied to the examination room to view the body. In some instances there may be a group of people in the room to view the body.

At the same time (except in cases of homicide, suspicious death and where the body is not suitable), after the identity of the body has been confirmed, family members can touch the body and be left alone with the body for a few minutes.

When identification cannot be established with the assistance of the family and further tests are required, the family members and the public prosecutor are informed and the body cannot be released until identity is established.

A notification of death is handed to the person who identified the body, and this is recorded in the registry. When no post-mortem examination is required, the body is released to the family.

### **2.4.3 Interaction with the family – before and after the autopsy**

The Palestinian forensic doctor initially deals with the family upon conducting an external examination of the body of one of their family members. If not at the scene of the death, this usually takes place at the mortuary within the hospital. The situation can become tense when a ruling is issued by the Public Prosecutor to transfer the body for an autopsy, as the family often objects to this. Despite the fact that the decision for an autopsy is issued by the Public Prosecutor, the family often attributes this decision to the forensic doctor. They then approach the forensic doctor to try and persuade him/her that there is no need for an autopsy, that the death is the result of fate and that they are ready to do anything, and sign any document, in order to prevent the autopsy of their loved one.

The forensic doctor responds to the family as follows:

- Paying condolences to the family for the loss of their loved one and empathetically acknowledging their shock and pain
- Setting out for the family the benefits of the autopsy which will assist in determining the circumstances of the death of their loved one. When the truth about the death becomes known, the family will not become suspicious about the circumstances of the death later and can address possible rumours from neighbours, acquaintances or those who hold animosity towards the family.
- Explaining to the family that the autopsy decision is made by the Public Prosecutor. The family should be able to see the Public Prosecutor if that is what they wish.

- The family may request attendance at the autopsy. It should be explained that this is not desirable, but they can ask to be represented by a doctor and this will probably be permitted by the Public Prosecutor.

Any procedures in the interests of the family are facilitated and simplified to reduce confrontation with the family. For example, allowing them to conduct the washing procedures (i.e. ghusl) and other actions in preparation for burial at the autopsy location if they so desire.

Usually, the family asks the doctor responsible for the autopsy about the cause and circumstances surrounding the death. The family is informed about the cause of death, if it is known. Depending on the circumstances, other details relating to the death may or may not be communicated. For example, in criminal cases, care needs to be taken to avoid interfering with the investigation.

### **3. OPERATING THE MORTUARY**

#### **3.1 Introduction**

The mortuary is a unique environment. It is best thought of as a hospital for the dead. This means obligations of care co-exist with obligations to discover knowledge. In the hospital, this is knowledge about the patient's illness. In the mortuary, it is knowledge about the deceased's death (including any preceding illness). This is a very important function for justice, for the deceased's family and for the wider community. The community should expect high standards in the operation of its forensic mortuaries. These expectations should be met by medical and technical staff who provide a professional service. The service should provide reliable, valid results and conclusions about the death in a manner which is respectful of the deceased and his or her family.

#### **3.2 Mortuary quality system**

Ideally, the expectations mentioned above should also be met by having controls on the operations of the mortuary in the same way that the operations of any high performing hospital, or part of a hospital, have controls. The mortuary should be understood as, operate as, and be controlled as a system. It is a system with many components, such as:

- management
- staff
- facilities
- equipment
- occupational health and safety requirements
- body admission and receipt
- autopsy
- body release
- waste disposal

Because the performance of the mortuary is so important for justice, families and the community, these components must be properly governed. The only way this can be done, so that everyone involved has the same understanding, and so that responsibility and therefore accountability is clear, is for the requirements of these components to be documented. Together with processes for implementing improvements and correcting mistakes or near misses, the documents thus created will make up the mortuary's Quality Manual, and describe the mortuary's Quality System. It takes time to develop Quality System documentation and processes and train staff in their usage. Significant institutional commitment, leadership from the institution head and allocation of resources are essential prerequisites. (While limited resources may preclude the full implementation of a Quality System, it is possible, with an understanding of the basic principles, to implement core system aspects over time).

##### **3.2.1 Quality manual**

The mortuary's Quality System is set out in writing in the Quality Manual. Expanding on the brief list above, the elements of the system could include, and would not be limited to:

### 3.2.1.1 Management and Administration

- Organisation of the mortuary services: the staff structure; lines of communication; meetings; authorities required for different processes; covering arrangements for staff absence; supervision requirements
- Mission and core business of the mortuary: mission statement; list of clients and stakeholders; key performance indicators –
  - Outputs (e.g. number of cases admitted and discharged, number of autopsies performed, number of identifications or other procedures undertaken);
  - Work flow efficiency (e.g. percentage of cases where deceased person is available for collection within x hours of admission);
  - Quality (e.g. body count – see below, number of wrong bodies released, number of cases where autopsy undertaken on the wrong body, number of cases where technical errors are made)
- Documentation: register listing all key documents related to the quality system for the mortuary; document control procedures for approval, issue, changes, review (i.e. the system for creating documents, who approves them, how they are issued, how it is determined that the documents have been read by the staff that need to read them, how the document can be changed, how frequently the document needs to be reviewed)
- Tenders, contracts and purchasing
- Subcontracting of tests
- Complaints procedures (relating to services)
- Control of non-conforming testing or procedures, corrective and preventive action (i.e. the overall system for dealing with errors and mistakes)
- Control of records (e.g. autopsy reports: requirement for a central file, who can access them, how are they removed from the file, how the records' movements are tracked, etc.)
- Internal audits: internal checks that the required procedure is being followed (who does this, how often, to whom is the audit report provided, what actions follow when deficiencies are uncovered)

### 3.2.1.2 Technical requirements

The following are factors that may contribute to the correctness and reliability of the tests and procedures performed by the mortuary:

- Qualifications of staff
- Training and development: in-house training, staff meetings, seminars, lectures; training records
- Accommodation and environmental conditions
- Evidence management: addressing the security and the chain of custody; biological and non-biological specimens and evidence; paperwork received or generated at autopsy; collection details; labelling; dealing with evidence management deficiencies; evidence retention and disposal
- Methods and procedures (these could be included in a separate document entitled Mortuary Standard Operating Procedures): general policies and principles that are followed; code of conduct/ethics; dress code for staff, visitors, funeral staff, police, workmen; security; safety practices; general management of deceased persons; handling of clothing and property; policy

for autopsies including for case allocation, obtaining medical records, objections to autopsy, inspections; general autopsy procedures; protocol for infectious cases; protocol for suspicious cases

- Equipment: commissioning; use; breakdown; calibration and maintenance (e.g. weighing scales); equipment register
- Sampling procedures
- Handling of test items: general evidence control; scope; principles (integrity, identification, deficiencies, storage); procedures (transportation, receipt and handling, liaison deficiencies, item identification, item transfer, item security)
- Accommodation and safety: security; environmental conditions; space and design; health and safety

If not included in the Quality Manual, the following documents might be referenced as required reading for staff:

- Institutional policy and procedures manual (if the mortuary is part of a larger institution such as a hospital or university department)
- Mortuary standard operating procedures
- Forensic pathology quality manual
- Occupational health and safety manual
- Body admission and release work instructions
- Autopsy procedures work instructions (these contain greater detail of some of the mortuary standard operating procedures)
- Cleaning and waste disposal work instructions
- Building/mortuary access policy and procedures

### **3.3 Universal precautions**

It is not the role of this manual to detail all aspects of how a mortuary should function. There are numerous local conditions and constraints, not least available resources, which will lead to reasonable variations in approach. However, one important aspect – the concept of universal precautions – does need to be understood in detail. Universal precautions are precautions that should be taken by all staff and everyone attending the mortuary. They protect against the transmission of disease by aerosols, direct contact with body fluids, or by sharp injury, all of which are significant hazards in a mortuary. Universal precautions in the mortuary are implemented through dress regulations and safety practices.

Each body undergoing autopsy should be considered capable of transmitting a range of infectious diseases including:

- Viral hepatitis
- HIV
- The agent responsible for CJD
- Mycobacterial infections
- Other infections such as clostridiumtetani, and various salmonella species

The assumption is that all blood and body fluids of all deceased are potentially infectious. All those present in the mortuary, as well as staff or visitors<sup>1</sup> (for example medical students or police), should be schooled in universal precautions. The presence on staff of exudative or weeping skin lesions, especially involving the face and hands, should preclude involvement in an autopsy.

In some cases, such as the known presence of HIV, tuberculosis, meningococcus or CJD, additional precautions may be justified. For example, traffic through the mortuary might be limited. Advance consideration needs to be given, as to whether it is appropriate or not for trainee pathologists or technicians to undertake such cases, and if so, what is the required preparation and training.

Haemorrhagic fevers, filoviruses (e.g. Ebola or Marburg), arenaviral fevers (e.g. Lassa Fever) or arthropod borne viral fevers require microbiological security over and above that available in routine mortuaries. Autopsies in these cases should not be performed unless in purpose designed facilities (of which there are very few in the world) by staff trained in the use of those facilities and the associated techniques. However, particularly with Ebola, it is possible that such deaths may appear unannounced or unexpectedly at the mortuary before anyone realises what the deceased was suffering from.

As mentioned above, universal precautions are implemented through dress regulations and safety practices. The following represents guidance. Service heads should consult with mortuary staff in the development and implementation of operational regulations. These will take into account local issues such as the geography and layout of the mortuary and the categories of staff and visitors requiring access. A document specifying the dress regulations and safety practices needs to be developed and implemented through training and communication. This document can form part of the mortuary's Quality Manual. The dress regulations and safety practices outlined below focus on biological and infectious hazards. For chemical and radiological hazards, specific information relevant to mortuary practice is difficult to find. See 'Other Materials and References' at the end of this manual.

### 3.3.1 Dress regulations

The dress regulations for the mortuary should be specified in the Quality Manual. The regulations may be consistent throughout the mortuary, or vary for different parts of the mortuary and for different categories of people (e.g. the funeral director in the body admission area may have different dress regulations to the pathologist in the autopsy room). No person should be permitted in the mortuary without complying with the dress regulations. The senior staff member in the mortuary at the time should ensure that all visitors comply with dress regulations. The regulations for the autopsy room in the mortuary could include:

- Surgical pants and top
- Surgical gown
- Disposable apron (whilst performing the autopsy)
- Boots
- Visor, goggles or glasses
- Surgical mask
- Rubber gloves
- Additional cut-proof glove/chain mail glove (worn on the non-dominant hand, the hand not using the scalpel during all eviscerations and dissections)

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<sup>1</sup>There should not be casual visitors in the mortuary. Everyone present should have a demonstrable need to be in the mortuary.

It is important that consideration is given to what is desirable and achievable in the circumstances of each particular mortuary. The result of this consideration needs to be recorded, approved by the responsible person, communicated to staff and implemented.

For higher level security, the mortuary should keep the following additional items on hand if possible: full body disposable suits (e.g. Tyvek suits), hoods that cover the head (except face) and shoulders, over boots (which cover boots to knee level) and respirators.

### 3.3.2 Safety practices

The first level of safety practice is vaccination. The mortuary should have a system for monitoring and keeping vaccinations (e.g. Hep B) up to date.

A good safety system will specify entry and exit paths in and out of the autopsy room that keep 'clean areas' and 'work areas' separate. Protective processes in the autopsy room are significantly weakened if blood and fluids are inadvertently taken into clean areas. Food and drink should not be consumed in the mortuary.

Staff should develop good dissection disciplines and habits:

- Cover cuts, abrasions or other skin lesions with an appropriate bandage prior to putting on PPE
- If two prosecutors are working on the body at once, there must never be overlap of hands or working areas
- Avoid making splashes and creating avoidable aerosols. There should be no high pressure sprays in the mortuary
- Towels can be placed over sharp rib ends
- Care must be taken when exploring traumatised body cavities with hands to avoid punctures from bone spicules
- Strong procedures around the use of needles must be developed. These include procedures to be followed when attaching needles to syringes, uncapping needles and disposing of them. Despite wearing cut-resistant gloves, continuous attention to the safe handling of knives and scalpels is required, especially when attaching and removing scalpel blades. (Devices for the hands-free removal of scalpels should be provided if resources allow).
- Long knives and scissors must be frequently sharpened
- Organs should be sectioned with care and in such a way to minimise aerosols
- Any spillages should be cleaned immediately
- Disposable knife blades are sometimes as sharp as scalpels and very flexible, thus there is an increased risk of injury with their use in inexperienced hands
- Incise with long strokes
- Much dissection can be done with blunt-tipped but sharp scissors
- Only use a scalpel when necessary (e.g. for collecting suitable tissue for histology blocks, and for incising small organs)
- Set the scalpel down in clear view, not in the midst of organs, blood/fluids, or in the body itself
- Never point or gesticulate with a scalpel
- Keep well away from a scalpel blade in another person's hand
- Wash hands and skin with water and soap immediately after any direct contact with blood and after removing gloves even if they appear intact

- Avoid touching skin, mouth, nose, eyes or any skin lesions or cuts with contaminated gloves, fingers or other contaminated items or surfaces

This list is not exhaustive, and the forensic doctor responsible must develop an approach to the safe operation of the mortuary. The requirements for safe operation should be documented and form part of the mortuary's Quality Manual.

There need to be procedures for maintaining universal precautions while dealing with the inevitable interruptions that occur during an autopsy. How will the telephone be answered when the pathologist and technician are both fully involved in the autopsy? How will samples be labelled, and forms completed while maintaining the required precautions?

Good procedures for cleaning, washing and reconstructing the deceased following autopsy need to be considered, discussed with staff, put in writing and implemented. These issues relate both to safety and to the respectful handling of the deceased.

Assuming personal protective equipment meets the required standard, and staff proficiency with the required practices, an authorised forensic medical doctor should be able to undertake an infectious autopsy (except as set out above in cases of haemorrhagic fevers such as Marburg and Ebola, arenavirus infections such as Lassa Fever and arthropod borne viruses).

Safe practices in the mortuary extend beyond those required as part of universal precautions:

- There must be procedures setting out the response to a chemical injury or spill. The most common dangerous chemical in the mortuary is formaldehyde; other chemicals are usually cleaning agents
- The moist environment of the mortuary makes it a particularly dangerous place to be using electricity
- Water on the floor makes the mortuary a slippery place; falls are common
- Never wear contaminated PPE or clothing outside the work area
- Remove and replace PPE and underlying clothing immediately if they become damaged or penetrated by potentially infectious material
- Lifting and moving bodies can be strenuous and precipitate back problems. Good body handling practices are worth implementing
- Mortuary staff may have to respond to aggressive family members angry at the unexpected death of their relative

### 3.3.3 First aid and other responses

A needle stick or 'sharps' injury represents a failure of the mortuary's observance of universal precautions. It is usually not the individual's 'fault'; in any event, concentrating on fault finding, as opposed to understanding the root cause of the failure, is counterproductive. For example, a mortuary technician may not report the needle stick or 'sharps' injury if there is reason to believe that he or she will be blamed. If the injury is not reported, an opportunity to improve the operation of the mortuary has been lost (as has the opportunity to make sure the health response to the injury is appropriate). Importantly the constructive and positive team atmosphere which is vital to the effective running of a mortuary can be undermined. The occurrence of a needle stick or 'sharps' injury will almost always be a system problem with responsibilities for management (organising training, reviewing practices) and for staff (discussion with colleagues and managers, changing practice) to prevent a re-occurrence.

Procedures must be developed for the first aid response to a needle stick or 'sharps' injury. The former most commonly occurs to technical staff when sewing the scalp or trunk while reconstructing the body. The latter most commonly occurs when loading a scalpel blade on to the scalpel handle, or removing it. The first aid response should include:



- stopping immediately the activity being undertaken
- allowing the wound to bleed freely
- washing with soap and water
- applying disinfectant (e.g. ethanol, iodine)
- covering the wound
- reporting the injury according to normal accident reporting procedures
- activating medical responses, which are designed to deal with the transmission of HIV or the various hepatitises

Protective eye wear should be worn in the mortuary, but even so, procedures for splashes into the eyes or onto skin should also be developed. Splashes of blood, urine or CSF into the eye require immediate eye washing procedures using warm water and the notification of the incident according to normal accident procedures.

When unbroken skin comes into contact with infective material, the contaminated area should be swabbed with 1M sodium hydroxide, allowed to remain for five minutes and then washed with copious amounts of water. Vigorous scrubbing should be avoided. Mucous membranes should only be washed with water as they cannot tolerate sodium hydroxide.

A first aid box should be located in the mortuary. Some thought should be given to its contents which could include:

- Adhesive bandages
- Adhesive tape
- Fabric bandage
- A cleansing anti-septic such as chlorhexidine
- Eye bath
- Sterile eye pads
- Scissors (which are never used for mortuary purposes)
- Airway, for mouth to mouth resuscitation purposes

As indicated by this list, staff should be familiar with and trained in how to undertake mouth to mouth resuscitation and cardio-pulmonary resuscitation.

Finally, working in a mortuary can be psychologically or emotionally stressful. This can be difficult to manage. Mechanisms for dealing with this could include informal debriefing between staff. Confidential strategies for staff support should also be considered, developed, discussed with staff and included in the Quality Manual.



## 4. ADMISSION AND STORAGE OF THE BODY, AND PREPARATION FOR THE AUTOPSY

### 4.1 Introduction

It is the pathologist and not the technician who has to accept and take ultimate responsibility for the conduct of the autopsy. In some cases, subject to the skill levels available in a particular mortuary, considerable responsibility can be devolved to the technician. However, the autopsy is first and foremost a medical procedure and overall responsibility rests with the pathologist. It is the pathologist who is accountable for the performance of the autopsy. The mortuary is a medical facility. For the mortuary to function properly, and for the autopsy to be undertaken to the highest possible standard, there must be a relationship of trust and mutual respect between pathologists and mortuary staff manifested through good team work.

### 4.2 Admission of the deceased

This is the beginning of the mortuary's involvement and a crucial process where mistakes can have disastrous consequences. The body is handed over by the funeral, ambulance or police staff into the care of the mortuary. At this point information also needs to be carefully handed over, observations made, and all of them correctly recorded:

#### Admission of the body:

<p><b>Information to be handed over, observations to be made and recorded, and actions to be undertaken</b></p>
<p><b>Allocation of a body number</b></p> <p><i>Comment:</i></p> <ul style="list-style-type: none"> <li>• The mortuary must have a robust sequential, unique numbering system for bodies/cases admitted.</li> <li>• An approach which deals with unknown skeletal remains (including non-human remains) needs to be developed.</li> <li>• The system could be local or jurisdiction-wide (as in the State of Palestine).</li> <li>• A common approach is to have a sequential number followed by the year (e.g. 0001/2015, 0002/2015).</li> </ul>
<p><b>Name of the deceased (and other demographic information if known)</b></p> <p><i>Comment:</i></p> <ul style="list-style-type: none"> <li>• The identification of the deceased is probably the single most important fact to be established.</li> <li>• At the time of admission, the mortuary must be aware of whether or not the identity has been established to the satisfaction of the relevant authority, usually the authority in charge of the death investigation.</li> <li>• Clear procedures of ordinary visual identification under controlled circumstances need to be established by the death investigation system.</li> <li>• The acceptability of the remains for viewing must be determined.</li> <li>• The procedures should include preparation of the person or family for the task of viewing the deceased.</li> <li>• The result of the viewing needs to be recorded at the time and certified; that is, the person</li> </ul>

viewing needs to formally state in writing the identification – or not – of the deceased

- Visual identifications can be mistaken, and false positive and false negative identifications are both possible.
- Procedures should be established defining how to record the identity if the deceased is completely unidentified or has not yet been formally identified (e.g. should the body be recorded as being admitted as unidentified; or should the body be admitted as ‘believed to be’ (BTB) ).
- All bodies admitted should have two identifiers, at least one of which is unique, recorded on body tags and all documents created. Usually this is the name and body number, the latter being the unique identifier. If the name is not known then a second identifier, in addition to the number, might be the location where the body was found. (See below: ‘Labelling the body’).
- The system of recording identity must include the secure attachment to the body of at least one identity tag (see Figure 1).

**Sex of the deceased**

*Comment:*

- This is a mandatory identifying feature to be recorded on all documentation and body tags.

**Age, including date of birth if known**

*Comment:*

- The age is a mandatory identifying feature to be recorded on all documentation and body tags. The date of birth should be included in all documentation if it is known.

**Property and belongings**

*Comment:*

- Procedures to deal with these must be developed. Property (for example, cash and jewellery) which is lost between the scene of the death and when the body is returned to the family can cause much distress to the family and damage the reputation of the mortuary. If at all possible, at least two people should be involved in the admission of the body to the mortuary. If necessary, the mortuary staff member and the funeral director, or other person present who is not employed by the mortuary, should together confirm and sign for the property and belongings present on the deceased.
- A secure place to store property and belongings will be required.
- When the property and valuables are released, two staff should also be involved to verify the return of the property and valuables to the family or their representatives.

**Related evidence**

*Comment:*

- Procedures to deal with material such as medications, documents, ligatures, weapons and other extraneous items that often accompany bodies to mortuaries must be developed.
- Re-usable hospital equipment (e.g. some surgical devices) should be returned to the hospital.
- The procedures should try to avoid the mortuary becoming an exhibits store.
- If exhibits are important for criminal investigations, the police should have responsibility for storage.

**Admission photography**

*Comment:*

If resources allow, serious consideration should be given to taking a photograph of the body and an anterior view of the head and shoulders routinely in every case. From time to time, these will prove to be crucial photographs for later reference.

- Care should be taken to include the case number in the photograph. Detailed advice on photography is contained in this manual.

**Weight and height**

*Comment:*

- See below: ‘External examination’

**Labelling the body or body part (e.g. a skull)**

*Comment:*

- See Figure 1. A secure wrist or ankle band should be attached. As an option, an additional tag can be attached by a long string that makes the identification of the body easier to access in storage and other circumstances. A minimum of two identifiers, one of which is the unique number, should be on the label.
- The second identifier is usually the name. If the name is not known then the second identifier could be the place where the body is found. Note, if two unidentified bodies are found at the same location, then a means of labelling them so they can be distinguished and traced back to where they were found at the location needs to be decided before they are moved.
- Procedures for labelling body parts, as distinct from bodies, need to be developed for the mortuary.

**4.3 Identification**

**4.3.1 Routine Identification Procedures**

Human identification is the allocation of the correct name to human remains. It is based on the comparison of ante mortem and post-mortem information. (Technically, it is this sort of comparison that is made even when a visual identification occurs). The outcome of the comparison relies on the quality of both the ante mortem and post-mortem data, and how the comparison is carried out.

Visual identification by family or friends is used all over the world, and most often it works. It is however quite possible for visual identification of a deceased relative or friend to be mistaken. Virtually all mortuaries have experience of such mistakes. Factors contributing to this possibility include:

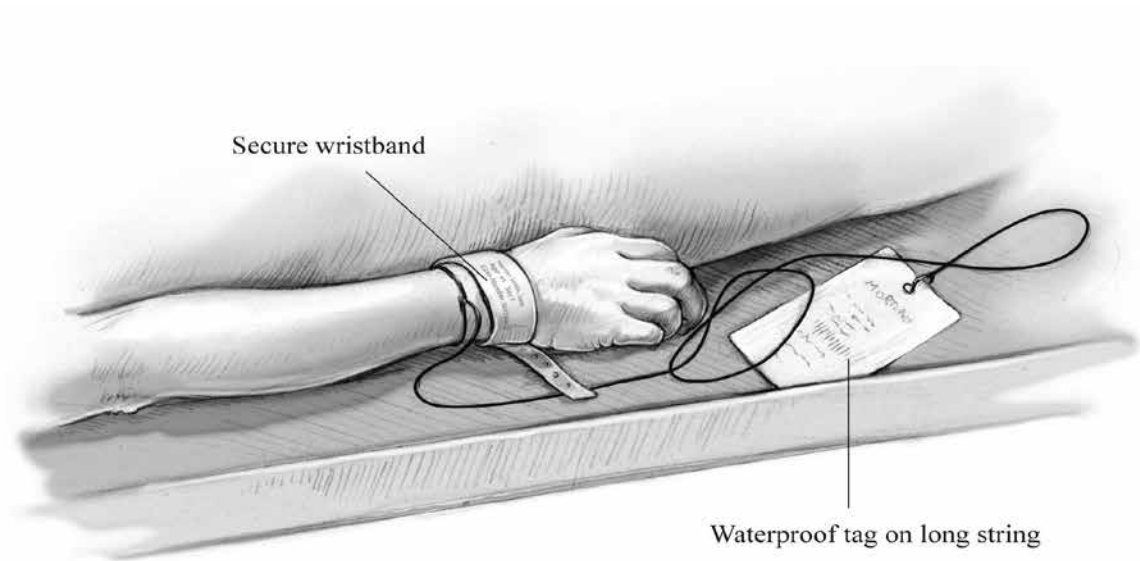
- Ante mortem and post-mortem changes (congestion, lividity, oedema, gastric fluids issuing from mouth and/or nose)
- The presence of injuries or bleeding
- Anxiety or distress causing the family member to perhaps not even look at the body or face of the deceased
- Reliance of the family member on something other than the facial appearance of the deceased, like the appearance of the clothing or an item of jewellery such as a ring on a finger
- A wrong assumption on the part of the identifier that the body he/she is being shown is already known to be the relative

Visual identification should be limited to the following controlled circumstances:

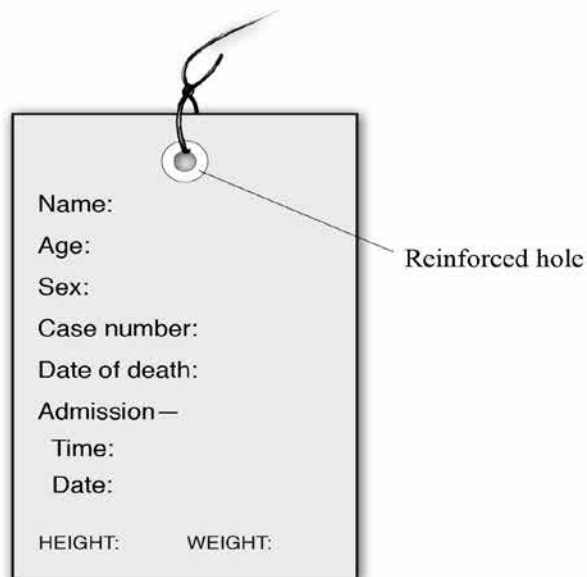
- Recent death with fresh facial appearance not showing signs of decomposition or significant injury
- Psychologically competent next of kin (identifier) who has been well prepared about what to expect when he/she sees the deceased
- The process is witnessed by the forensic pathologist, a trained mortuary technician, a grief counsellor (social worker) or other professional and identification is convincing.

It is preferable to ask the next of kin simple questions such as what were the facial (or body) features he or she relied on in reaching their decision. For example, the appearance of the face, the hair style, a mole on the face, or a scar. Whenever possible, the process of the visual identification should be conducted in a designated area which respects the viewer's privacy and emotional state.

**Figure 1. Labelling the body**



Labeling the body with a secure wristband and a tag attached by a long string



Information on waterproof tag

The scientifically reliable methods of identification, known also as ‘primary’ identifiers are: fingerprints, dental information and DNA. Comparison of ante mortem and post-mortem X-rays, body deformities, scars, tattoos, orthopedic prostheses with specific manufacturing numbers and other similar features, in the circumstances of the particular death, may approach the level of being a primary identifier. Generally, methods such as scars, tattoos or personal effects found on the deceased

are less reliable because they are either not necessarily unique or are not part of the body itself. In particular cases, depending on the circumstances, such methods may be very reliable. The assessment of such reliability is an expert judgement requiring education, training and experience.

Consideration of the method of identification in the particular case will be required. For example, bodies that are decomposed, burnt or have sustained facial injuries should be subjected to at least one scientifically reliable method of identification. The selection of the most appropriate method is an expert decision, the responsibility of the forensic doctor, and the results should form an essential part of the final report.

#### **4.3.2 Human identification in a multi-fatality incident**

Visual identification alone must not be relied upon in cases of multiple fatalities. Mis-identification is common in those settings due to time and emotional pressures. Looking at a row of deceased victims, or a number of deceased individually one after the other, does not allow a reliable determination of the victim's identity. Additionally, identifying a body based on personal effects can be a common occurrence. However, personal effects are not unique and, depending on the processes around retrieval of the bodies, such personal effects may have been incorrectly put with the wrong body.<sup>2</sup>

In all multiple-fatality incidents, identification should only be established following post-mortem examination that may or may not include a full internal autopsy. Elements should include one or more of the following:

- 1- Fingerprints
- 2- Dental examination
- 3- As required, full or limited internal autopsy
- 4- Other procedures as indicated (e.g. frontal sinus X-rays)
- 5- DNA profiling and kinship matching

This, of course, does not take account of crucial aspects of the scene examination, the recovery and recording of property and effects and the collection of ante-mortem data. The approach to disasters on a small to moderate scale has been standardised by Interpol (Interpol, 2009). For disasters on a large scale see *Management of Dead Bodies after Disasters: A field manual for first responders* (PAHO, WHO, ICRC 2009). Understanding the relationship between these two approaches, when they should be used, and when combined approaches should be used is crucial.

#### **4.4 Storage**

The conditions for storage of deceased vary considerably according to the resources available and the priority accorded to storage by the responsible authorities. Whatever storage is available, it must be clean and free of infestation. Wrapping bodies in sheets or securing them in disposable body bags will assist with this and protect their dignity. Refrigeration for the storage of deceased is expensive to install and maintain and is beyond the resources available in many parts of the world. Where available, four degrees centigrade is the preferred temperature of storage. In some places, embalming has been adopted as an alternative to mitigate the effects of decomposition during storage. While this may be the only option available, it has obvious disadvantages in a forensic context.

The body store should be secure so that it can be accessed only by authorised staff. There should be a 'body count' once or twice daily. This is a reconciliation or audit of the number and identity of bodies actually in the store compared with the number and identity of those that should be there according to

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<sup>2</sup> In fact, correct Interpol DVI procedures require loose personal effects to be collected separately at the scene and NOT allocated to a body.



the records. If there is any discrepancy, this must be investigated and solved immediately. The ‘body count’ is a mandatory quality assurance activity for any mortuary.

#### **4.5 Preparing for the autopsy**

The instrumentation available for the autopsy will depend upon the resources available and the priority accorded to this by the responsible authorities. Some mortuaries are able to supplement their stores with disposable items (e.g. surgical gloves) which have passed their ‘use by’ date elsewhere, for example in a nearby hospital, especially the operating theatres.

Ideally, there should be a suitable working bench adjacent to the autopsy table for dissection of the viscera following their removal from the body. Next to this should be a place for equipment and instruments needed during the autopsy.

Instruments to be placed next to the working bench adjacent to the autopsy table could include:

- Pair of double blunt pointed long handled scissors
- Serrated tipped forceps
- Scalpel handle with fresh blade
- Histology pot with 10% buffered formalin
- 10cm blade dissection knife
- Histology/mortuary/brain long bladed knife
- Metal probe
- Ruler
- T-piece (‘skull key’)
- Mallet
- Rib shears/bone cutter
- Oscillating or hand saw
- Head block(s)

Other instruments and equipment which should also be close by could include:

- Tape measure
- Large and small rat toothed forceps
- Small dissection scissors
- Scalpel handles and blades
- Range of probe(s)
- Long probes/knitting needles for indicating passage of projectiles
- White board
- White board marker
- Biohazard labels
- String
- Sewing needles – large and small
- 20ml syringes

- Different gauge needles
- Sterile jars
- Artery forceps
- Bowel clamps

While resources may not extend to one being available, a very high priority should be placed on obtaining weighing scales. The weight of organs is a strong guide to normality or underlying pathology. A system for ensuring that organ weights are measured and the weights recorded (for example, at first on a white board next to the autopsy table or working bench, and then later permanently captured in the report) is a fundamental requirement for all autopsies.

Sometimes steps will be required for shorter pathologists to comfortably access the organs on the working bench. Such steps may also assist with photography. Alternatively, the dissection tray may need to be elevated for the taller pathologist.

Before commencing the autopsy, information about the circumstances of the death, including any photographs that might be available, and the deceased's medical history should be reviewed. If necessary, investigating police, the treating hospital and/or the deceased's doctor should be telephoned to inquire about the death. Subject to any law or formal procedural requirements, they might even be invited to attend the autopsy.

#### **4.6 Preparation for the retention of organs, tissues and fluids**

Any special investigations (see Section 5.6) that can be anticipated should be prepared for.

#### **4.7 Moving the body from the trolley to the table (if required)**

Some mortuaries are fortunate enough to have arrangements whereby the trolley onto which the deceased is placed when being admitted to the mortuary also serves as the table upon which the autopsy is subsequently undertaken. However many mortuaries still use fixed, often porcelain or metal, mortuary tables, requiring the body to be moved from a trolley to the table.

Small bodies of infants and children are, of course, lifted from the trolley and placed on the table. For larger bodies, the transfer of which can be difficult, certain procedures should be followed:

- Assuming the trolley is the same height as the table, for larger bodies the trolley should be wheeled next to the table so that there is no space between the two.
- The brakes should be applied, or the trolley held, so that it cannot move.
- Preferably two people should be involved in the transfer: one at the head end of the deceased, holding the head and shoulders up and lifting them across; at the same time, the second person should pull the deceased over by traction, preferably on whatever sheet the deceased is lying on.
- If there is no sheet, then the traction might be applied to clothing. If there is no clothing, and this is the least desirable option, traction might be applied to the arms and legs to pull the body across. Sometimes, water is required to make it easier for the body to move across the surface of the trolley or the table.



## 5. THE AUTOPSY

The forensic pathologist undertaking the autopsy is responsible and accountable for its conduct. The pathologist must be competent in all the following procedures, even if on a routine basis some of them are undertaken by a technical assistant. Virtually all autopsy procedures are associated with the creation of possible artefacts that might be confused with, or obscure, true pathological findings. Thus, the pathologist and the technician need to be constantly on the alert for these artefacts, notice when they occur and, to the greatest extent possible, avoid creating them.

An autopsy must not be rushed. The pathologist and the technician should take as much time as is needed for the autopsy.

An autopsy is an exercise in solving problems. What was the cause of this person's death? What can be discovered from this autopsy that will help understand the circumstances in which the death occurred? It is an exercise that is also vulnerable to bias. For example, confirmation bias would lead the pathologist to only look for things that confirm the hypothesis about the cause and circumstances of death, and not those things which would cast doubt on the hypothesis. The pathologist should ask him or herself: What questions do I need to answer as a result of undertaking this autopsy? What questions will investigators, the family or the court have?

A basic truth, perhaps even a golden rule, about clinical medicine can also be applied to autopsies: 'If you do not look, you will not find!'

### 5.1 Introduction to the body

Both the technician and the pathologist should check the name and number on the body tag and compare this with a separate record of the authority for the autopsy. If there is any discrepancy, this must be clarified before proceeding further.

If the identity of the deceased is uncertain or unknown, the approach to establishing identity will need to be decided, if this has not already occurred (see Human Identification, above). While the specific approach will vary from case to case depending on the circumstances, and on what ante-mortem information is available relating to the person the deceased is thought to be, the approach will often include consideration of:

- examination of clothing and personal effects and photography of these as indicated
- the value of fingerprints in the particular case (in some mortuaries, fingerprints are taken routinely and kept as part of the case record)
- facial photography
- dental examination and forensic radiology
- particular attention to identifying characteristics on external and internal examination
- recording and/or photography of these identifying characteristics
- obtaining necessary samples for testing (e.g. for DNA profiles and kinship matching)

Additionally, the date and time the examination begins should be noted.

The risk of mis-identification in multiple fatalities, even when it is believed the identity of each deceased is known, is much greater than in a single fatality. As such, serious consideration should be given to regarding every multiple fatality (for example, two people killed in one car crash) as a disaster and using the Interpol DVI approach to establish/confirm the identity in all such events. This has the additional benefit of ensuring that Interpol DVI protocols are regularly practised as part of the

routine experience of the mortuary and all its staff. The time spent on this will repay itself many times over when a serious disaster strikes, which could happen at any time without warning.

Detailed procedures relating to finding, recording, removing and securing any evidence before undressing the body, for example in a homicide case, are outside of the scope of this manual.

## 5.2 Clothing

### 5.2.1 Examining the clothing

Examining the clothing can be an important part of the overall examination, part of the aim of which is to re-create the circumstances under which the death occurred. The presence (or absence) and orientation of stains on the clothing or shoes may indicate conclusions about the position or mobility of the deceased after sustaining bleeding injuries to the head, for example. One thing is certain: if the clothes are not examined, then they will be of no help!

Examining the clothing for trace evidence is beyond the scope of this manual. Procedures for this should be developed in collaboration with local police and forensic science colleagues, and then documented in the relevant manual. Increasingly it is understood that it may be desirable to secure such trace evidence at the scene of the death before the body has been disturbed and subject to further opportunities for contamination.

### 5.2.2 Removing the clothing

In removing clothes upon admission to the mortuary or at the commencement of the autopsy examination, efforts should be made to ensure they remain intact. This means that:

- they are complete and intact when photographed separate from the body,
- they can be examined later more easily than if they have been cut, and
- they can be returned to the family (preferably having been washed) if it is appropriate to do so.

Using scissors to remove the clothes may be necessary in some cases. They may be impossible to remove any other way. Some upper garments simply cannot be removed from the arms, especially in the presence of rigor mortis. It may not be necessary to examine the clothing and they may be so soiled, that there is no prospect of the clothing being returned to the family. If the clothing is to be cut, serious consideration needs to be given to whether there should be a photographic record of the deceased before the clothing is removed, even in routine cases.

It is desirable that the pathologist be involved in removing the clothing, as the autopsy is a convenient time to examine it.

The following description of how to remove clothing intact is based on Western style dress.

Clothing should be removed layer by layer.

#### 5.2.2.1 Upper body

**To remove clothing such as a jumper or a pullover from the upper half of the body, firstly work the bottom hem of the garment upwards so it is sitting under the axillae and neck of the deceased. Jackets or coats will need to be un-zipped or un-buttoned first.**

**Then, starting in the axillary region of the garment, stretch the fabric down over one elbow to expose or release the elbow from the jumper.**

*Comment:* The arm must be flexible at the elbow for this to be possible, and this may involve

<p>'breaking' the rigor mortis. At this point it may become apparent that garment will need to be cut with scissors. After unbuttoning, shirts may possibly be removed in the same way, but generally the sleeves will have to be cut with scissors from the cuff, up the sleeve, and across to the midline of the garment</p>
<p><b>Remove the remainder of the sleeve by working it down over the forearm and hand.</b></p>
<p><b>Next, stretch the neck of the jumper together with the whole front of the garment and lift it over the face to the back of the head.</b></p>
<p><b>If two people are present assisting, one person can roll the body onto its side, while the other removes any portion of the jumper remaining under the back.</b></p> <p><i>Comment:</i> If only one person is present, and the body is not too large, then he/she can roll the body towards him/her using both hands, steady it with one hand and use the other hand to clear the clothing from under the back.</p>
<p><b>Work the sleeve of the jumper down over the remaining forearm and hand to finish (garment may end up inside-out).</b></p>
<p><b>The same process can be followed to remove successive upper garments. Short sleeved singlets are relatively easily removed.</b></p> <p><i>Comment:</i> Dresses may need to be undone at the back first, before following the same process described above.</p>
<p><b>Brassieres should be undone at the back first, then removed over each arm, one at a time.</b></p>

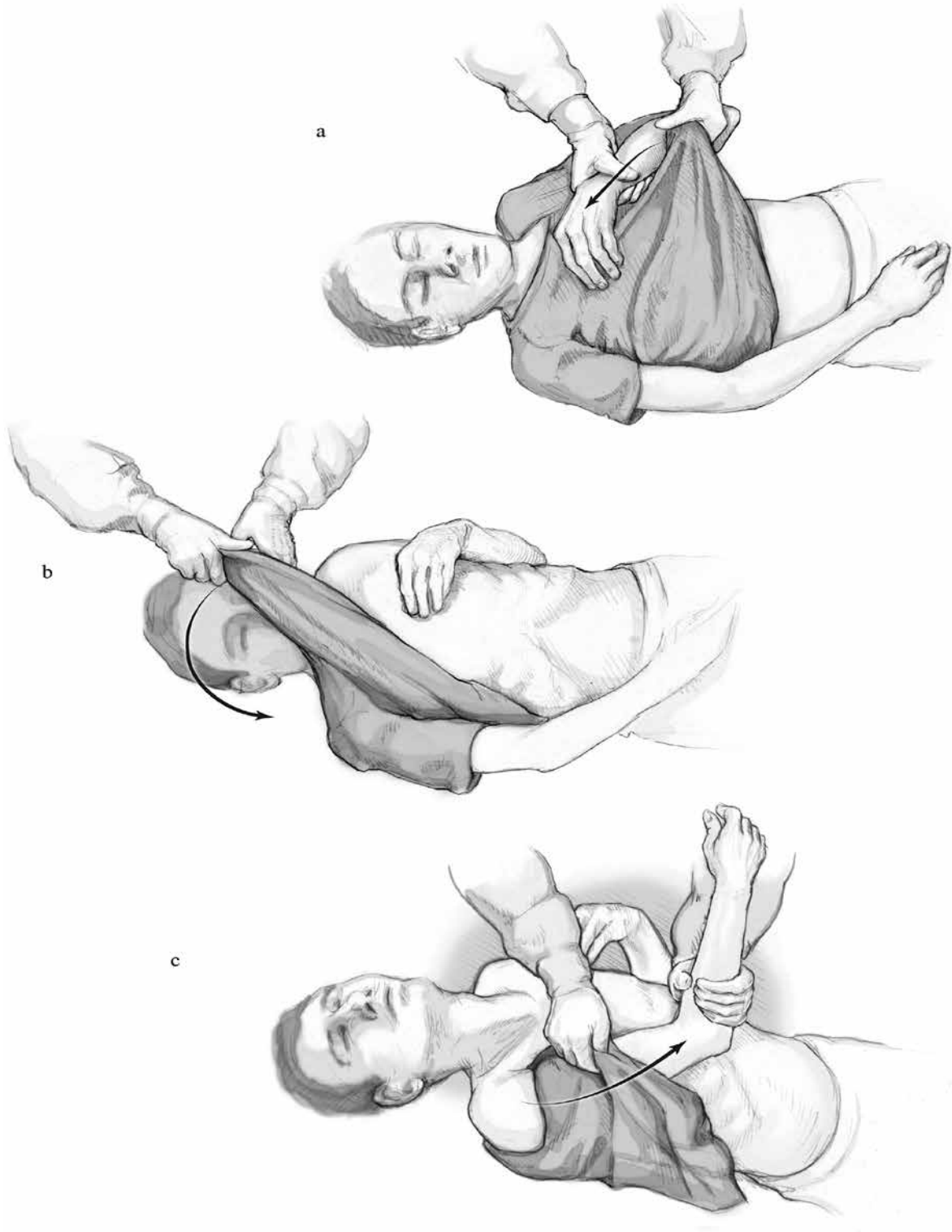
See also Figure 2

#### 5.2.2.2 Lower body

<p><b>To remove clothing from the lower half of the body (e.g. trousers or pants), start by removing footwear and undoing any buttons, zippers or belts that may be present.</b></p> <p><i>Comment:</i> Remember that it may be important to record some of these features, including whether the belt was done up, if the pants were buttoned up or not, if there were drops of blood on the top of the shoes, and if there were smears of blood on the soles of the shoes indicating that the deceased may have been walking in blood at some point.</p>
<p><b>With one person present, lift a leg by holding it under the heel and with the other hand work the garment under the buttocks on one side by pulling down on the waist band.</b></p> <p><i>Comment:</i> With two people present, both sides can be done simultaneously.</p>
<p><b>Change sides and repeat</b></p> <p><b>Once the garment is sitting below the buttocks on both sides, work down both legs, holding one leg then the other under its heel, until the feet are cleared. Towards the end of the procedure, the pants can be pulled by the cuffs over the feet, helping to prevent them turning inside out at the same time as removing them.</b></p> <p><i>Comment:</i> Skirts are easily removed using the same process although they may need to be undone at the back first if a zip is present.</p> <p>Make sure to check any pockets for property before considering whether to photograph the clothing, recording them and their contents, securing and labelling the clothing and property according to the mortuary's documented procedures.</p>

See also Figure 3.

Figure 2. Removing the clothing – upper body



Removing the clothing — upper body

## 5.3 External examination

The importance of the external examination in forensic pathology cannot be over-emphasised. Sometimes it may take two to three times as long as the internal examination, or even more, and it must not be rushed. The proper completion of this part of the examination is one of the key competencies of forensic pathology. It is the means by which much of the data, which will form the basis of opinions and conclusions, is assembled. Such opinions and conclusions are crucial, and the data upon which they are based must be correct, otherwise the conclusions may wrongly convict the innocent, or wrongly exculpate the guilty.

### 5.3.1 Measuring the height (and other linear measurements)

This is a mandatory piece of data. The usual method is to apply a rigid ruler to measure from the heel to the crown of the head. Common mistakes are to measure from the toes, which may be extended as much as 5 centimetres or more beyond the heel, leading to over-estimations of height. On the other hand, this longer measurement may be important for funeral directors in some cases to obtain the right size coffin or casket.

#### See Figure 4

At the other end of the body, there can be confusion about whether the measurement point is the scalp, or the scalp plus the hair. One should attempt to measure the height to the upper most portion of the scalp in the bi-temporal/bi-parietal region. Slight errors can be introduced if the head is flexed or extended. Further error can be introduced if the legs are flexed at the knees and/or the hips. This may necessitate measuring from the heel to the lateral femoral condyle, and from the same point on the lateral femoral condyle to the greater trochanter of the femur, and from there to the crown of the head.

Unknown degrees of error exist in relation to horizontally measured true length post-mortem versus vertically measured true height in life. In addition, most heights in life are not measured in controlled circumstances. Nonetheless, on admission or at autopsy, measurement should be carefully made in a reproducible fashion.

Other linear measurements externally can include:

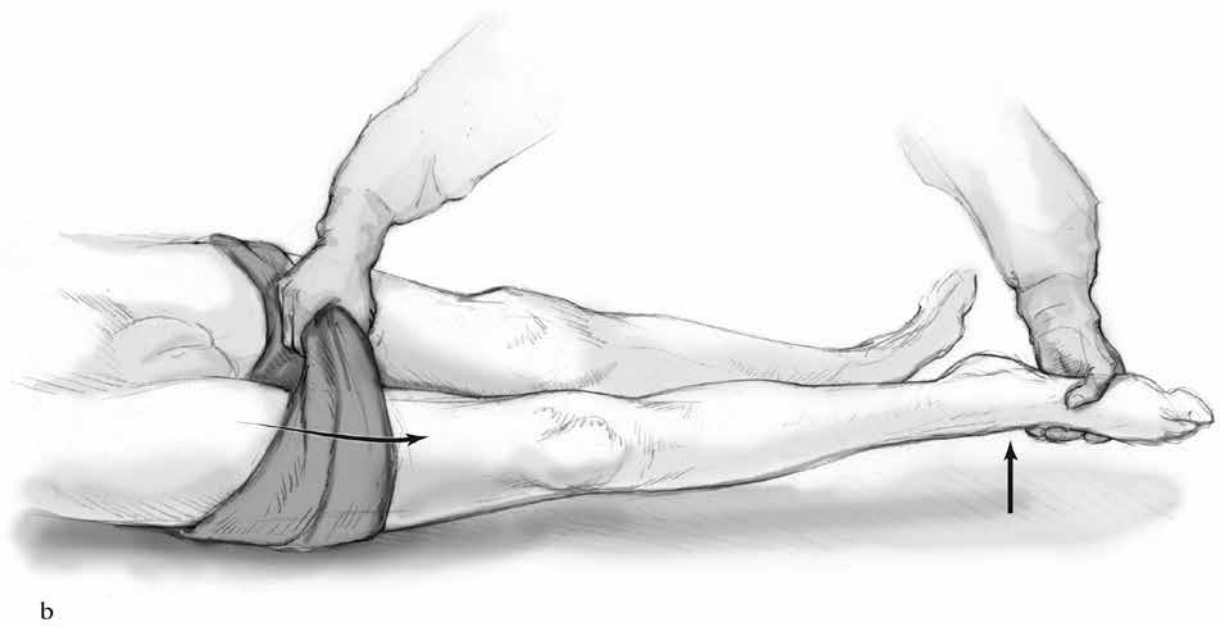
- serial measurements of leg circumference at 10 cm intervals from the sole looking for asymmetry that may indicate wasting or swelling (e.g. from deep vein thrombosis); one usually notices asymmetry and measures bilaterally at the level of that asymmetry
- cranial circumference, chest (at nipples) circumference and abdominal (at umbilicus) circumference (all mandatory in infant and paediatric autopsies)

On occasion, it may be important to measure the length of the arms. This can arise when there are issues about suicide involving rifles, or the deceased reaching hanging points for example. One approach is: to measure from the acromio-clavicular joint to the olecranon process of the humerus, then from the olecranon process to the ulnar styloid and finally from the level of the ulnar styloid to the tip of the third finger. This last measurement can be difficult because of the usual post-mortem flexion of the fingers.

The relationship between this length and whether or not a particular action could have been performed will depend on many factors and will need very careful consideration and discussion in the report before any conclusion can be made.

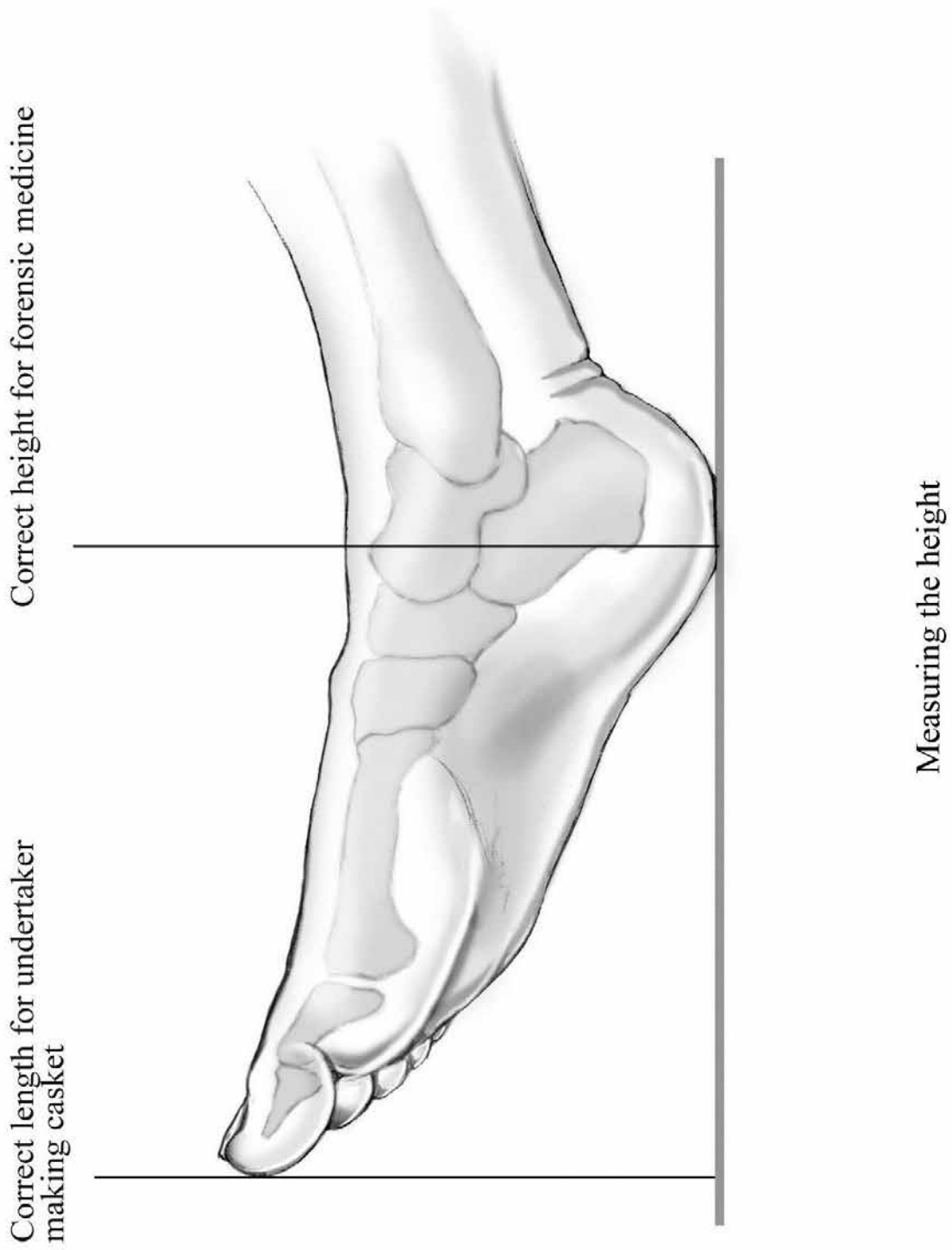


Figure 3. Removing the clothing – lower body



Remove the clothing — lower body

Figure 4. Measuring the height



### 5.3.2 Weighing the deceased

Again, this is a basic piece of post-mortem data. Comparison with a previous weight may be an important indicator of illness or growth.

Usually, the simplest method is to weigh the body at the time of admission (bearing in mind the body is usually clothed at this point) on an in-floor scale calibrated to account for the weight of the trolley (See Figure 5). This, unfortunately, is beyond the resources of many mortuaries.

In the absence of scales, the pathologist will need to develop descriptors, preferably supported with photographs, to convey to the reader the weight of the individual. For example, recording the size of clothing (e.g. neck size, waist size, shoe size) conveys this well in many instances.

Body Mass Index ( $\text{kg/m}^2$  – body mass in kilogrammes divided by the height in metres squared) is an increasingly common measure of body proportion along a spectrum from cachexia to obesity. It correlates well with direct measures of body fat (CDC, 2013). Note the table below is based on a western population.

Body Mass Index – $\text{kg/m}^2$	Significance
<18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
>30.0	Obese

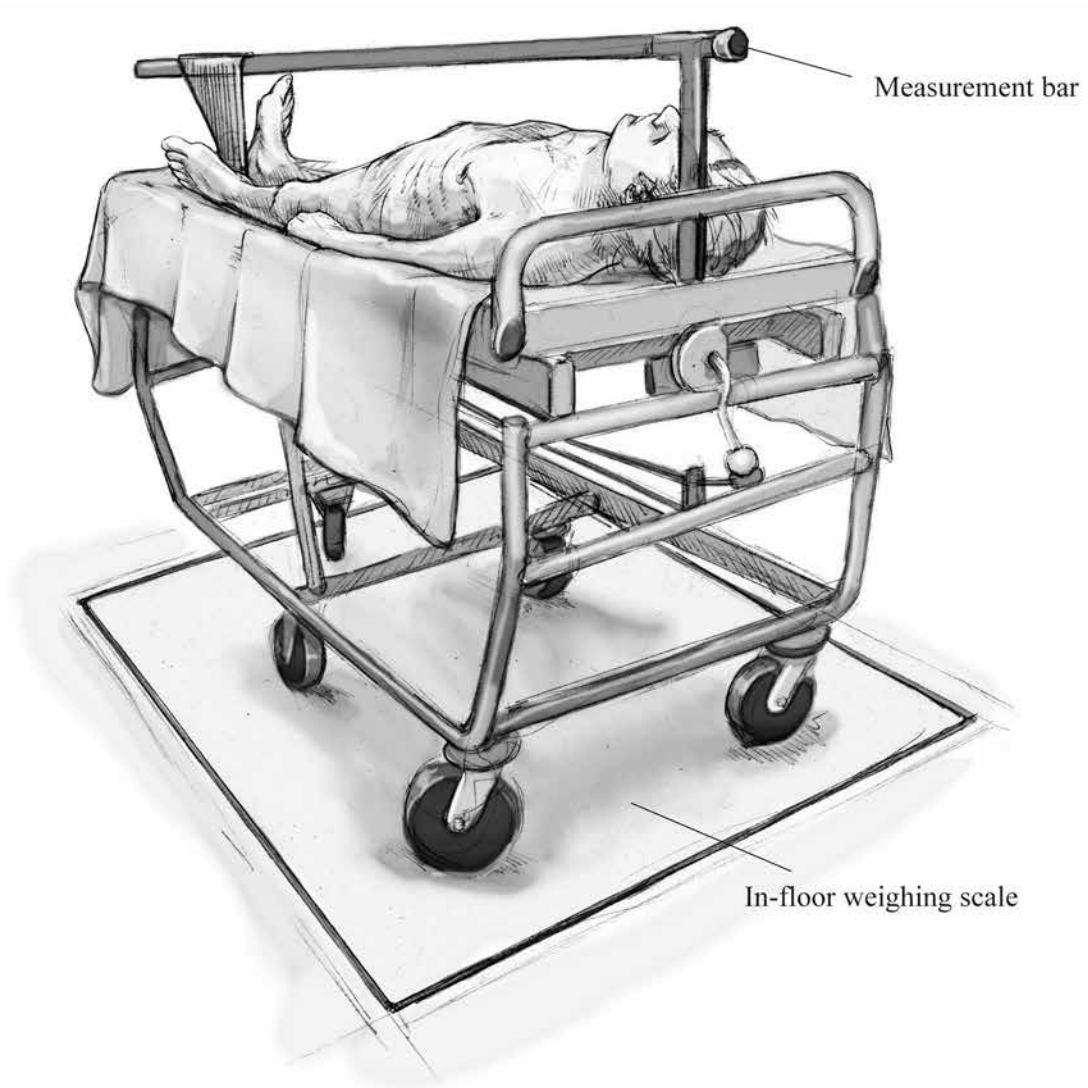
### 5.3.3 General description

The unclothed body must be inspected externally on both the front and back as a mandatory requirement with no exceptions. The arms and legs should be individually inspected. Lividity, areas of pallor and the presence of rigidity should be evaluated and described. Assessment of rigidity is a time honoured part of the examination. Its major relevance relates to the time since death. However, the relationship between the degree of rigor and time since death can vary dramatically, so its usefulness in this regard is extremely limited. The deceased's colour, sex, build, nutritional status, apparent age, hair colour, hair length, pattern of hair distribution (facial, body, axillary, and pubic hair) should all be inspected.

Routinely inspect:

- The eyes, including eyebrows, eyelashes, eyelids, conjunctivae. Evert the eyelids very gently with forceps to examine their conjunctivae and sclerae. Note: forceps can easily damage the soft and often fragile epidermis of the eyelids, interfering with the facial appearance for later viewing
- Ears, including behind the ears. Inspecting the ear drum and canal with an otoscope can on occasion be rewarding (e.g. blood behind the ear drum)
- Mouth including inner lips, frenulum, buccal mucosa, teeth (number and condition). Remove any dentures present to examine the gums. If the mouth can be opened, inspect all its structures. It is not necessary to incise the angles of the mouth to inspect the interior of the mouth – this can be achieved with no facial damage by inspecting from below after removal of the neck structures. The only possible exception to this is, perhaps, circumstances of a very badly burnt or charred body.
- Face, scalp
- Neck; palpate it and the supraclavicular regions
- Chest; palpate breasts

Figure 5. Weighing the deceased



In-floor scales allow weight of the body to be easily measured

- Abdomen; palpate it and inguinal regions
- Ano-genital/perineal region
- Arms, hands including palms – this can be difficult when the fingers are flexed. Flexing the wrist with pressure on the back of the hand (while holding the forearm with the other hand) will extend the fingers, allowing a good view of the palm. This may also be required to take fingerprints. It is not necessary to incise the flexor tendons at the wrist to achieve these purposes. Neither is it necessary to amputate the hand or fingers to take fingerprints. Removing the hand for fingerprint examination including to end it elsewhere, is not acceptable.
- Legs, feet

#### **5.3.4 Describing the location of an external finding**

For the purposes of describing the external findings at autopsy, it is assumed that the body is in the ‘anatomical position’ – that is, the findings are described as though the deceased is standing with head erect, looking directly forward, the palms turned anteriorly and the feet parallel to each other.

A mandatory skill and competency in external examination is to accurately locate an external finding. This requires knowledge of suitable anatomical points of reference. See Figure 6, which illustrates a number of anatomical points of reference to enable accurate location of physical findings.

The finding (or a part of the finding) can then be located as x cm/mm superior/inferior, and y cm lateral/medial to the point of reference.

These anatomical points of reference include:

##### Head and neck

- orbital margins: lateral, superior, inferior
- external auditory meatus
- hairline
- glabella (junction of the nasal and frontal bone)
- angle of the mandible
- point of the mandible (i.e. the point of the chin at the midline)
- sternal notch
- mid-point of the clavicle
- acromio-clavicular joint
- occipital protuberance
- spinous process of seventh cervical vertebra

##### Chest and abdomen

- sternal notch
- anterior axillary line
- mid axillary line
- posterior axillary line
- in men, the nipple
- umbilicus

- mid clavicular line
- midline
- xiphisternum
- costal margin
- symphysis pubis
- anterior superior iliac spine
- acromio-clavicular joint
- spinous process of seventh cervical vertebra

#### Arms

- acromio-clavicular joint
- olecranon process
- head of the ulna
- ulnar styloid process
- radial styloid process
- metacarpo-phalangeal joints (numbered one to five)

#### Legs

- greater trochanter of the femur
- lateral/medial condyles of the femur
- tibial tuberosity
- lateral/medial malleoli
- heel
- metatarso-phalangeal joints

In addition, the shape, location or course of findings may require reference to the sagittal (median, midline or longitudinal) plane, the transverse (or horizontal) plane, and the coronal plane. See Figure 7: Anatomical planes. Pathologists and technical staff should be very familiar with these terms.

In cases where the absolute height of particular findings might be important (for example, in deaths from gunshot wounds), then reference to the height of the finding itself above the heel should also be included. On occasions it may be important for the point of reference to be fixed. For example, in describing a ligature mark on the neck, a single fixed point of reference such as the sternal notch will enable an accurate representation of the horizontal or sloping nature of the mark. This is achieved by referring to the distance above the sternal notch in the midline (anteriorly and posteriorly) and at the line of the external auditory meatus, and at points in between if necessary.

**Figure 6. Anatomical points of reference**

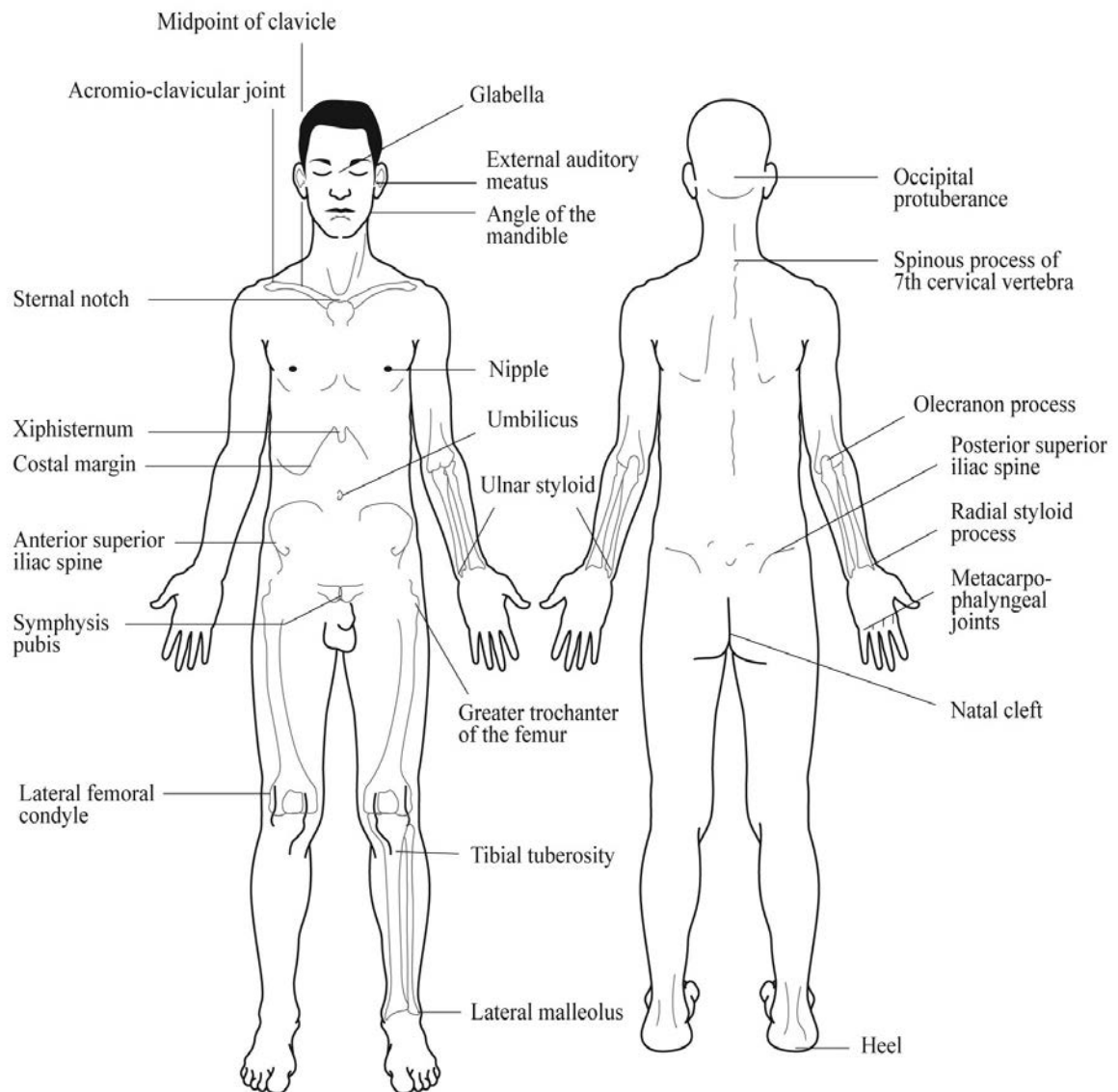
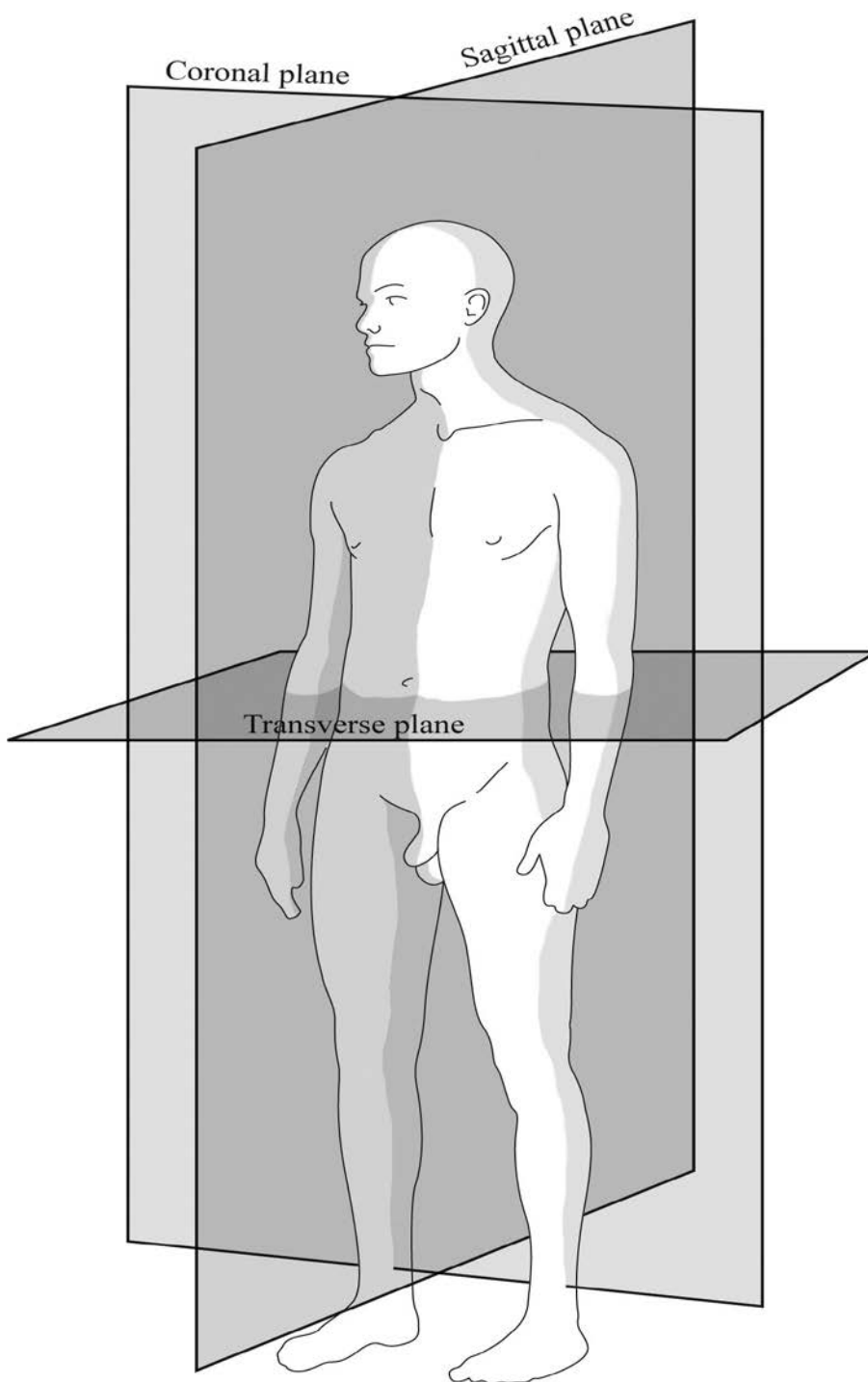


Figure 7. Anatomical planes



Anatomical planes

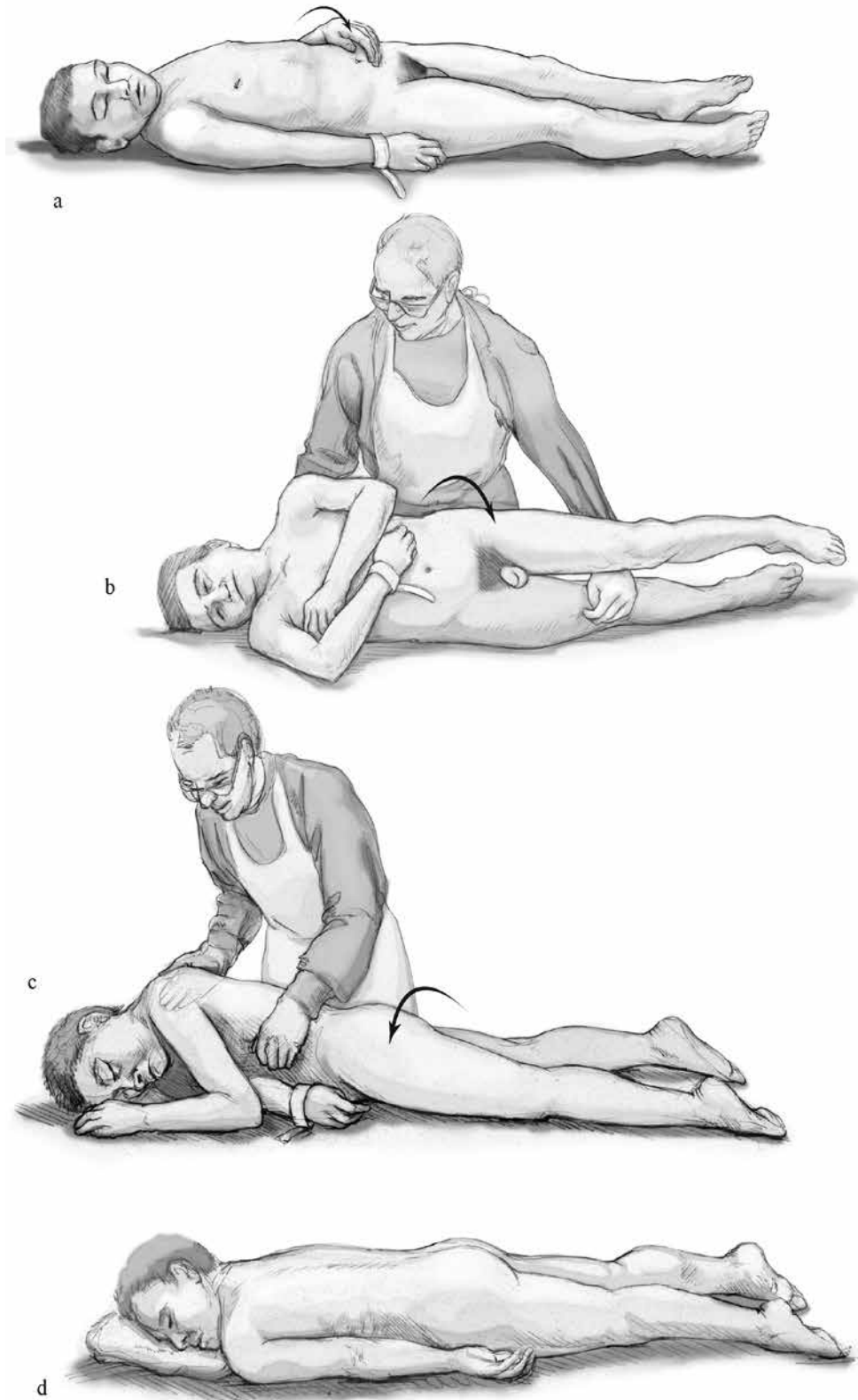


### 5.3.5 Turning the body over

Turning a body from a supine ('on the back') to a prone ('on the front') position to examine the back closely can be difficult without following a proper procedure. There is more than one way of doing this, but adopt a method which minimises trauma to the body. This is respectful to the body and forensically better because it minimises artefact. See also Figure 8: Turning the body. The method shown in Figure 8 represents an alternative to that described in the text for smaller bodies and only one technician or one pathologist

<p><b>First, ensure that the legs and arms are as straight as possible.</b></p> <p><i>Comment:</i> If this requires 'breaking' the rigor mortis, be aware that this introduces artefact internally.</p>
<p><b>For smaller bodies:</b></p>
<p><b>Slide the deceased so that his or her right side is resting against the edge of the trolley to ensure adequate space for rolling.</b></p> <p><i>Comment:</i> For unclothed bodies, this may require some water to be put on the surface to make it easier for the body to slide.</p>
<p><b>Standing on the left side of the body, cross the right leg over the left leg and draw the right arm towards you across the body.</b></p>
<p><b>Roll the body up so it is resting on its left side (use the right arm of the deceased to 'pull') and the front of the body is facing in your direction.</b></p>
<p><b>Then, gently lower the right side of the body at the same time as pushing the left side of the deceased away from you across the table/trolley. The deceased is now resting face down.</b></p> <p><i>Comment:</i> The arms may need to be released or manoeuvred from under the torso to ensure the body is balanced.</p> <p>Rest the face on a towel.</p>
<p><b>For larger bodies:</b></p>
<p><b>If the deceased takes up most of the trolley or table width, then another trolley may be required to roll the deceased on to. A second person will also be required to assist.</b></p>
<p><b>Place the two trolleys so they are touching each other side by side with the empty trolley on the deceased's left.</b></p>
<p><b>One person should stand on either side of the deceased (one person will have to lean across the empty trolley).</b></p>
<p><b>The person on the right side of the deceased will be required to 'push' while the person opposite will 'pull' the body up onto its left side.</b></p>
<p><b>The right side of the body should then be gently lowered down onto the empty trolley. The deceased is now resting face down.</b></p> <p><i>Comment:</i> It may be necessary to slide the deceased to ensure they are centred on the trolley top.</p> <p>Rest the face on a towel.</p>

Figure 8. Turning the body



## 5.4 Internal Examination

Note: This is an instructional manual on how to do an autopsy, not a forensic pathology textbook. We therefore do not concentrate on the details of observations to be made. It is axiomatic that all pathology (and even normality) encountered should be evaluated, measured and sampled as required to meet the obligation of ensuring that, as far as possible, the results of the autopsy are reviewable.

### 5.4.1 Dissection hints

Dissection hints:

- use fingers to separate planes of tissues, being particularly careful if there may be fractures;
- when using knives and scissors, look and feel before you incise or cut;
- hold slippery tissues in paper or towels;
- knives and scissors must be sharp – competence in sharpening these is essential for mortuary staff;
- when slicing, do not saw (which results in an uneven surface) but use the minimum number of passes of the knife, firmly holding the tissue/organ being cut with the assistance, if necessary, of a damp towel.

### 5.4.2 The head

As a general principle, the head should be opened first and the brain removed. There may be time or logistical constraints on this. The reason for opening the head first is to allow the blood vessels of the neck to drain, reducing the risk of artefactual bruising during later dissection of the neck. Note that special procedures apply if there is any thought that the deceased may have Creutzfeldt Jakob Disease. (Brown P, 1990; Bell J et al, 1993).

#### 5.4.2.1 Reflecting the scalp and removing the skull cap

**The occiput is supported by a head block.**

**The hair is carefully parted along the line of the proposed incision.**

*Comment:* This prevents hair being unnecessarily lost during the incision of the scalp and assists with covering the incision on reconstruction of the deceased.

**The incision is made from the superior part of the mastoid process behind one ear to the same point behind the other ear, coursing over the top of the head in the coronal plane.**

*Comment:* The incision should be made with very firm pressure on the blade so that the full thickness of the scalp, down to the outer table of the skull, is incised.

**The incision is undermined anteriorly (for a centimetre or so) using the scalpel (or knife), after which it is often possible to manually peel the anterior scalp flap forward.**

*Comment:* This may be assisted by using a towel to grip the incised edge of the scalp flap.

The reflection should continue to the orbital ridges to maximise exposure of any bruising; some advise ceasing the reflection a centimetre or two above the ridges to minimise the risk of forehead distortion if there is to be viewing of the deceased following the autopsy.

**The posterior scalp is manually peeled or reflected away from the parietal and occipital bones.**

*Comment:* This is generally more difficult than the anterior flap and requires strong thumbs and sharp dissection may be required. It may be necessary to ask for assistance to hold the head by the anterior scalp flap while the posterior flap is dissected sufficiently far down from the occiput and back of the neck to assess for the presence of bruises for example. This could be done later if the body is to be turned over.

**The superior attachments of the temporalis muscle are divided using a scalpel/knife and the muscle reflected from its temporal bone attachment but left attached inferiorly.**

*Comment:* The temporalis muscles should be intact after reflection of the scalp. Dividing the superior attachments of the muscle clears them from the path of sawing of the skull, allows better assessment of any haemorrhage, and leaves the muscles to assist in reconstructing the head following the autopsy.

**Strip the aponeurosis from the outer table of the skull using rat toothed forceps. This can take time.**

*Comment:* This apparently innocuous and often omitted procedure may reveal fine hairline fractures that could otherwise be missed.

**Saw the skull. In experienced hands, a hand saw is probably the best method of removing the skull cap. However, mechanical saws require less physical effort, but at least the same dexterity.**

*Comment:* An important aim in opening the skull is to create sufficient space to inspect all surfaces of the brain in situ and to enable removal of the brain with the minimum of additional damage.

**Whether a hand saw or a pneumatic/electric oscillating saw is used, the head should be supported on a head block, with the posterior scalp flap folded back (held between the skull and the block) and the anterior flap folded forward.**

(see hints below for using a hand saw or pneumatic/electric oscillating saw)

*Comment:* Aerolisation of bone dust poses a risk of infection and is one of the reasons a mask and face protection is required as a part of universal precautions. Further protection can be obtained by sawing the skull while the head is in a large plastic bag. This is mandatory for some cases, like those at high risk for CJD (Waters B, 2009. Ch 4; CDC, 2014).

**The 'T' piece is used to finalise the separation of the sawn segment from the rest of the calvarium.**

*Comment :* A mallet is used lightly to divide the last areas of endosteum, finally releasing the skull cap.

**Elevate the skull cap off the dura. When this is complete, the intact dura should remain encompassing the brain. If achievable, at this point some assessment of brain**

**swelling/oedema can be made, any extra dural haemorrhage can be assessed, an early indication of the presence of sub dural haemorrhage (visible through the dura) can be made, and the extra dural and left and right sub dural haemorrhages can be collected and measured separately.**

*Comment:* This may require some additional manipulation. Holding and retracting the anterior edge of the skull cap away from the frontal bone with the fingers of the right hand, carefully (to avoid bone splinters) use the fingers of the left to prise the dura away from the inner table of the skull cap. Sometimes the dura of the sagittal sinus is attached particularly tenaciously and requires the assistance of a scalpel or knife to detach.

**Sometimes the dura is so adherent that it may not be possible to remove the calvarium and leave the dura behind, intact. If so, to remove the calvarium it will be necessary to divide the falxcerebri anteriorly to release the calvarium with dura attached.**

**The middle and inner ears can be inspected using a hammer and chisel to remove the top of the petrous temporal ridge.**

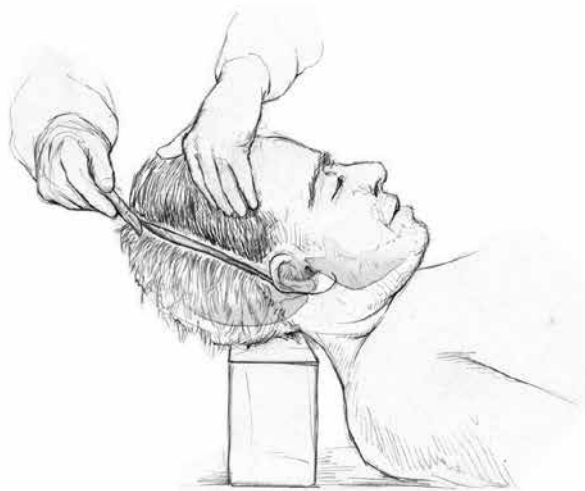
*Comment:* This procedure should be routine in paediatric practice to look for infection.

Some of the above steps are illustrated in **Figure 9**, which shows incising and reflecting the scalp using a hand saw to remove the Calvarium.

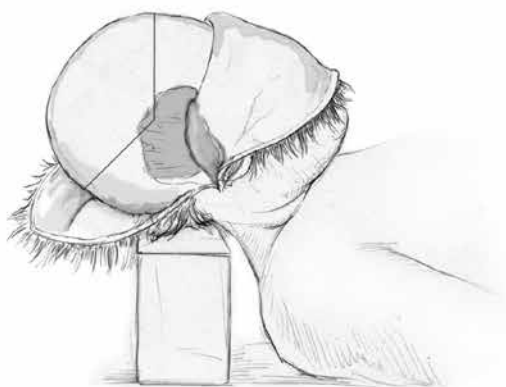
#### 5.4.2.2 Using a hand saw, or a pneumatic/electric saw

HAND SAW	PNEUMATIC/ELECTRIC SAW
<ol style="list-style-type: none"> <li>1. Ensure saw is sharp.</li> <li>2. For a right handed person: Standing on the deceased's left, hold the frontal region in a towel draped left hand, carefully commence sawing transversely (i.e. in the horizontal plane), with the saw in the right hand, across the frontal region about 2 cm above the orbital ridges. After creating a small groove, sawing can be continued more vigorously.</li> <li>3. Continue sawing until you feel you have just reached or breached the inner table then continue in the transverse/horizontal plane until you reach the mid temporal region on each side.</li> <li>4. The next saw cut is a bi-parietal cut so that the angle with the anterior cut is about 135 degrees.</li> <li>5. All sawing should be to, or just cutting through the inner table. The final breach can be made with a hand held chisel and a light blow from a mallet. Such an approach ensures the integrity of the dura. It takes considerable experience to achieve this on a regular basis.</li> </ol>	<ol style="list-style-type: none"> <li>1. Move oscillating blade from side to side during sawing to avoid deep penetration and damaging the dura and brain. Some saws have a guard on them to prevent this happening.</li> <li>2. When doing lateral sawing, turn the head to the side allowing the brain to sink away from the sawing, thus reducing the risk of damage to the brain (but the dura, of course, is still at risk as it is attached to the inner surface of the skull).</li> <li>3. Do the anterior and then posterior (bi-parietal) sawing.</li> <li>4. Include a 'step' at the junction of the two saw cuts to assist with the stability of the skull vault's later reconstruction.</li> </ol>

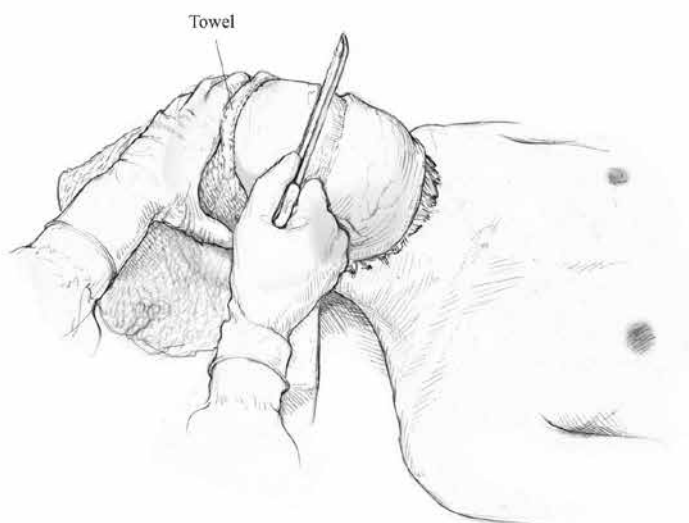
**Figure 9. Reflecting the scalp and opening the head**



a Lateral view showing head on block, hair parted and line of skin incision



b Lateral view, scalp being reflected and approximate location of cranial saw marks



c Steadying the head by holding it with the help of a towel and using a hand saw

### 5.4.2.3 Removing the brain and stripping the dura

<p><b>If it has been possible to remove the calvarium leaving the dura intact, open the sagittal sinus along its length with scissors.</b></p> <p><i>Comment:</i> As mentioned above, sometimes the calvarium is removed with the dura attached. Open the sagittal sinus along its length with scissors. The dura should then be stripped from the calvarium to inspect for skull fractures and extradural blood.</p>
<p><b>Divide the dura adjacent to the sagittal sinus on the left and then divide the dura along the horizontal saw cut.</b></p>
<p><b>Repeat this on the right.</b></p>
<p><b>Gently inspect all compartments of the skull.</b></p>
<p><b>Gently retract the frontal lobes upwards and backwards to expose the intracranial internal carotid arteries and optic nerves. Carefully incise the carotids and the optic nerves as they emerge from their foramina in the skull base.</b></p>
<p><b>Gently retract the frontal and temporal lobes further back and incise both sides of the tentorium cerebelli in the midline, working laterally then backwards adjacent to the bony margins towards the back of the skull.</b></p>
<p><b>Release the remaining exposed cranial nerves as they exit their foramina about the brainstem (rehearsing the anatomy as you go).</b></p>
<p><b>Now that there is maximum exposure, visualise the vertebral arteries. Cut across the brainstem/upper cervical cord as deep down in the foramen magnum as possible with one clear incision.</b></p> <p><i>Comment:</i> If there is any possibility of vertebral artery trauma, consider a special approach (see below) to maximise the chances of identifying it.</p>
<p><b>Place a finger gently beneath each side of the exposed cerebellum, taking care not to injure the brainstem. Lift upwards and backwards, controlling the cerebrum with your other hand.</b></p> <p><i>Comment:</i> The cerebrum, brainstem and cerebellum should come away easily from the cranial cavity. If not, ensure that the tentorium cerebelli has been adequately incised.</p>
<p><b>Strip the dura from the base of the skull with a dura stripper, and/or rat toothed forceps, and/or manually by gripping the dura with a towel.</b></p> <p><i>Comment:</i> Doing this manually requires the assistance of a towel held in the stripping hand grasping some redundant dura, steadying the skull with the other hand, and pulling the dura from the floor of the skull.</p>
<p><b>The final step involves using a scalpel or scissors to divide the dura from its attachments around the foramen magnum and central portions of the base of the skull.</b></p> <p><i>Comment:</i> If necessary, the skull can then be subject to some mild manual distortion looking for fine fractures.</p>
<p><b>The usual method of removing the pituitary gland requires using a chisel and mallet to easily dislodge the posterior wall of the pituitary fossa with a relatively light tap making removal of the gland very simple.</b></p> <p><i>Comment:</i> Alternatively, the pituitary can be dissected from its fossa using forceps and a scalpel to carefully separate it from the walls and floor of the fossa.</p>
<p><b>See below for special procedures to inspect and remove the spinal cord, the eye(s),</b></p>

**inspect the paranasal sinuses and evaluate the vertebral arteries.**

#### 5.4.2.4 Dissecting the brain

**Weigh the brain (without its coverings).**

*Comment:* Examine the convexities. Look for any asymmetry and observe any changes to the meninges. Comment on any gyral or sulcal abnormalities. Observe the corpus callosum at the depths of the interhemispheric fissure.

**Turn the brain over and examine its base. Comment on any changes to the meninges and cranial nerves.**

**Examine the unci (medial temporal lobes). Expose the vessels of the Circle of Willis (including anterior cerebral arteries and middle cerebral arteries to the trifurcation) and examine.**

**Examine the posterior fossa structures, noting the appearance of the cerebellar tonsils.**

**Remove the posterior fossa structures from the cerebrum via a horizontal cut through the cerebral peduncles. After doing so, inspect the exposed inferior occipital and temporal cortices.**

*Comment:* The division of the posterior fossa structures from the cerebrum should be approximately at the level of, or just below, the red nuclei of the midbrain.

**Make serial coronal sections through the cerebrum. Make uniform sections from the anterior half then the posterior half of the cerebrum. Lay out the sections sequentially for examination.**

*Comment:* If the brain is sufficiently fixed, this may be done with the aid of a cutting guide that ensures uniformity of section thickness (usually 1 or 0.5 cm). If using such an aid, make the first section through the level of the mammillary bodies, dividing the cerebrum into anterior and posterior halves.

If the brain is insufficiently fixed to use a cutting guide, i.e. if examining the brain in the fresh state, place the brain on the cutting board, convexity side down, exposing the base of the brain. Take uniformly thick sections starting anteriorly and progressing posteriorly, laying each section out as you go. Aim to take a section through the mammillary bodies.

Ensure that you have oriented the sections correctly (i.e. left side of the brain on the left).

**Examine the laid out sections.**

**Pay specific attention to the cortical grey matter, the demarcation of the grey white interface, the cerebral white matter and the corpus callosum.**

**Observe the calibre and patency of the cerebral ventricles, and the structure of the deep grey nuclei and hippocampi.**

**Now turn your attention to the posterior fossa structures (cerebellum and brainstem).**

**Remove the cerebellum from the brainstem by sections through the cerebellar peduncles, taking care not to incise the brainstem.**

**Make serial transverse sections through the brainstem, laying out each section for examination.**



*Comment:* If laterality may be of importance, score one side of each section with a scalpel to indicate left or right.

**Make parasagittal sections through the cerebellar hemispheres, with a saggital section through the cerebellar vermis.**

**Commence in the midline and section outwards. Lay out the sections for examination.**

### 5.4.3 Opening the chest and abdomen

#### 5.4.3.1 The incision(s)

There are three main approaches to the incisions for the opening of the chest and abdomen. They are compared and contrasted in the table below:

<p><b>Single simple midline incision</b> from above the sternal notch (or higher on the neck) to the symphysis pubis.</p> <p><i>Not suitable if neck to be viewed post-autopsy.</i></p>	<p><b>Low ‘Y’ incision</b> from outer clavicles curving down to the upper sternum, and midline from the sternum bypassing the umbilicus to the left to terminate at the symphysis pubis.</p> <p>This incision can be even lower on the chest, commencing at the level of the axilla when perhaps the cervical organs are not to be removed.</p>	<p><b>High ‘Y’ incision</b> from lateral upper neck/mastoid processes, extending down the lateral neck to meet just below sternal notch, then midline incision, bypassing the umbilicus to the left, to terminate at the symphysis pubis.</p> <p><i>May require effort to obscure for post autopsy viewing.</i></p>
<p>Depending on how high on the neck the incision starts, part of the neck can be directly inspected during dissection. Unless incision commences immediately beneath the chin, some removal of the tongue and attachments from the mandible likely to be undertaken blindly. Overall, a less satisfactory exposure of the neck for a full forensic examination.</p>	<p>Subcutaneous dissection of the upper chest flap will allow visualisation of lower neck structures with difficulty. Not possible to actually dissect the neck structures in situ. They need to be removed by blindly dissecting (or incising) the upper neck structures from the overlying skin and blindly removing the tongue and attachments from the mandible. Overall, a much less satisfactory exposure of the neck for a full forensic examination, and liable to introduce artefact seriously compromising interpretation of neck findings.</p>	<p>This is the only method which allows full exposure of the neck structures and direct vision as it is dissected in layers and is the preferred method where the examination of the neck is of any importance.</p>

**5.4.3.2 Reflecting the skin and musculature of the trunk, opening the chest and abdomen and removing their organs**

<p><b>A block is placed between the scapulae on the back of the body.</b></p>
<p><b>The skin is reflected in the subcutaneous plane so that the chest flap is dissected to the posterior axillary line, and the abdominal flap dissected similarly (See Figure 10).</b></p> <p><i>Comment:</i> Dissecting in the subcutaneous plane, and not including the pectoral and abdominal wall musculature in this primary approach, allows evaluation of subcutaneous bruises and haemorrhage which will be missed if the primary dissection includes those muscles; small bruises will not be missed and the absence of bruising will be more thoroughly confirmed.</p>
<p><b>Pectoralis major is then dissected from its clavicular and costal origins, being left attached by its humeral tendon.</b></p> <p><i>Comment:</i> The costal origins of the external oblique and abdominis rectus muscles are reflected at the same time as this.</p>
<p><b>Pectoralis minor is then dissected from its costal attachments.</b></p> <p><i>Comment:</i> Further dissection of subcutaneous and other fat may be necessary to properly expose the sternum, ribs and intercostal muscles</p>
<p><b>Consider at this point whether dissection to evaluate the presence of a pneumothorax is necessary. This involves dissecting very carefully in an anterolateral intercostal space down to the pleura where, normally, provided there are not adhesions, one can see the lung immediately beneath the pleura (See Figure 11).</b></p> <p><b>If it is possible to have a chest X-ray taken, then this should be seriously considered if pneumothorax is suspected.</b></p> <p><i>Comment:</i> This dissection needs to be practised as it is quite easy to breach the pleura with a scalpel, or even with a blunt dissecting instrument making the assessment of pneumothorax impossible. An alternative approach (which can also follow direct inspection of the pleura as a confirmatory step) is to pool a little water between the chest skin flap and the ribs and penetrate, underwater, an intercostal space. If there is a pneumothorax, bubbles will escape, especially if at the same time the chest is slightly compressed by hand. <b>See Figure 11</b></p> <p>(An additional method of assessing pneumothorax is to inspect the domes of the diaphragm from their abdominal aspect and see if they are pushed inferiorly)</p>
<p><b>First using a scalpel to penetrate the abdominal wall, then using scissors, the abdominal wall is divided in the midline from the xiphisternum to the symphysis pubis.</b></p> <p><i>Comment:</i> If there is any risk of accidentally perforating abdominal viscera, then the scissors can be used together with the fingers of the other hand being used to raise the abdominal wall, and depress the abdominal contents, ahead of the points of the scissors, keeping them out of the way.</p>
<p><b>The abdominal wall on one side at the xiphisternum is grasped in forceps or by hand, and divided by scissors (or scalpel) from the costal margin; then the other side. This should continue as far laterally and posteriorly as possible to maximise the exposure.</b></p> <p><i>Comment:</i> At any point from when the peritoneal cavity is opened it may be necessary to collect ascites or haemorrhage for the purposes of assessing volume</p>

<p>and/or other purposes e.g. microbiological culture.</p>
<p><b>Likewise, the anterior abdominal wall is divided from the superior pubic ramus on each side.</b></p> <p><i>Comment:</i> An incision in the infero-lateral abdominal wall flap extending superiorly relaxes the flap and opens the abdominal cavity fully.</p>
<p><b>At this point, it will be useful to have a preliminary inspection of the peritoneal cavity. Now is the time to take photographs, swabs, or to collect samples of ascites or pus, if indicated.</b></p> <p><i>Comment:</i> In addition, if indicated, look for perforations or sources of haemorrhage. Palpate and inspect for any pathology that should be identified before continuing with the evisceration.</p>
<p><b>Subsequent dissection is facilitated by now removing the small and large bowel. Locate the emergence of the duodeno-jejunal junction into the peritoneum. Divide the mesentery and tie the jejunum in two places 3-4 cm apart. Divide the jejunum between the ties preparatory to removing the small and large bowel.</b></p> <p><i>Comment:</i> The removal of the small and large bowel serves to debulk the subsequent en-bloc removal, and enables better examination of the bowel.</p>
<p><b>Having done this on one side, repeat on the other.</b></p>
<p><b>About 1 cm from the bowel wall, divide the mesentery from the jejunum and then the ileum down to the ileo-caecal junction.</b></p> <p><b>Dividing the mesentery closer to its root in the posterior peritoneum is quicker but leaves the small bowel in loops which makes subsequent opening of the bowel more difficult and time consuming.</b></p> <p>With experience, this can be done by holding the scalpel (or scissors) so that the mesentery is gently pulled across the cutting edge by the other hand, drawing the bowel towards the place where it will rest awaiting later opening and inspection.</p>
<p><b>The ileo-caecal junction is then freed along with the ascending, transverse and descending colon, dividing the greater omentum as required (which can usually be done manually) at the same time.</b></p> <p><i>Comment:</i> Care needs to be taken in dividing the mesocolon in the region of the hepatic flexure and the spleen. Some divide the mesocolon of the descending colon leaving the splenic flexure for last, as it is easy to perforate the flexure and/or damage the spleen if one is not careful.</p>
<p><b>Divide the rectum.</b></p> <p><i>Comment:</i> The neatest way to do this is again to make two ties and divide the rectum between them. This reduces the amount of soiling.</p> <p>Following this, the remainder of the separation of the diaphragm can be undertaken manually by pulling on the free diaphragm with one hand and using the other hand to assist with dislodging the diaphragm from its more posterior attachments.</p>
<p><b>Collect urine via a needle and syringe through the dome of the bladder immediately behind the symphysis pubis.</b></p> <p><i>Comment:</i> If there is not much urine present, it may be necessary to open the bladder to collect the urine under direct inspection.</p> <p>If done sufficiently well, it should then be possible with relatively little extra</p>

dissection to remove the neck, chest and abdominal organs in continuity. Do not pull the organs out by holding the larynx and simply pulling. Hold the aorta and posterior mediastinal structures with one hand, and ease the remaining organs and tissues out using the other hand to remove them from the posterior abdominal wall by traction. Use a knife and scalpel to assist as required.

**Free the pelvic organs. The fingers of both hands are used to free the bladder from the symphysis pubis and in the same tissue plane the pelvic organs are separated from the pelvic wall, with the rectum being manually drawn anteriorly from the sacrum, often requiring both hands being used together.**

*Comment:* This is a manual process, thus care needs to be taken if there is any possibility of pelvic fractures being present as bony splinters can cause injury with the attendant risks of transmission of viral infections or sepsis.

**The pelvic organs can then be divided using a knife at the floor of the pelvis through the membranous urethra (then the vagina in females) and lower rectum.**

*Comment:* The pelvic organs should be freed to a point distal to the prostate, which can be palpated.

**Returning now to the chest, using a scalpel, divide the intercostal muscles along the line you will use to divide the costal cartilages or ribs.**

**Some people at this stage use a scalpel or short knife to divide the sterno-clavicular joint. This is followed by using bone cutters or a saw to divide the ribs, starting at the lower end of the rib cage. Others divide the ribs, and with the saw or bone cutters, divide the clavicle at about its mid-point.**

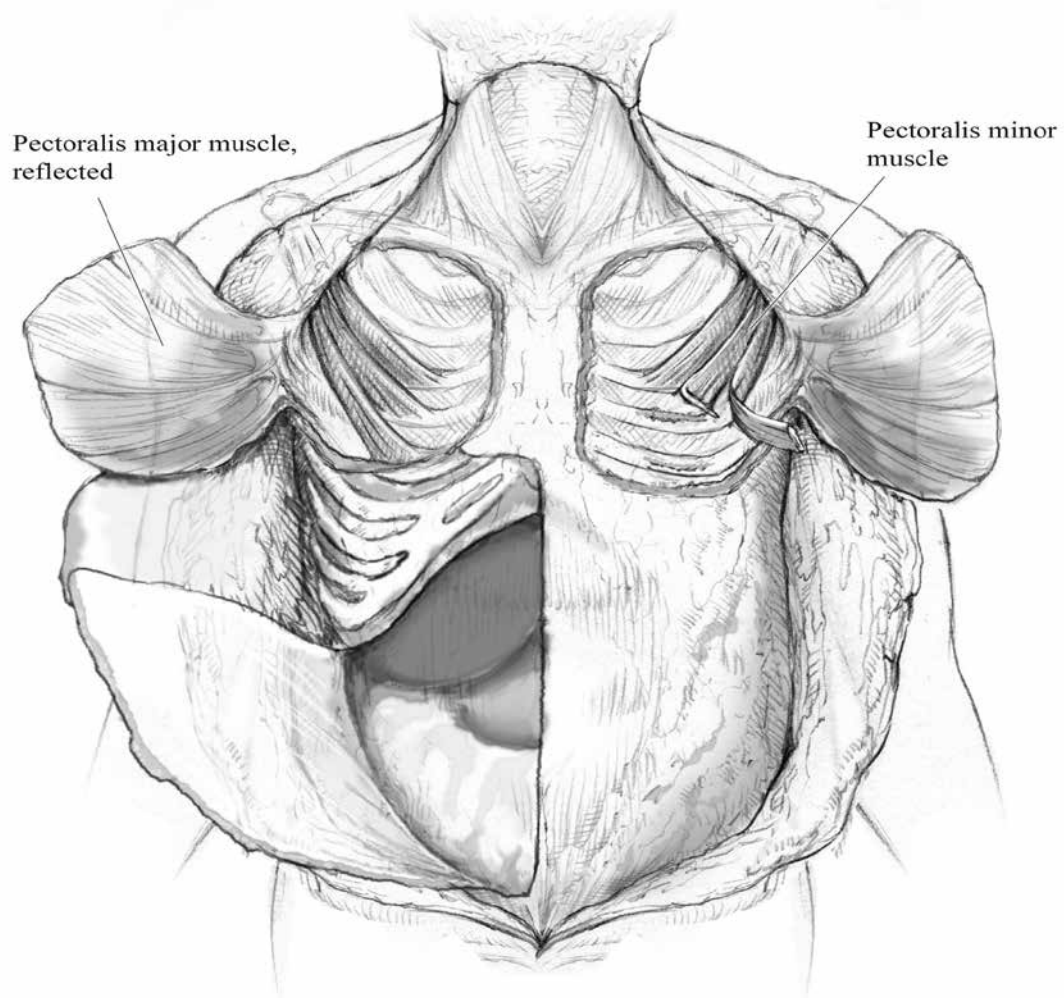
*Comment:* There is no particular merit in one or other approach, except that dividing the sterno-clavicular joint requires less effort and is less destructive.

**While pulling anteriorly on the divided central segment of the rib cage, the diaphragm is divided from the back of the segment inferiorly. Any adherent mediastinal tissues are also divided and the central segment is completely removed; additional tethering around the sterno-clavicular joints may need to be divided.**

*Comment:* Following this, the pleural cavities are inspected, as are the mediastinal contents.

Sampling is considered, and volumes measured. Measuring the volume of effusions or haemorrhage in the pleural cavities, and in the pericardial sac is a mandatory requirement.

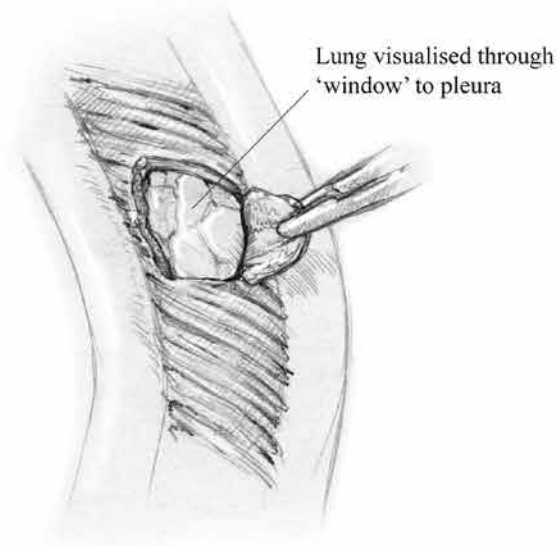
**Figure 10. Reflecting the skin and musculature of the trunk**



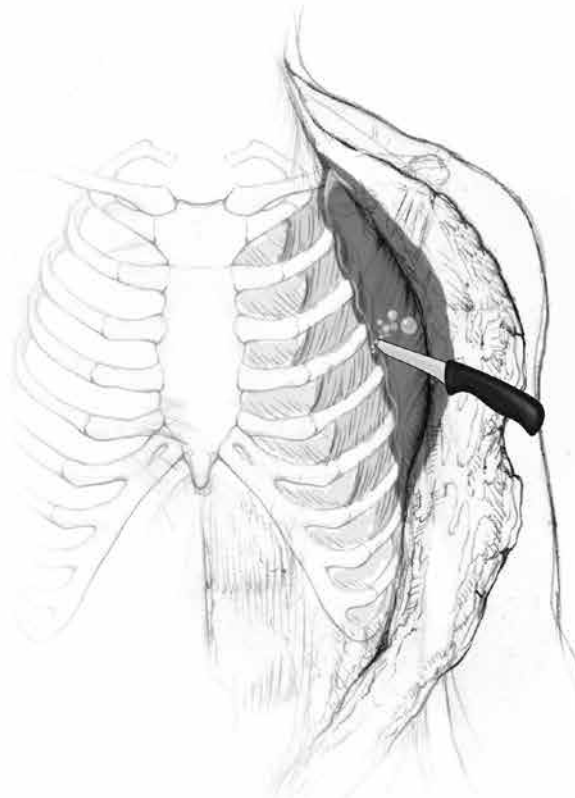
Reflecting the skin and musculature of the trunk

**Figure 11. Checking the pneumothorax**

Checking for pneumothorax



a Expose parietal pleura and see if there is space between it and underlying lung



b Pooling water between ribs and chest skin flap before penetrating pleural cavity to see if bubbles form from escaping air

### 5.4.3.3 Dissecting the neck

An early decision needs to be made whether the neck will be dissected in situ, layer by layer, or whether it will be removed in continuity with the chest and abdominal organs and dissected as part of the 'en bloc' process. There should be a low barrier to undertaking in situ dissection, as removal before dissection introduces artefact which may be indistinguishable in some cases from ante-mortem injury.

In situ dissection of the neck (See Figure 12)

<p><b>The head is opened first and the brain removed.</b></p> <p><i>Comment:</i> As mentioned above, this helps drain the neck of blood and reduces (but does not completely remove) the risk of artefactual haemorrhage occurring during the dissection.</p>
<p><b>The body should be resting on a block between the scapulae so that the neck is extended.</b></p> <p><i>Comment:</i> The resulting tension on the skin of the neck facilitates dissection.</p>
<p><b>A high 'Y' incision (see Figure 12) best facilitates this dissection, although lower incisions are possible (but less desirable from a technical point of view) if there is technical support to manually hold the upper chest flap while dissection is undertaken beneath it.</b></p> <p><i>Comment:</i> The high 'Y' incision means the best possible neck dissection can be undertaken by the pathologist alone without assistance.</p>
<p><b>The neck flap is then carefully dissected in the subcutaneous plane.</b></p> <p><i>Comment:</i> The platysma muscle can be included and left on the skin flap.</p>
<p><b>Consider also dividing the neck structures after their descent through the thoracic inlet. This will require the chest to already have been opened (see above).</b></p> <p><i>Comment:</i> This reduces to an absolute minimum the risk of artefact by further draining the neck of blood. A disadvantage of this manoeuvre is that the neck structures lose their anchorage and, with it, some of the ease of their dissection.</p>
<p><b>Dissect the remaining subcutaneous fat from the front of the neck to expose the underlying strap muscles.</b></p>
<p><b>Identify the sternal and clavicular heads of the sternocleidomastoid muscle; divide them and reflect the muscle to the edge of the field or up to the mastoid process.</b></p>
<p><b>Identify omo-hyoid muscle and dissect to the lateral edge of the field from the hyoid and the underlying neck structures.</b></p>
<p><b>Identify the individual strap muscles and reflect from below upwards: sterno-hyoid muscle, sterno-thyroid muscle. Identify and reflect thyro-hyoid muscle.</b></p>
<p><b>Divide the thyroid gland in the mid line and dissect from the underlying trachea, leaving it attached posteriorly.</b></p>
<p><b>Inspect the cricoid cartilage including crico-thyroid muscle.</b></p>
<p><b>Gently palpate the wings of the thyroid cartilage and its superior horns for fractures, and the hyoid bone as well.</b></p>
<p><b>Divide the tissues of the floor of the mouth from the inner aspect of the mandible exposing the base of the tongue.</b></p>

<p><i>Comment:</i> Sometimes the anterior tongue is tightly caught between the teeth by rigor mortis of the jaw. Take care in disengaging the tongue.</p>
<p><b>With fingers, or forceps, pull the anterior tongue inferiorly through the floor of the mouth to expose the roof of the mouth and naso-pharynx.</b></p>
<p><b>Divide the tissues in the retro-pharyngeal region on the front of the cervical spine, and dissect the pharyngeal tissues from the spine, pulling on the tongue at the same time to keep the area exposed and to keep tension/traction on the tissues to assist dissection.</b></p> <p><i>Comment:</i> There is a great temptation during this dissection to grab the neck structures around the thyroid cartilage and the hyoidbone region. This must not be allowed as the possibility exists of causing fractures of these structures.</p>
<p><b>Decide in advance whether or not to include the carotid arteries in this dissection, or whether to leave them attached to the retro-pharyngeal/para-oesophageal tissues. Dissect accordingly.</b></p> <p><i>Comment:</i> The carotid arteries are easily seen at this point and can either be left attached to the neck structures or not. They are probably more easily dissected if left in situ. If not opened for inspection, they are then available for embalming purposes if this is important.</p>
<p><b>In this way the neck structures are reflected to the thoracic inlet where they can be divided from the thoracic structures (or simply removed, if the thoracic structures have been previously divided).</b></p>

#### 5.4.3.4 Dissecting the organs of the chest (with neck structures attached) and abdomen

<p><b>Lie the organs of the chest and abdomen prone on the dissecting board with the neck structures closest to the prosector. The oesophagus and aorta are lying upper most.</b></p>
<p><b>Open the descending aorta from its distal arch down to, and open, each common iliac artery. Open each renal artery.</b></p>
<p><b>Dissect the opened descending thoracic aorta from its posterior mediastinal attachments.</b></p>
<p><b>Open the oesophagus from the superior posterior pharynx down about one quarter or one third of its length. At this point divide the oesophagus completely.</b></p> <p><i>Comment:</i> This is the last opportunity the pathologist has to separate the neck structures from the chest organs if necessary for later, separate, more detailed examination.</p>
<p><b>Dissect the remaining oesophagus from its posterior mediastinal attachments down to the oesophago gastric junction.</b></p> <p><i>Comment:</i> At this point, if it is anticipated that the gastric contents may be important, apply a clamp or tie the open upper end of the oesophagus with string, so that gastric contents are not lost.</p>
<p><b>Insert the long autopsy knife, blunt side upper most, between the diaphragm and the diaphragmatic surface of the lungs. When the blade contacts the inferior vena cava and the pericardial attachments to the diaphragm, turn the blade 180 degrees so the cutting edge is uppermost, and separate the thoracic</b></p>



<p><b>and abdominal organs.</b></p> <p><i>Comment:</i> This may first require division of any adhesions between the lung and the diaphragm. Take care to leave the pericardial sac intact.</p>
<p><b>Put the abdominal organs to one side.</b></p>
<p><b>Palpate gently the laryngeal structures for any fractures.</b></p> <p><i>Comment:</i> At this point, the pathologist must be sure that no further closer examination of the laryngeal skeleton will be necessary, because its integrity is about to be damaged for the purposes of the autopsy.</p>
<p><b>Open the trachea posteriorly using scissors to divide the posterior thyroid cartilage. Open the posterior main bronchi and their branches (See Figure 13).</b></p>
<p><b>Turn the chest organs over and open the pericardial sac.</b></p> <p><i>Comment:</i> Inspect the great vessels.</p>
<p><b>Open the right ventricle below the pulmonary valve and cut through it into the pulmonary trunk. Continue to open the right and left pulmonary artery. This involves dividing also the pulmonary arteries.</b></p>

#### 5.4.3.5 Dissection of the heart

<p><b>Examine the pericardium, open it, examine the pericardial space – note adhesions, note and measure the volume of any fluid.</b></p> <p><i>Comment:</i> It can be a difficult manoeuvre to collect, and therefore measure, all the contents of the pericardial space.</p>
<p><b>Assess the situs of the heart.</b></p> <p><i>Comment:</i> Situs is a term describing normality – the morphological right atrium actually being on the right, the morphological left atrium actually being on the left, the right atrium joining to a right ventricle which has a pulmonary arterial trunk, and the left atrium joining to a left ventricle with the aorta. There also should be concordance of the lungs with the morphological left lung actually being on the left and the morphological right lung being on the right.</p>
<p><b>Assess the anatomy of the great arteries and venous return to the heart.</b></p>
<p><b>Make a small nick in the upper anterior wall of the right ventricle, insert scissors and cut through the pulmonary valve into the pulmonary trunk and pulmonary arteries.</b></p> <p><i>Comment:</i> Unless the pathologist has his/her mind focused on the possibility of a pulmonary thrombo-embolus, it is possible for the embolus to slip unnoticed out of the pulmonary trunk, onto the dissecting table and be lost down into the sink and plug hole. Contrary to popular view, it can be difficult to distinguish, on occasions, pulmonary thrombo-embolism from post-mortem clot. It is important on every occasion to inspect the contents of the pulmonary trunk and arteries carefully.</p>
<p><b>To preserve the sino atrial node, transect the superior vena cava approximately 2cm above the point where it joins the right atrial appendage.</b></p>
<p><b>Transect the inferior vena cava at the diaphragm.</b></p> <p><i>Comment:</i> At this point the heart should be free from its attachments.</p>
<p><b>Open the right atrium from the IVC to the apex of the atrial appendage.</b></p>

<p><b>Open the left atrium from the pulmonary veins to the atrial appendage.</b></p>
<p><b>Inspect the atrium and the inter-atrial septum.</b></p> <p><i>Comment:</i> Determine if the foramen ovale is patent or not.</p>
<p><b>Examine the mitral and tricuspid valves from above.</b></p>
<p><b>Examine the aortic valve from above.</b></p>
<p><b>Examine the coronary arteries including:</b></p> <ul style="list-style-type: none"> <li>• noting the position and number of coronary ostia</li> <li>• assess the dominance of the left or right coronary arteries</li> <li>• transversely section the coronary arteries at 3mm intervals</li> <li>• assess bypass grafts with transverse sections if possible, paying particular attention to points of anastomosis</li> <li>• remove heavily calcified arteries intact and de-calcify prior to sectioning (calcification does not necessarily mean occlusion).</li> </ul> <p><i>Comment:</i> It takes time and experience to develop the most efficient manner of holding the heart while dissecting the coronary arteries. Let the heart hang from your hand; allow the weight of the heart to work for you by passively stretching the region of coronary artery you are incising. Start at the left anterior descending, and work backwards to the left main stem, before continuing down the remainder of the descending part.</p> <p>Segments of coronary artery with stents can be removed whole and, to assist with histological evaluation, the stents can be either dissolved using electrolysis, or embedded in resin and processed. If neither of these procedures is available, attempt to cut along the coronary artery to assess the endothelial aspect of the coronary artery and the stent.</p>
<p><b>Place the heart on its posterior surface on the cutting board, and make a transverse cut across the mid-ventricles.</b></p> <p><i>Comment:</i> Empty the heart of all blood clot.</p>
<p><b>Weigh the whole heart.</b></p> <p><i>Comment:</i> Assess against tables of normal heart weight related either to the height or weight of the deceased.</p>
<p><b>Make transverse parallel slices approximately 1cm apart towards the apex.</b></p> <p><i>Comment:</i> Examine for acute infarction, hypertrophy, scarring, thinning, fatty replacement, nodules, pericardial or endocardial thickening as well as papillary muscle abnormalities.</p>
<p><b>Measure wall thickness.</b></p> <p><i>Comment:</i> Inspect the endocardium, measure thickness of mid cavity free wall of the left ventricle, right ventricle and of the septum(excluding the trabeculae and epicardial fat).</p>
<p><b>Dissect the basal portion of the heart in the direction of blood flow.</b></p>
<p><b>Measure valve circumferences.</b></p> <p><i>Comment:</i> Note any changes to the papillary muscles, chordae tendinae.</p>
<p><b>Take histological sections.</b></p> <p><i>Comment:</i> Ideally take mapped sections of a single ‘donut’ of myocardium and multiple sections of coronary arteries. At the very least section right ventricle outflow tract, LV septum, anterior, lateral and posterior left ventricle.</p>

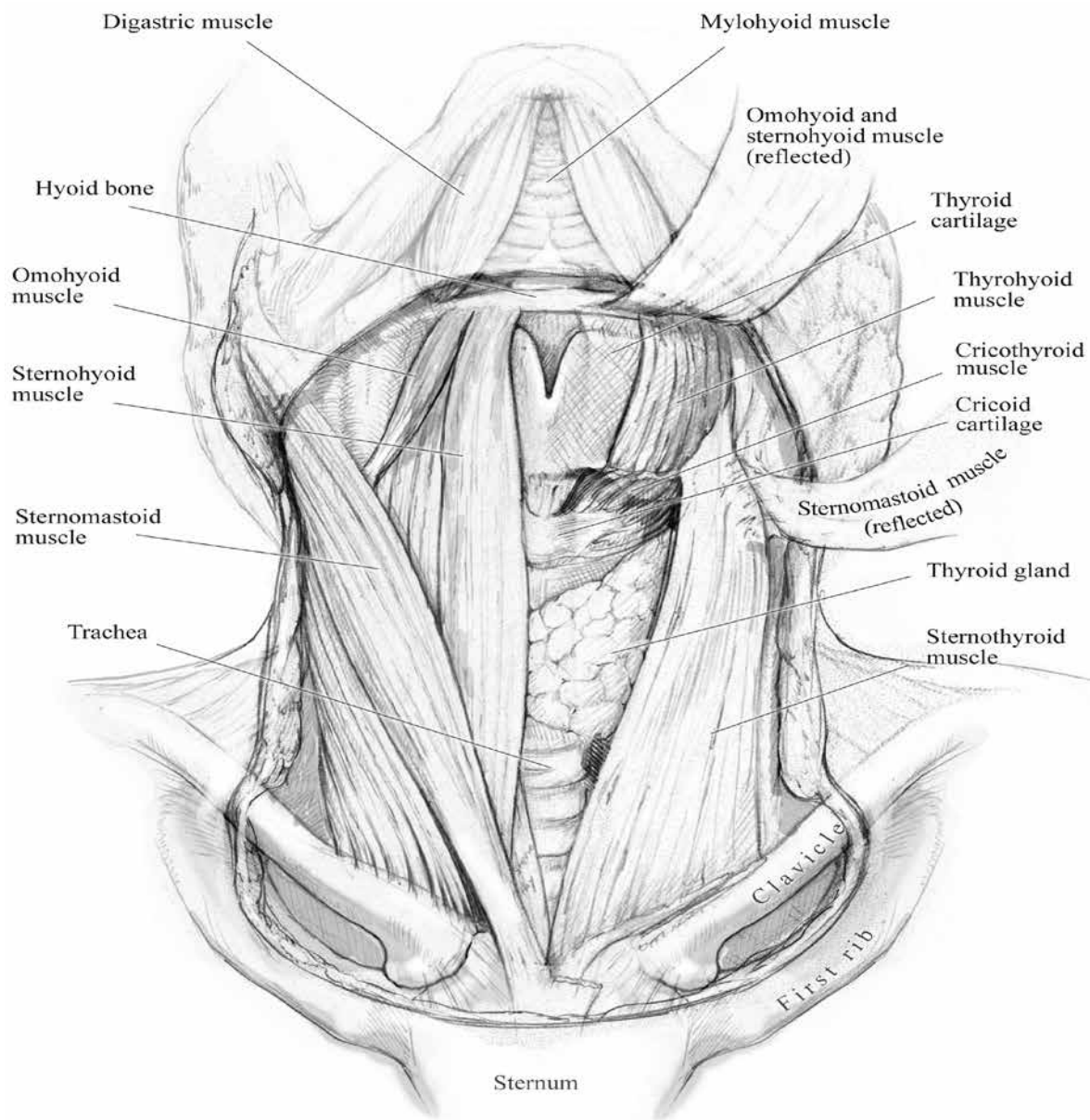
**In selected cases, consider sino-atrial (SA) and atrio-ventricular (AV) node dissection.**

*Comment:* These include cases where the cause of death may be unascertained, or cases where ECG changes suggest a conduction system defect.

**Examination of the SA node: This saddle shaped structure is located subepicardially within the terminal groove at the junction of the superior vena cava and the right atrial appendage. This entire area is removed, sliced, embedded and serially sectioned.**

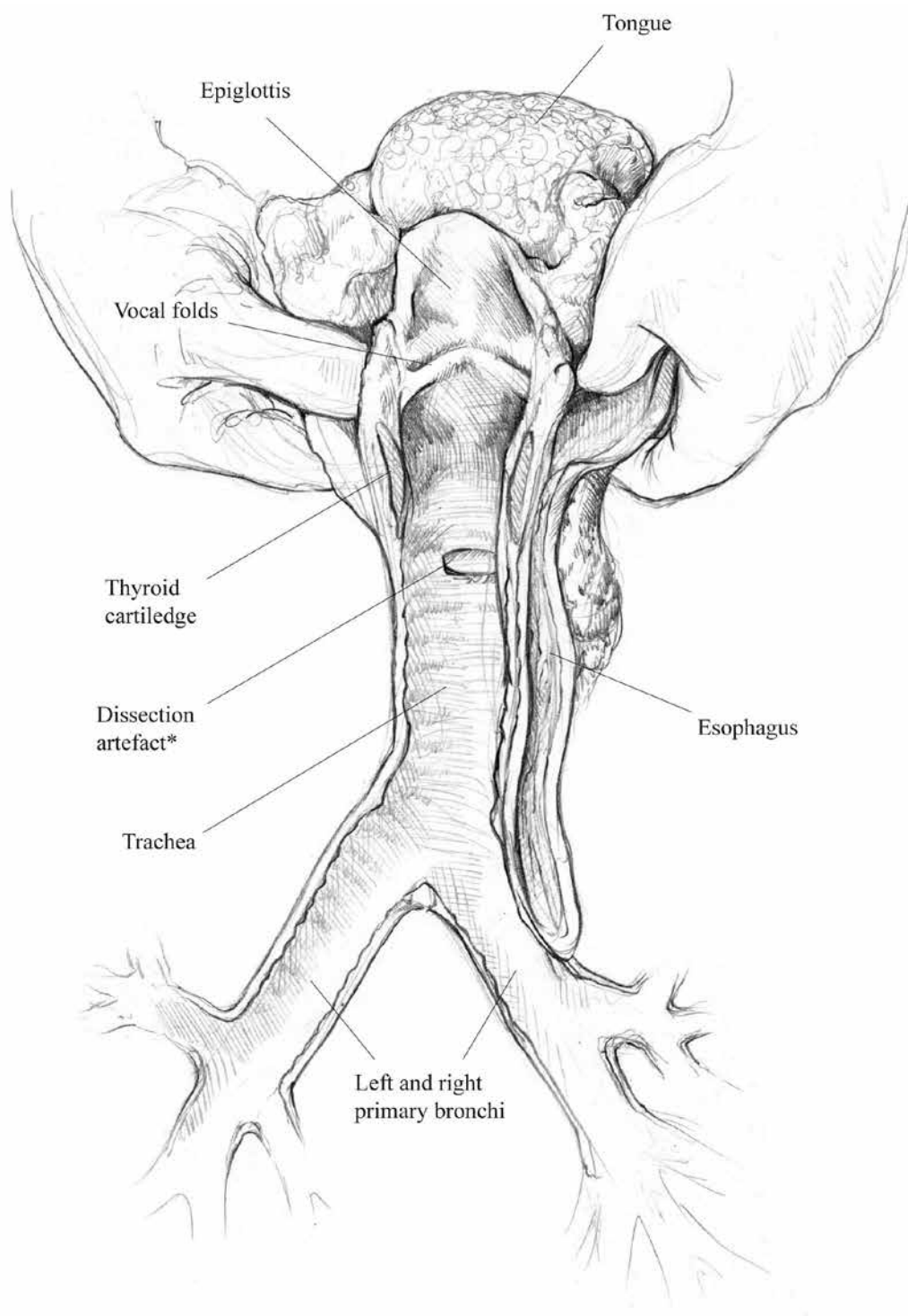
**Examination of the AV node: The AV node is contained within the triangle of Koch which lies between the opening of the coronary sinus and the septal leaflet of the tricuspid valve including the membranous septum. Dissect out this area, using these anatomical landmarks, slice, embed and serially section.**

**Figure 12. Structures of the neck**



Structures of the neck (skin and platysma reflected back, shaded gray)

Figure 13. Larynx, trachea and bronchi



Larynx, trachea and bronchi opened

\*created from anterior aspect prior to removal of neck and chest structures to assess positioning of the endotracheal tube before removing it.

5.4.3.6 Dissection of abdominal and pelvic organs and tissues.

<p><b>Lie the abdominal organs prone with the diaphragm facing you, the pelvic organs further away from you, and the retroperitoneum with its opened aorta uppermost.</b></p> <p><i>Comment:</i> Open the iliac arteries if not already opened.</p>
<p><b>Open the renal arteries. Identify the ostia of the superior and inferior mesenteric arteries and check the patency of the proximal portions of these vessels.</b></p>
<p><b>Open the inferior vena cava inferiorly from the diaphragmatic hiatus. Check the various tributaries, including hepatic, renal and iliac veins.</b></p>
<p><b>Find the adrenal glands and incise them transversely. From time to time it is necessary to dissect them free of their surrounding fat to weigh them.</b></p>
<p><b>Finely incise the capsule of the right kidney, with forceps begin removing it from the outer surface of the kidney; insert your finger or thumb between the capsule and the kidney and complete the task if possible.</b></p> <p><i>Comment:</i> Be careful of tense renal cysts which can easily release volumes of fluid under pressure during this manoeuvre causing splashes, even into the eyes (which should be protected by glasses, goggles or a face shield).</p>
<p><b>Do the same for the left kidney.</b></p>
<p><b>Identify and isolate the ureters tracing them down to their bladder insertions.</b></p>
<p><b>Release the kidneys by using scissors to cut across the renal pedicle and ureter.</b></p> <p><i>Comment:</i> Weigh the kidneys.</p>
<p><b>Turn the organs over. Open the stomach along the greater curvature and collect the stomach contents so they can be inspected, the volume measured, and if required, retained for toxicological analysis. Complete the opening of the stomach by continuing up the oesophagus, and distally, by opening the duodenum.</b></p> <p><i>Comment:</i> Collecting the stomach contents can be difficult. See 5.6.2.6 below.</p> <p>Once the stomach is empty, return it to the dissection board. Complete its opening. Assess the mucosal surface. Squeeze the gall bladder and see if bile is expressed into the duodenum through the ampulla.</p>
<p><b>Reflect the posterior wall of the stomach to expose the pancreas. Incise along the length of the pancreas.</b></p> <p><i>Comment:</i> Practise occasionally opening the pancreatic duct and trace its course.</p>
<p><b>Turn the liver so that the gall bladder bed is upper most. Identify the common bile duct, and using small dissection scissors, open it up to and along the hepatic duct, and down to the Ampulla of Vater.</b></p> <p><i>Comment:</i> Note the presence of lymph nodes, and incise them.</p>
<p><b>Open the gall bladder.</b></p> <p><i>Comment:</i> Note that some toxicology laboratories use bile. Consider collection of bile for toxicological analysis before opening it.</p>
<p><b>Detach the liver from its surrounding structures, including the diaphragm, and weigh it.</b></p>

<p><b>Remove the spleen and weigh it.</b></p>
<p><b>Move now down to the pelvic organs. Find the urethra and open it (thus dividing the prostate) and continue to open the bladder. Inspect and note the mucosa.</b></p> <p><i>Comment:</i> Note the presence and volume of urine.</p> <p>Incise and examine the prostate.</p>
<p><b>Palpate the uterus. Inspect the cervix, and open the uterus through the cervix to display it and the endometrial cavity. Identify the fallopian tubes and ovaries.</b></p> <p><i>Comment:</i> Incise and examine the ovaries.</p>
<p><b>The testes should be directly inspected by exposure through the inguinal canal.</b></p> <p><i>Comment:</i> The testes can thus be replaced in the intact scrotum after examination, and any histological sampling that is required.</p>

## 5.5 Female external genital and vaginal examination

### 5.5.1 Routine

This part of the forensic autopsy intersects with deeply ingrained cultural preferences, some of which are not shared by all in the community. On this topic, the view of the Palestinian pathologists in the editorial group was expressed as follows:

If the body is that of a married, divorced or widowed woman, then neither the hymen nor the anus is examined unless there is suspicion of sexual assault. The examination is limited to external observations by inspecting the genitalia externally and the perineum region, without setting apart the labia majora or taking vaginal or anal swabs.

If the body is that of an unidentified woman, or it is unknown whether or not she is married, or she is unmarried, then the hymen is inspected by setting apart the labia majora and the thighs. Further, the perineum region and the anus are examined.

The editorial group agreed unanimously that, taken in isolation in teenagers and adults, conclusions based on hymenal observations are not reliable indicators of sexual history. Thus, any conclusions about the deceased's sexual history based on observations of the hymen should be made with extreme caution. The group agreed that results of hymenal observations can be easily misunderstood or misused and when misunderstood or misused can result in injustice or wrongly impugn the reputation of the deceased. The group observed that in many cultures, because of the unreliability of the conclusions, no external genital or internal vaginal examination would be undertaken, unless there was suspicion of sexual assault. (Note, however, that part of the vagina immediately adjacent to the cervix is removed along with the other pelvic organs generally, as above, during the evisceration of the chest and abdominal organs).

### 5.5.2 Death resulting from or as part of sexual assault (sexual homicide)

Readers are advised to consult the UNODC publication *Sexual and Gender Based Violence* and apply the approaches set out there to the autopsy context. There is no reason why virtually the same approach should not be used. Note that if sexual assault is suspected, then this part of the examination would happen very early in the autopsy process.

The editorial group agreed that it is rarely, if ever, justified to remove the labia, vagina, perineum and/or anus at autopsy. It should be possible to make all the necessary observations, record them, and take any necessary samples without doing this. If it is to be done, the pathologist must be prepared to

justify it in public (e.g. in court). If it is considered necessary, the pathologist should seriously consider obtaining further authorisation for the dissection from the person authorising the autopsy.

## **5.6. Special Investigations**

Special investigations routinely result in additional samples and specimens which must be properly labelled and secured. Such procedures should be set out in detail in the mortuary's Quality Manual and Work Instructions.

### **5.6.1 Tissue**

#### **5.6.1.1 Large specimens**

Large organ and tissue specimens may be retained by the forensic pathologist because:

- it may enable better examination of an organ of particular importance in the case (e.g. the brain)
- it may require further examination by an expert, including one acting on instructions from an accused person
- it may be required as direct evidence

However, such retention must be in accordance with local law and ethical guidelines and take into account the family's wishes, including their preferences for disposal or burial of such organs and tissues. Organs should be stored in adequate volumes of formalin. Bone may have to be decalcified prior to further examination.

While practice will vary with regard to informing relatives about the retention, many forensic pathology organisations around the world over the last 25 years have experienced major public embarrassment when it became clear that they were retaining organs and tissues without the knowledge or consent of the family. The next of kin should be informed and preferably their consent obtained to the retention. If consent is not provided, and the retention is still regarded as being necessary, then formal authorisation of the retention should be obtained.

A plan for disposal of the organ should be in place at the time of its retention. Mortuaries should be very aware that without such plans and procedures to dispose of organs and tissues, they simply accumulate and it then becomes increasingly difficult to dispose of them respectfully. It is also difficult to justify the often large store of tissue when there is no systematic approach to proper examination and disposal as it appears disrespectful. Disposal includes incorporation into museum collections if the legally and ethically necessary consents have been obtained.

Large organs and tissue specimens are retained in 40% formalin. Organs and tissues should be covered by the formalin in buckets or containers that have room for the formalin to circulate around the entire specimen. Formaldehyde is a well known carcinogen, and its use requires special precautions. There should be formal procedures in place in the mortuary for this (e.g. appropriate personal protective equipment, including respirator mask). The retained organ being stored in formalin should be placed in a ventilated room set aside for the purpose.

#### **5.6.1.2 Histology**

Approaches to post-mortem histology vary. In some centres it is a routine mandatory part of every autopsy, while in others it is discretionary. This is in part a resource issue. However, if the reviewability of the autopsy is regarded as a primary principle underpinning the forensic autopsy, then histology will be routinely undertaken. In addition, histological evaluation will reveal findings not suspected macroscopically, or better characterise aspects of the macroscopic findings. Procedures for histology samples should be agreed with the histology laboratory. An efficient approach is to cut the



fresh tissue for histology at the time of the autopsy and place it directly into numbered cassettes, labelled also with the case number, record their contents at the time of autopsy, cover the individual cassettes securely, and place them into 10% formalin.

The tissue(s) placed in the cassette at the time of autopsy should be no larger than about postage stamp size and no thicker than 4mm to ensure adequate fixation. Certain tissue types such as bone and calcified blood vessels will have to be decalcified for optimal processing. Haematoxylin and eosin stains are routinely performed but special stains and immunohistochemistry may be performed if required.

This process has the added advantage of reducing to a minimum the tissue that is not returned to the body, thus reducing to a minimum the tissue stored in the mortuary that needs to be disposed of later. In addition, different coloured cassettes can be used for different purposes (e.g. yellow for tissues to be decalcified; blue for neuropathology specimens; white for routine sections; orange for homicides or suspicious deaths).

For particularly important histology sections it may still be necessary to cut the tissue after fixing in formalin. For some pathologists who are less comfortable with histology, the wet tissue is sent to the histology laboratory, and another pathologist undertakes the 'cut up'. This is not satisfactory if the person doing the cut up is not aware of the particular reasons why the tissue was retained, or of particular aspects that need to be represented in the section.

### **5.6.2 Toxicology (and Biochemistry)**

Blood, urine, vitreous humour, bile and/or liver are commonly sampled for toxicological analysis. Other samples include other organs, stomach contents, CSF, hair, nails and faeces. Contamination due to leakage from other structures, such as gastric or bowel contents, mucous, urine, pus or serous fluids is an inherent problem with the collection of blood/fluid from the body cavities; therefore samples from the cavities themselves should not be used, unless no other sample is available. Whatever the sample, its specific origin must be explicitly recorded so that there is no confusion whether, for example, a sample of blood is from a femoral vein, a ventricle, or the thoracic cavity.

When deaths have occurred in a hospital, it may be useful to obtain for toxicological analysis any specimens taken in the hospital for other diagnostic purposes. These samples will often have been taken closer to the time of the assault or poisoning episode. This will require urgent action immediately following the report of the death to avoid loss of such samples that are often rapidly discarded by hospital laboratories.

#### **5.6.2.1 Blood**

It is vital that, if toxicological analysis is contemplated, at least a sample of blood is collected at autopsy for possible testing. Blood provides the most direct evidence of a substance in the body and the results may allow an expert to infer its likely or possible pharmacological effects. The volume of blood collected should be about 10 ml and should be collected from a peripheral site, i.e. the leg or arm, wherever possible. Ideally this should be collected before the autopsy to avoid any contamination or changes in blood concentration due to artefacts. This can be performed by direct puncture of the skin, which does not seem to affect the quality of blood too much compared to isolating a blood vessel through dissection (Hargrove V, 2008).

To avoid post collection fermentation and putrefaction, add at least 1% w/v sodium fluoride (NaF) to the collection tube. NaF inhibits the enzyme enolase and thus serves as a preservative by preventing fermentation.

Larger peripheral blood volumes can be collected, however this will increase the risk of drawing blood from the abdominal or thoracic regions. Collection of blood from the heart or another central site is very likely to be severely contaminated with drugs diffusing from the gastrointestinal tract or

neighbouring organs (i.e. lungs, heart, stomach). Blood collected from a peripheral site is not immune to drug diffusion (known as redistribution), however it is likely to be substantially less than a central site (Pounder D et al, 1990; Drummer O, 2007).

Samples should be obtained during the early post-mortem period (i.e. before the onset of putrefaction). Blood obtained during this period should not show significant haemolysis.

In all cases the sample should be appropriately labelled. The basic information should include the following: name of the deceased, age, sex, hospital number (if applicable), body number, the date and time of collection and the sample site.

#### **5.6.2.2 Urine**

This is usually obtained by direct needle puncture of the exposed bladder after the abdomen has been opened. Alternately a Foley's catheter may be inserted via the urethra before the start of the autopsy (or if an autopsy is not to be performed). A wide variety of substances can be detected in the urine.

#### **5.6.2.3 Vitreous Humor**

The vitreous is an isolated pool of material suitable for many types of chemical analysis (e.g. estimation of ethanol, acetone, glucose, creatinine, urea, potassium, lactate, drugs). This isolation and its anatomically protected site (even in multi-trauma) means that the vitreous is less subject to contamination or putrefactive changes. Post-mortem biochemical changes generally occur more slowly than in other biochemical fluids.

The post-mortem specimen of vitreous humour is obtained by needle puncture of the globe. As the vitreous is relatively viscous, a 15 or 17 gauge needle should be used attached to a small volume syringe. The eyelids are firmly retracted and the needle inserted into the outer canthus at an angle of 45-60 degrees. The needle is directed to the centre of the globe. Gentle suction will allow about 2-3 ml of clear vitreous to be aspirated from each eye. A common error is to aspirate too forcefully disrupting the fragile structures of the retina contaminating the aspirate.

The aspirated eye tends to collapse and this may be disturbing to the relatives of the deceased. In order to remedy this, cosmetic restoration of the eyeball is easily achieved by leaving the needle in the eye after aspiration and replacing the lost volume with tap water and saline.

#### **5.6.2.4 Bile**

Analysis of bile may be useful in toxicological studies e.g. paracetamol and opiates. Bile is aspirated from the gall bladder before abdominal evisceration.

#### **5.6.2.5 Tissue**

Liver and muscle are the most common organ and tissue sampled for toxicological analysis. Other tissue samples may be taken in cases where specific toxicological studies are indicated by the history (e.g. putative skin site of insulin injection); or when the cause of death is not apparent; when toxicological studies are indicated but there is little or no body fluid/blood available for analysis (e.g. second autopsy or after exhumation); in the investigation of inborn errors of metabolism.

Other tissues that are sometimes submitted are kidney, brain, and adipose tissue. The samples should be placed in clean glass/plastic jars without a fixative. Formalin denatures proteins and thus affects the toxicological analysis. If undue delays are anticipated before transport to the laboratory or before the performance of the assays, the samples may need to be kept frozen. In cases of suspected volatile substance abuse an entire lung should be taken and sealed in a nylon (polythene/plastic bags are permeable to volatile substances) bag and submitted for analysis.

#### **5.6.2.6 Stomach contents**

The stomach contents are first isolated by clamping or by use of ligatures (of the lower oesophagus and pylorus) prior to removal from the stomach. The stomach should then be opened inside a large clean dish so that the contents are not contaminated. After describing the contents (volume, colour, consistency, odour, presence of blood, food, its stage of digestion, foreign materials including drugs, etc.) the total volume should be submitted for toxicological analysis after consultation with the analyst.

#### **5.6.2.7 Cerebrospinal Fluid (CSF)**

Collection of CSF by lumbar puncture at autopsy is difficult. It is easier to obtain a sample by cisternal puncture (under direct vision in the posterior fossa or by percutaneous aspiration). The latter is accomplished by flexing the neck, piercing the atlanto-occipital membrane directing the needle in the direction of the bridge of the nose. At a depth of about 2 cm there will be a loss of resistance and CSF can easily be aspirated. An alternative technique is to insert a needle into the spinal theca via the spinal foramina between the first and second lumbar vertebrae after anterior evisceration.

CSF is rarely used because it is more difficult to collect than blood, it is difficult to obtain free of blood and other contaminants, direct comparison with ante-mortem blood biochemistry is difficult because of differences in water and protein concentration and the effects of the blood-brain barrier, and the concentrations of the analytes may vary at different levels of the spine.

#### **5.6.2.8 Hair and fingernails**

Hair and fingernails may be used in cases of heavy metal poisoning or certain drugs. The hair sample should be obtained by plucking, which includes the root, and not by cutting with scissors. Nail samples should also be sent whole, easily achieved by using an artery forceps and removing the nail from the nail bed.

### **5.6.3 Microbiology**

Microbiological examination of post-mortem tissues and fluids is not a routine investigation in an autopsy. The main problems are:

- Inappropriate technique leading to contamination from mortuary personnel, the environment and other compartments of the body of the deceased
- Normal body flora may be difficult to distinguish from organisms causing infection/disease
- The selection of appropriate cases for investigation

To minimise artefacts, the body should be cooled to 4°C as soon as possible after death. Ideally, samples should be taken as soon as possible after death to minimise the effects of post-mortem bacterial invasion. Longer post-mortem periods are not necessarily a contra-indication for post-mortem microbiology; however, care must be exercised in the interpretation of results. Close cooperation with an interested microbiologist who has developed experience in the interpretation of post-mortem results is helpful in this regard.

Samples:

- Close interaction with the local microbiologist with regards to the type of sample would be useful
- Blood should be taken using a sterile needle and syringe from the femoral vein or artery before dissection or samples may be obtained under direct vision from the relevant blood vessels

- Sampling of a small piece of tissue, or tissue aspirates or swabs of tissues/organs may be submitted for smears and culture. The organ to be sampled should be raised by the technician to avoid contamination. It is also helpful to keep your gloves dry to avoid dripping and contamination of the area to be sampled. A 2x2 cm area on the surface should then be seared to dryness with either a flat-faced soldering iron or a flat metal object (spatula) made red-hot over a Bunsen burner. A sterile scalpel blade is then used to incise the seared area and a swab or needle is inserted into the tissue and a specimen obtained. Alternately a 1 cubic centimetre portion of tissue is removed and submitted
- The specimen should be taken to the microbiology laboratory without undue delay. If delays in transport are anticipated, the specimen should be kept in a refrigerator until transfer.

In spite of problems in the collection of specimens and interpretation of results, post mortem microbiology is a useful investigation in some circumstances. These include the investigation of clinically suspected infections; patients dying with fevers of unknown origin; determination of the development of antibiotic resistance; the investigation of deaths with organ changes of infection; patients who are immunocompromised (e.g. HIV infection, post transplantation); and the investigation of sudden unexpected deaths in children and adults. Alert forensic pathologists have often been at the forefront in identifying infectious threats to public health.

## **5.6.4 Other**

### **5.6.4.1 Entomology**

Larvae of flies and beetles, as well as adult insects and other invertebrates may be collected from a decomposing body. They could be used to estimate the minimum post-mortem interval and/or potentially determine the place of death if the body has been moved some distance after death. Larval samples can also be used for toxicological analysis.

Collection of samples depends on the test required.

For toxicological analysis:

- The larvae should be collected in a clean container and refrigerated as soon as possible. Some toxicologists may prefer the samples to be frozen. This should be discussed with the laboratory.

For entomological analysis:

- It is essential to liaise with an entomologist as soon as possible. Maggots should be fixed in hot water (ideally from a boiled kettle) and then transferred to 70-80% ethanol for preservation. Never use formalin, and never transfer maggots straight to alcohol without hot water fixation.
- Adult insects and insect eggs can be placed directly into 70-80% ethanol.
- A duplicate live sample of maggots or eggs (half of the live maggots or eggs) should be collected into a ventilated container to allow them to breathe. A surgical mask secured by a rubber band can be used to make the container breathable. Never use gauze as maggots can escape through the holes. Place a small amount of paper towelling moistened with tap water into the container to stop the maggots or eggs from dehydrating. Refrigerate them immediately pending transport to the entomologist.
- A full entomological analysis will also require samples from the scene.
- Label entomological samples in pencil (ink can be dissolved by alcohol) with the date and time that they were collected, and transport them to the entomologist, preferably within 24 hours of collection.

#### 5.6.4.2 Radiology

Plain post-mortem radiology may be useful for discovering and recording fractures, especially in areas of the body not routinely accessed during autopsy. In addition, it can be used to:

- Confirm the pathological presence of gas, usually air, e.g. pneumothorax, subcutaneous emphysema, air embolism;
- Confirm the position of endotracheal tubes, CVP and Swan-Ganz catheters, tube thoracostomies and nasogastric tubes;
- Detect or confirm the presence of foreign objects such as bullets and shrapnel
- Diagnose diseases like tuberculosis and bone diseases such as rickets, osteomalacia, osteoporosis, hyperparathyroidism, Paget's disease of bone, and metastatic disease in bone
- Angiographically demonstrate disease/injury to the coronary, vertebral, pulmonary and cerebral arteries
- Demonstrate congenital abnormalities (e.g. gyral abnormalities) and pathological lesions/injuries (e.g. infarction, hypoxic lesions, haemorrhages, penetrating wounds) in the central nervous system by use of CT and MRI
- In thallium poisoning, see radio-opaque material in the liver and intestines
- Assist with establishing identity
- Serve as a permanent record

The use of CT and MRI scanning in post-mortem investigations is being defined in a number of centres around the world. It will be quite some time before these become routinely available, even in wealthier settings.

#### 5.6.4.3 Molecular testing/Genetic testing

Splenic tissue is one of the best organs for DNA recovery, though liver, muscle, kidney and brain may also be used. At least two grams of tissue should be placed in a plastic tube without fixative or preservative. The specimen may then be frozen if not to be used immediately. In decomposed or skeletonised cases, a sample of bone may be submitted, often the head or part of the shaft of the femur. Techniques using less invasive samples such as cartilage, phalanges and finger or toenails have been developed in some centres.

#### 5.6.4.4 Macroscopic dye techniques

Macroscopic dye techniques are performed not primarily for diagnosis but for making lesions clearly visible for demonstration purposes. These purposes are detailed below.

##### **Amyloid**

Gross amyloid deposition in an organ produces a firm texture and a 'glassy' (waxy) cut surface in most cases. To show up the amyloid more clearly, Lugol's iodine is applied to the organs or a thin slice is immersed in Lugol's iodine. The presence of amyloid is revealed by a dark brown colour [Hint: use a slice of the corresponding organ from another autopsy as a negative control].

##### **Iron (haemosiderin)**

Take a thin slice of tissue from an organ such as the liver, spleen or heart and immerse it in a container of the reagent (Perl's Prussian Blue reaction). Ferric iron produces a blue staining.

##### **Fat (atheroma)**

The fat in atheromatous plaques may be stained with the Sudan IV method to produce a red reaction, which is useful for demonstration purposes.

### **Calcium**

Calcium deposits may be made visible using the Alizarin red S method. This may be used to show calcium in ageing vessels. This stain is also useful in demonstrating the fetal skeleton (as a museum specimen), after evisceration and a clearing stage (see Chapard et al.).

### **Demonstration of early myocardial infarction**

The demonstration of early myocardial infarction is hampered by the fact that macroscopic changes are only visible if the infarct is more than about 24 hours old. To overcome this problem enzyme techniques have been developed. The test depends on the fact that enzymes diffuse out of the ischaemic muscle so that differential gross staining between damaged and normal muscle can be shown. This test is best done within 12 hours of death as the enzyme activity in the unaffected myocardium also decreases with increasing time after death. In the Nitro-BT dye test, normal myocardium stains blue-purple and the ischaemic myocardium is unstained. The earliest lesions detected by this technique are about 8 hours old. The triphenyltetrazolium chloride (TTC) test is said to be more sensitive than the Nitro-BT test and works on the same principle (Ludwig J, 1972).

### **Carbon monoxide/carboxyhaemoglobin (COHb) detection.**

It is a common mortuary experience that the pinkish cherry red colour of COHb from a deceased with significant levels of COHb resists denaturation when placed in formalin or a denaturing agent such as cleaning agents often easily available in mortuaries. Normal haemoglobin becomes brown on contact with formalin or such agents.

## 6. SPECIAL TECHNIQUES

### 6.1 Spinal cord removal

<p><b>Anterior approach:</b></p> <p><i>Comment:</i> This approach is generally preferred as it involves no additional external incisions at the autopsy</p>
<p><b>After removal of the brain and stripping of the dura from the base of the skull, free the dura around the foramen magnum circumferentially by holding the dura with toothed forceps and stripping from the inner and upper cervical canal.</b></p> <p><i>Comment:</i> This may require the assistance of a scalpel.</p>
<p><b>Once all the organs of the neck and trunk have been removed, the paravertebral muscles are dissected from the cervical and lumbar vertebrae, and the parietal pleura is stripped from the para-thoracic vertebral regions.</b></p>
<p><b>The saw is used to saw through the pedicles of the lumbar vertebrae by placing the blade just anterior to the lumbar nerve roots. Continue this process inferiorly and after releasing the pedicles of the 5th lumbar vertebra, a deep oblique cut is made through the sacrum.</b></p> <p><i>Comment:</i> In the thoracic region, the saw cut is more oblique than in the lumbar region, and in the cervical region, the cut is almost vertical. The saw cut is continued right up to the base of the skull.</p>
<p><b>The vertebral bodies are lifted from the canal revealing the anterior surface of the spinal cord.</b></p> <p><i>Comment:</i> Any adhesions can be divided.</p>
<p><b>The cord is removed within the dura (i.e. the dura remains attached to the cord) by holding the dura with forceps and releasing the nerve roots external to the dura.</b></p> <p><i>Comment:</i> Avoid angulating the cord.</p>
<p><b>After the cord enclosed in dura has been removed, the dura is opened anteriorly and posteriorly then placed in 40% formalin around the rim of a bucket which, very often, also contains the brain from the same case.</b></p>
<p><b>Posterior approach:</b></p>
<p><b>Incise the length of the trunk posteriorly from the base of the skull to the sacrum in the midline. Reflect the skin subcutaneously on both sides.</b></p>
<p><b>The long back muscles are reflected laterally from the laminae of the vertebrae exposing the vertebrae.</b></p>
<p><b>The laminar processes on both sides are divided with the saw.</b></p>
<p><b>Bone shears are used to lift the segments off the vertebrae exposing the dura of the cord.</b></p>
<p><b>The nerve roots are divided with a scalpel. The ligaments tethering the dura to the periosteum in the superior cervical canal are divided.</b></p>
<p><b>The cord is then removed within its dura, care being taken to avoid acute bending or angulation of the cord.</b></p>

## 6.2 Cervical spine removal

<b>This will require a ‘high Y’ incision extending up behind the ears with the skin of the front of the neck reflected over the chin to ensure adequate exposure of the cervical spine.</b>
<b>After removal of the neck structures, the paravertebral muscles anteriorly are dissected from the cervical vertebrae.</b>
<b>Using the saw, cut through the body of the first thoracic vertebra and through the head of the first rib on either side.</b>
<b>After brain removal the blade of the power saw is passed through the base of the skull surrounding the foramen magnum in a square shape.</b> <i>Comment:</i> This should loosen the cervical column. A scalpel is used to divide the muscles and tissues holding the spine in the neck, including posteriorly.
<b>The vertebral column is removed, X-rayed if necessary (taking care to label right and left sides) and then it is placed in 40% formalin.</b>

## 6.3 Dissection and inspection of the vertebral arteries

<b>Angiography – in situ</b>
<b>When removing the structures of the neck, ensure a good length of the thoracic portion of the vertebral arteries are left for cannulation.</b> <i>Comment:</i> Ensure you know where the vertebral arteries arise from the supero-posterior aspect of the first part of the subclavian artery and its course to the transverse process of the 7th cervical vertebra.
<b>With the calvarium removed and dura reflected, inspect the base of the brain including the brainstem and ligate the basilar artery by passing a curved needle beneath it, close to the junction with the vertebral arteries.</b> <i>Comment:</i> This procedure can also be undertaken on the removed cervical spine, which also includes the brain stem and cerebellum. Care needs to be taken to not damage the vertebral arteries as they pass around the transverse processes of C2.
<b>Replace the calvarium and secure it with a safety pin.</b>
<b>Insert cannulae into the origins of both vertebral arteries and secure them with string ties.</b>
<b>X-ray the cervical spine in situ both AP and lateral views to ensure correct exposure.</b> <i>Comment:</i> Radiographic guidelines are: AP – 20 degree tilt with buckey, 100mA, 80kV, 0.8 seconds; Lateral view – 100mA, 70kV, 0.4 seconds with grid.
<b>5 mls of contrast medium diluted in water to 0.5% are injected into one vertebral artery.</b> <i>Comment:</i> Because the basilar artery has been ligated, the contrast medium is directed down the other vertebral artery and should appear at its thoracic origin.
<b>Repeat the X-rays.</b>
<b>Dissection</b>
<b>Bone scissors should be used to divide the anterior aspects of the vertebral</b>



<p><b>foramina of C7-C3 inclusive.</b></p> <p><i>Comment:</i> If the opportunity is available, angiography is strongly recommended to be done prior to dissection.</p>
<p><b>From C3, a chisel is directed upwards and laterally to pursue the sinuous course of the artery.</b></p> <p><i>Comment:</i> The vertebral artery has strong fibrous attachments in this area which need to be carefully visualised.</p>
<p><b>From above, chisel away the posterior process of the superior articular surface of the atlas.</b></p> <p><i>Comment:</i> This will expose the vertebral artery which can then be dissected free from the dura down to the transverse process of the atlas. Close inspection, description, photography and histological sampling can then proceed.</p>

## 6.4 Facial dissection

It is possible to directly inspect the inner aspects of the lips, the upper and lower frenula and some anterior teeth without a facial dissection, but not much more. Where a full characterisation of all the injuries (or lack of injury) to the face is important, a facial dissection is required. The need for such a dissection requires anticipation, as a high ‘Y’ incision is needed. The external aspect of the face is not incised in this procedure.

<p><b>The high ‘Y’ incision usually has the neck flap raised to the level of the submandibular region.</b></p> <p><i>Comment:</i> The aim of this dissection is to turn the neck flap into a neck and face flap. When this is done well, the flap can be returned and the facial features restored.</p>
<p><b>Grasp the neck flap firmly in one hand, and with a scalpel continue the dissection of the flap from the submandibular tissues and the mandible itself.</b></p> <p><i>Comment:</i> Be particularly careful at the anterior mandible as it is easy to perforate the skin at this point.</p>
<p><b>Divide the flap from the mandible at the junction of the inner lower lips with the mandible. Continue this division so that the entire inner lips and gingivae are separated from the mandible and maxilla.</b></p> <p><i>Comment:</i> Dissect sufficiently superficially to leave the parotid gland and masseter muscles intact.</p>
<p><b>Continue the dissection upwards to the upper part of the zygomatic arch and also the external auditory canal can be divided.</b></p> <p><i>Comment:</i> If photography is to be considered, ensure that as little extraneous background as possible is included, as this dissection is very distressing for lay people to view.</p>

## 6.5 Dissection to facilitate dental examination for identification

The above facial dissection is the preferred approach to assisting with a full forensic odontological examination. In rare cases, the condition of the body does not permit such a dissection, for example

where there is extensive incineration. Because direct inspection of the dentition of the upper and/or lower jaws is an essential step for collecting post-mortem data for identification purposes, an approach to achieve this needs to be agreed by both the pathologist and the odontologist. Approaches that involve the separation of the jaws from the body are to be avoided. Such extensive dissection is not necessary, and where there are multiple fatalities, creates the opportunity for the mandibles to be associated with or returned to the wrong body.

## 6.6 Dissection possibly required in a maternal death

Reduction of maternal mortality is one of the WHO/UNICEF common goals for the health of women and children. At present, globally, there are some 585,000 maternal deaths each year, 99% of them in developing countries. Most maternal deaths could be prevented if women had access to basic medical care during pregnancy, childbirth and the postpartum period.

Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (Dada, M. 2001).

The standard autopsy procedure should be followed remembering that some complications of pregnancy are either unique or unusual. These include:

- air embolism
- amniotic fluid embolism
- dissecting aneurysms of the aorta or coronary arteries or local aneurysms of mesenteric, splenic, hepatic, uterine or ovarian arteries
- aspiration of gastric contents
- perforations of the uterus and even intestines in cases of abortion
- trauma to the bladder and urethra
- trauma and tears to the external and internal genitalia
- disseminated intravascular coagulation
- septicaemia
- pre-eclampsia, eclampsia and hypertension
- placental infarction, retroplacental haemorrhage
- acute fatty liver of pregnancy

Routine sections should be taken for histological assessment. In addition, blocks from any abnormal tissue found at autopsy, the pituitary, right and left ovaries, right and left fallopian tubes, placental site of attachment in the uterus, cervix and placental tissue itself should be taken (Dada M, 2001).

## 6.7 Extended subcutaneous dissection

Many bruises may not be visible externally. There could be many bruises present which are not visible on or through the skin. Just because no bruises are visible externally does *not* mean that there are no bruises. The bruises observed on external examination may not be all the bruises that are in fact present. To discover the true state of affairs in relation to bruises, extended subcutaneous dissection may be required. This dissection is important when indicated and on occasions should be mandatory (e.g. death in custody, torture, some homicides and suspicious deaths). Because it is capable of being

regarded as disfiguring, the dissection needs to be justified on each occasion when it is undertaken. Sometimes confirming the absence of injuries is the justification. In some jurisdictions, special authorisation may be required. If there is any doubt, authorisation should be sought.

<p><b>The area(s) to be inspected by this dissection need to be decided.</b></p> <p><i>Comment:</i> The need most commonly arises to discover bruises possibly not visible externally on the arms, legs or back, including the back of the neck and buttocks.</p>
<p><b>To inspect the subcutaneous layer of the arms, an incision down their outer aspect can be made and subcutaneous dissection involving the circumference of the arm can then be made with no further incisions.</b></p> <p><i>Comment:</i> Sometimes it may also be necessary to incise the inner aspect of the arms. The outer arm incision can be extended to the back of the wrist, where the incision divides into two, one extending towards the 5th metacarpo-phalangeal joint, the other to the 2nd metacarpo-phalangeal joint. The subcutaneous plane of the back of the hand can then be dissected and inspected.</p>
<p><b>The same approach can be taken to the legs.</b></p>
<p><b>In relation to the back, a midline incision can be made from the spine of the 7th cervical vertebra down to the level of the buttocks and the subcutaneous plane dissected on both sides from here.</b></p> <p><i>Comment:</i> If necessary the incision can be extended over the mid region of each buttock.</p>

## 6.8 Removal of the eyes

As with subcutaneous dissection, this procedure must be absolutely justified every time it is undertaken. It may be necessary to justify this in public, for example in court. The main requirement for close examination of eyes in forensic pathology is in cases of paediatric head injury where the assessment of retinal haemorrhage has become important in cases of possible inflicted head trauma. In addition, removal may be necessary for corneal donation for transplantation. It is good practice whenever the eyes are removed to replace them with a prosthetic eye, usually on top of cotton wool packing within the orbit.

<p><b>From above</b></p>
<p><b>Remove the roof of the orbit with bone clippers perhaps with help from a chisel.</b></p> <p><i>Comment:</i> Obviously, this requires removal of the brain first.</p>
<p><b>The orbital contents are exposed, and the eye itself is carefully dissected from its surrounding soft tissue using a scalpel. It is then drawn up through the defect in the orbital roof.</b></p>
<p><b>From in front</b></p>
<p><b>Carefully lift the eyelids clear of the eyeball, slowly and carefully dissect the sclera away from its surrounding tissues.</b></p>
<p><b>The rectus muscles and the optic nerve need to be divided around the side of the eye.</b></p>

## 7. RECONSTRUCTION OF THE REMAINS

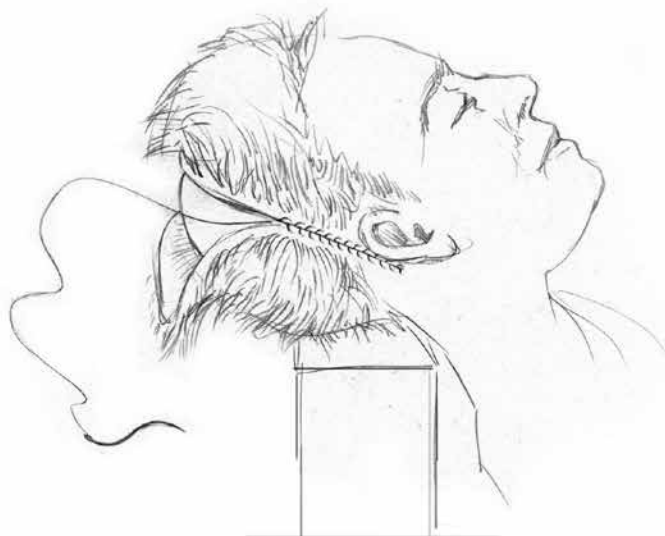
The reconstruction process is the most dangerous time for needle stick injury for the autopsy technician. The aim is to return the body to a state where, if at all possible, it can be viewed by relatives and friends without it necessarily being obvious that there has been an autopsy. Essentially this means a viewing of the face. See Figure 14 and Figure 15.

<b>The Head:</b>
<b>Using a towel, remove all fluids from the cranial cavity.</b>
<b>Cotton wool or similarly absorbent material is used to plug the spinal canal to prevent leakage of fluid into the cranial cavity.</b>
<b>Cotton wool or similarly absorbent material is used to fill the cranial cavity.</b>
<b>The skull cap is put in place ensuring it fits snugly around the material.</b>
<b>Temporal muscles can be reattached/reassociated to help stabilise/secure the skull cap.</b>
<b>The scalp is pulled back over the cranium.</b>
<b>After combing the hair out of the way, small blanket stitches are used to sew the scalp into place ensuring the stitches are tight and no hair is caught in any stitches.</b>
<b>The Trunk:</b>
<b>Using a cup or scoop and a towel, clear body fluids from the cavity of the trunk.</b>
<b>All organs and body tissues are placed in a large plastic bag which is sealed with a knot and placed in the body cavity.</b>
<b>The sternum and attached ribs are replaced.</b>
<b>A roll of cotton wool or similar material is used to replace the neck structures to ensure this appears as natural as possible.</b>
<b>Cotton wool or similar material is used to fill the pelvic cavity to prevent leakage from the body orifices.</b>
<b>The incision vertically down the trunk is then sewn together using a blanket stitch.</b>
<b>The body is then washed and dried, covered with a sheet, and with its clothing, returned to the body store.</b>

**Figure 14. Reconstruction of the head**

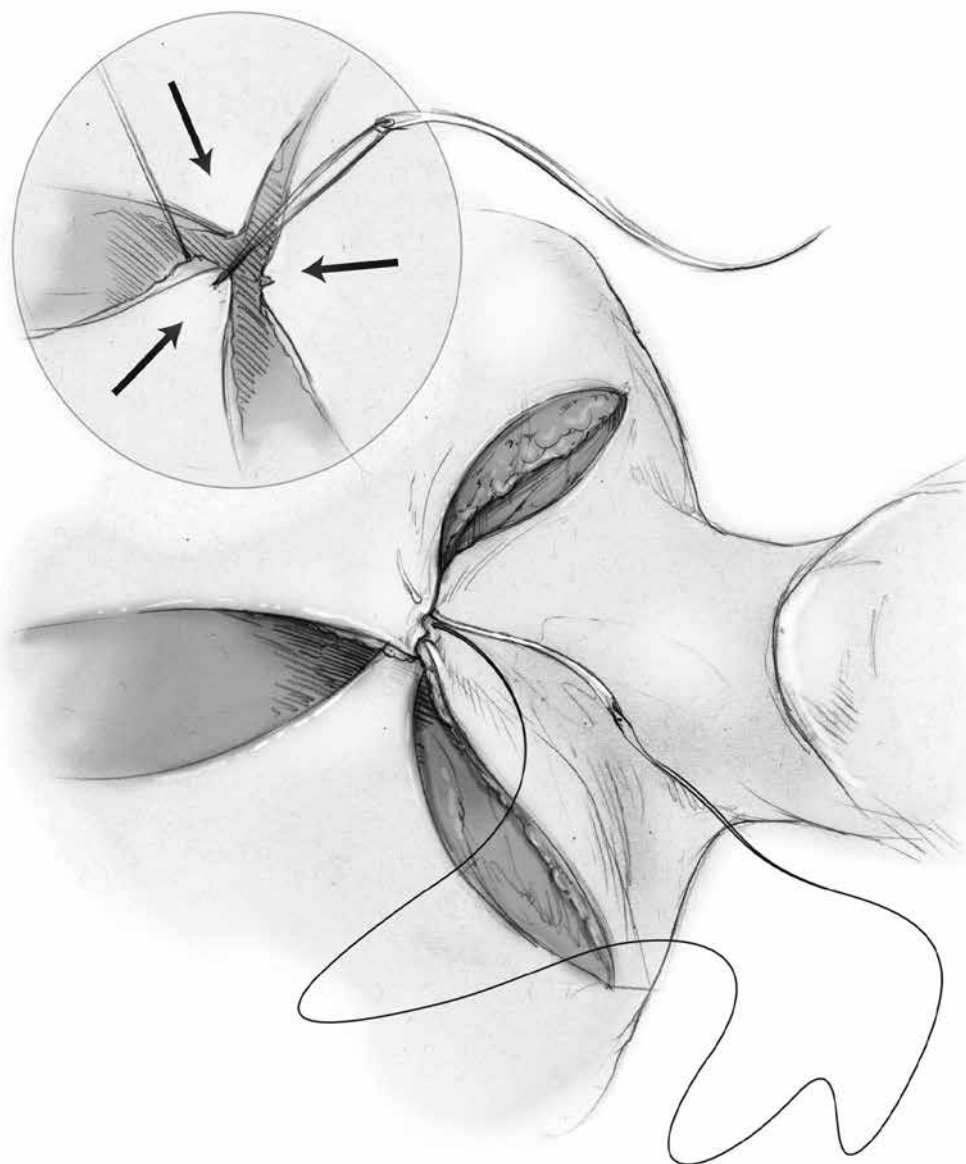


**a Reconstruction of head**



**b Sutured scalp**

Figure 15. Reconstruction of the chest



Reconstruction of chest showing approximation of skin flaps (including orientation 'nick' in skin) with suture pulling three points together



## 8. SOME PRINCIPLES OF PHOTOGRAPHY IN RELATION TO AUTOPSY

### 8.1 Introduction

Even when a specialist photographer is taking the photographs, it is ultimately the responsibility of the pathologist to ensure that sufficient photographs of sufficient quality have been taken. The main purpose of the photographs is to enable the autopsy to be independently reviewed. In forensic pathology, a picture may be worth a thousand words.

As a matter of routine procedure, and if the resources are available, the mortuary should consider implementing procedures to take photographs of every deceased upon admission. Such photographs should include, as a minimum, one of the whole body from the front and one of the face from the front.

Digital photography, for all of its technical advantages, has introduced a new and major risk to mortuary operations. The ease with which digital images can be transmitted and shared presents a serious challenge to the obligations of the mortuary. All the staff need to maintain the confidentiality of the mortuary's work and protect the privacy of those deceased admitted to the mortuary. How the mortuary (including pathologists and police photographers) deal with this needs to be documented in the Mortuary Quality Manual.

### 8.2 Technical hints

What follows is not a comprehensive account of what is involved in mortuary or autopsy photography. It represents some suggestions for setting up a photographic capacity, or incorporation into procedures.

<p><b>Select equipment that is capable of producing high quality images reliably. The equipment needs to be portable and quick to set up.</b></p> <p><i>Comment:</i> All equipment needs to be kept clean and dry. The limitations of the equipment need to be understood.</p>
<p><b>As photographs of the whole body need to be taken at a 90-degree angle to the front or back, a good sturdy ladder is needed.</b></p> <p><i>Comment:</i> Without a ladder, achieving this requires the body to be placed on a sheet on the floor.</p>
<p><b>Lenses need to be of high quality and an understanding of focal length is imperative. Fixed focal length lenses are preferred and a good quality lens used correctly is more than adequate and saves money.</b></p>
<p><b>A long focal length macro lens is required for close up work.</b></p> <p><i>Comment:</i> One common complaint about photographs is that they are not sufficiently close to the lesion of interest.</p>
<p><b>Be familiar with any legal requirements and guidelines for digital forensic photography in your area.</b></p> <p><i>Comment:</i> Develop secure systems in the mortuary to ensure confidentiality and privacy, and to also avoid allegations that the photographs have been digitally tampered with.</p>



<b>Have spare charged batteries and blank memory cards available.</b>
<b>Ensure the date and time on the image screen is correct before you start photographing.</b>
<b>Pick the correct focal length for your subject.</b> <i>Comment:</i> Photographing close up with a wide-angle lens will result in distortion. Choosing a long focal length for an injury may give a good close up image, but may isolate it from other injuries and make it hard for the viewer to place the injury on the body. Take two photographs to avoid this problem.
<b>The camera must always be perpendicular to the object or plane of interest to ensure there is no distortion in shape or size.</b> <i>Comment:</i> Taking a photo of the whole body from the head or feet distorts the view of the body. For the back, the body can be rolled and held on its side while on the table, and a photo taken from the side.
<b>Backgrounds must always be clean, non reflective and free of clutter.</b> <i>Comment:</i> Portable, neutral grey or blue boards are useful to isolate the subject from reflective surfaces, other parts of the body or the rest of the room.
<b>A portable flash unit that attaches to the camera hot shoe and a ring flash are the best alternatives when studio lights and tripods are not an option.</b>
<b>Beware of colour casts from surrounding light sources. The flash should be the main source of light illuminating the subject and the camera's white balance should be set to match this output.</b> <i>Comment:</i> Do not try to add light to the frame by shining examination lights on the subject as the light source may make the subject yellow.
<b>An identification tag must always be photographed at the start of the photo sequence. A case number should be included in each photograph.</b>
<b>Scales are necessary and these can also have the case number written on them. If a photo is taken with a scale you must take the photo again without the scale. This is to ensure that it cannot be questioned that the scale was covering something important.</b> <i>Comment:</i> Keep blood-stained fingers out of photos; ensure focus; avoid soiled labels or photographs that do not adequately represent the pathology.
<b>Close up photos contain more detail and can give a better representation of colour, texture and pathological changes. But always take a photograph first that locates the area of interest anatomically so that the viewer can orientate him/herself.</b>

### 8.3 Gross Specimen photography

If resources allow, a studio with a 'copy lighting' set up gives clean and detailed results when photographing gross specimens. The camera should be mounted on a vertical height adjustable stand 90 degrees above the middle of a glass table top. Underneath the glass table top there should be a non-reflective black material. This will give the photographs a clean black background without gradation in illumination.

Two studio flashes are set up at 45 degrees to the gross specimen on either side of the camera. Having them at 45 degrees keeps the reflections to a minimum and the subject will be evenly illuminated.

All specimens need to be patted dry before being photographed to minimise reflections.

Depth of field is always an important consideration in forensic photography. When photographing gross specimens in the studio or the mortuary, set the aperture to get sharp focus from the front to the back of the frame.



## **9. UNDERSTANDING MEDICAL CERTIFICATION OF CAUSE OF DEATH AND FATAL INJURY SURVEILLANCE**

### **9.1 Medical certification of cause of death**

A medical certificate of the cause of death is an important permanent record of information about a deceased person and the clinician's role in accurately completing the certificate (i.e. certifying the cause of death) is crucial. This section is intended to assist forensic pathologists and medical officers to complete a death certificate in accordance with the International Classification of Diseases (ICD) standards and guidelines as published by the World Health Organization (WHO). This is termed the Medical Certification of Cause of Death (WHO, 2012; WHO, 2004).

The ICD is part of the WHO Family of International Classifications (WHO-FIC), currently in its 10th revision (ICD-10)(WHO, 2004). It provides standards and rules on mortality coding (the process of correct assignment of ICD codes to conditions reported on the medical certificate of cause of death) and classification (selecting the single cause of death that is most relevant from those listed on the medical certificate of cause of death - the underlying cause). Coding is usually undertaken by a person trained in applying the ICD-10 rules and guidelines using the information from a medical certificate of cause of death as completed by the doctor. Thus, certifying the medical cause of death and mortality coding are mutually dependent processes: if a death certificate is incomplete or incorrect, so then will the coding be incomplete or incorrect.

Cause of death information has legal, medical and health care uses. The fact that a person died of injury has obvious implications for criminal law, just as death from asbestosis might be important for civil legal purposes. The cause of death is the primary source of mortality statistics used to justify health planning, for policy decisions apportioning priority to one health issue over another. It allows the measuring and monitoring of trends and patterns of disease over time and between areas or countries. At a more human level, the cause of death is crucial for families, providing primary information about the death of their loved one and helping the grieving process.

### **9.2 The International Form of Medical Certificate of Cause of Death (death certificate)**

The International Form of Medical Certificate of Cause of Death (death certificate) is recommended by WHO for international use.

The cause of all deaths are recorded on the death certificate, which has two sections:

- Part I – includes diseases or conditions directly leading to death (immediate causes), and antecedent causes (or underlying causes)
- Part II – other significant conditions contributing to death, but not contributing to or causing the conditions listed in Part I

A third part of the form is a column to record the approximate interval between onset of the condition(s) listed and the death.

#### **9.2.1 Important concepts in death certification**

All clinicians and other health practitioners involved should clearly understand the following concepts.

- Underlying cause of death – defined as the disease or injury that initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence that led to the fatal injury. This is the condition which is used as the basis for coding and for official mortality statistics.

- Contributory cause(s) of death – other significant disease(s) or condition(s) which contributed to the death but not to the disease(s) or condition(s) listed in the sequence in Part I as causing the death.
- Approximate interval between onset and death – the column on the right-hand side of Parts I and II of the death certificate is for recording the approximate time interval between the onset of the condition and the death in minutes, hours, weeks, days, months and/or years.

### 9.2.2 General guidelines for correct death certification

- Entries should be typed or written legibly in black ink, without the use of abbreviations, alterations or erasures. If an entry needs to be deleted, a single line should be drawn through it; do not use correction fluid.
- One condition per line, each causing the condition above it. Never leave blank lines within the sequence of events.
- The starting point of the sequence should never be entered in Part II because of lack of space in Part I.
- If there is only one cause of death, it is entered at I(a).
- In the case of accidents, injuries or poisonings, the external cause should be reported as the underlying cause.
- For neoplasms, indicate the site, whether benign or malignant, primary or secondary and the histological type if known.
- The mode or mechanism of dying, such as cardiorespiratory arrest or respiratory failure, should not be reported as the immediate cause of death.
- If the cause of death is unknown, even after investigation, it is correct to record it as ‘unknown’ or ‘unascertained’. Do not speculate.
- As much detail as possible should be recorded so that it can be used to assign complete and specific codes from the ICD.

### 9.3 Examples of medical certificates of cause of death

#### Example 1

A 30 year old male is hit by a bus while crossing the road on a poorly lit rural road. He is assisted by passers-by to the emergency department of the local hospital where he is assessed as having multiple fractures, a ruptured spleen and multiple facial lacerations. He dies two hours later of traumatic shock.

#### INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

Cause of death		Approximate interval between onset and death
<b>I</b> Disease or condition directly leading to death*	(a) <i>Traumatic shock</i> due to (or as a consequence of)	2 hours
<b>Antecedent causes</b> Morbid conditions, if any, giving rise to the above cause, stating the	(b) <i>Ruptured spleen and multiple fractures</i> due to (or as a consequence of)	2 hours

underlying condition last	(c) <i>Pedestrian hit by a bus on a poorly lit road</i> due to (or as a consequence of)	2 hours
(d)		
<b>II</b> Other significant conditions contributing to the death, but not related to the disease or condition causing it  <i>* This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury or complication that caused death.</i>		

The underlying cause of death was the fact that the deceased was a pedestrian who was hit by a bus on a poorly lit road. This led to the ruptured spleen and multiple fractures which in turn led to the traumatic shock.

### Example 2

A 58 year old woman presented at a clinic with a long history of haemoptysis and weight loss. The diagnosis was advanced pulmonary tuberculosis with cavitations, perhaps of 8 years duration. The patient also suffered from generalised arteriosclerosis and diabetes mellitus also of long duration.

Immediately after the admission, the patient had an acute and massive pulmonary haemorrhage and died about 10 hours later despite all attempts at resuscitation including transfusion (Rampitige, 2012).

### INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

<b>Cause of death</b>		<b>Approximate interval between onset and death</b>
<b>I</b> Disease or condition directly leading to death*	(a) <i>Pulmonary haemorrhage</i> due to (or as a consequence of)	10 hours
<b>Antecedent causes</b> Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last	(b) <i>Advanced pulmonary tuberculosis</i> due to (or as a consequence of)	8 years
	(c)	
	(d)	
<b>II</b> Other significant conditions contributing to the death, but not related to the disease or condition causing it  <i>* This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury or complication that caused death.</i>	<i>Generalised arteriosclerosis</i> <i>Diabetes mellitus</i>	Unknown

The underlying cause of death is the pulmonary tuberculosis that led to the pulmonary haemorrhage which is the immediate cause of death. Diabetes mellitus may have predisposed the individual to the recurrence or complicated the management of the tuberculosis and therefore has contributed to the death. The generalised arteriosclerosis, if it included the coronary or cerebral circulation, may have aggravated the consequences of the haemorrhage and has therefore also arguably contributed to the death.

### Example 3

A 52 year old male builder was brought into the emergency department conscious, having fallen off a ladder at work, landed on his head and sustained head injuries. He had a 15-year history of chronic obstructive pulmonary disease and a 35-year history of smoking. While waiting in the emergency department he lost consciousness and became unresponsive. His distraught wife reported that he had recently been diagnosed with a squamous cell carcinoma of the lung after being investigated for being overly tired and complaining of chest pains. A CT scan showed a large subdural haematoma and a mass on his right lung with enlarged hilar lymph nodes. Because of his very poor prognosis his family made the decision for him not to undergo surgery. The patient died early the next day.

#### INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

Cause of death		Approximate interval between onset and death
<b>I</b> Disease or condition directly leading to death*  <b>Antecedent causes</b> Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last	(a) <i>Subdural haematoma</i> due to (or as a consequence of)  (b) <i>Blunt force head injury</i> due to (or as a consequence of)  (c) <i>Accidental fall off a ladder from a building at work</i> due to (or as a consequence of) (d)	10 hours  10 hours  10 hours
<b>II</b> Other significant conditions contributing to the death, but not related to the disease or condition causing it  <small>* This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury or complication that caused death.</small>	<i>Squamous cell lung cancer</i> <i>Chronic obstructive pulmonary disease</i> <i>Smoking</i>	Unknown 15 years 35 years

The squamous cell carcinoma, the chronic obstructive pulmonary disease and the smoking are all listed as contributing to death, as collectively they may have led to a predisposition to falling from the ladder, for example from feeling faint.

### 9.4 Fatal injury surveillance tool

The WHO estimates that almost 5.8 million people die each year as a result of injuries and violence. 90% of these deaths occur in low and middle income countries (LMICs). A major contributing factor to these countries' inability to effectively develop prevention strategies has been the lack of useful, reliable and timely data. In most high income nations, and some middle-income countries, vital

registration (e.g. death certificates) are the usual source of injury mortality data locally and to the WHO mortality database. According to WHO, of the 193 member states, 74 (38%) are lacking cause-of-death data in their vital registration information set. Only 34 (18%) have high quality data including intent, underlying cause and manner of death that can be used to inform injury prevention policy and programmes.

In response to the growing burden of injury and violence the WHO, Monash University and the Victorian Institute of Forensic Medicine (VIFM) developed a practical manual with a standardised data collection instrument that can be used in mortuaries and health facilities to collect fatal injury data. The tool was piloted in five selected nations including Zambia, Tanzania, India, Sri Lanka, and Egypt. It was entitled '*Fatal injury surveillance in mortuaries and hospitals: A manual for practitioner*' and published in 2012. Further information on the manual is available at:

[http://www.who.int/violence\\_injury\\_prevention/publications/surveillance/fatal\\_injury\\_surveillance/en/index.html](http://www.who.int/violence_injury_prevention/publications/surveillance/fatal_injury_surveillance/en/index.html)

A further pilot study conducted in Ibadan, Nigeria, using this tool illustrates the promising potential of the mortuary as a direct source of fatal road traffic injury (RTI) data. It demonstrated capacity to augment other fatal RTI data sources, such as police data, in Nigeria to better inform targeted RTI prevention programmes. This study found motorised 2-wheeler users and pedestrians bear the greater burden of fatal RTI in Ibadan. It highlighted the value of promoting helmet use by both riders and passengers.

Further information on the study is available at:

<http://injuryprevention.bmj.com/content/early/2013/03/13/injuryprev-2012-040674.abstract>

The WHO has also developed a data collection form to assist in collecting information on fatal injuries as indicated below, which can be downloaded at:

[http://www.who.int/violence\\_injury\\_prevention/publications/surveillance/fatal\\_injury\\_surveillance/en/index.html](http://www.who.int/violence_injury_prevention/publications/surveillance/fatal_injury_surveillance/en/index.html)

The importance of fatal injury surveillance for data to inform death and injury prevention is obvious. Translating this simple statement into effective action requires effort. Mortuaries around the world are now contributing to this effort by collecting data which is otherwise not collected. On the next page is the short version of such a data collection tool developed by the WHO.



**1**

**1.1 FACILITY NAME** \_\_\_\_\_

**1.2 FACILITY TYPE**  Mortuary  Hospital/health facility

**1.3 CASE IDENTIFICATION NUMBER**

**1.4 POSTMORTEM EXAM DATE (DD/MM/YYYY)**

**1.5 INTERNAL AUTOPSY PERFORMED?**  Yes  No

**1.6 DECEASED AGE**    YEARS   MONTHS (F < 2 YR)   UNKNOWN

**1.7 DECEASED SEX**  Male  Female  Unknown

**2**

**2.1 DATE OF INJURY (DD/MM/YYYY)**

**2.2 DATE OF DEATH (DD/MM/YYYY)**

**3**

**3.1 PLACE OF INJURY OCCURRENCE**

01 Private house/home (including yard)  07 Industrial and construction area  11 School, institution or educational area

02 Residential institution  08 Farm or place of primary production  12 Public administrative area

03 Medical service area  09 Sea, lake, river, dam, borehole, well  13 Open land, beach, forest, desert

04 Street/highway/road  10 Sports/athletics area  77 Other: \_\_\_\_\_

05 Railway line/station  99 Unknown/unspecified

**3.2 PLACE OF DEATH OCCURRENCE**

01 At injury site  02 At home  03 In the ambulance/in transit to health facility  04 In hospital/health facility  77 Other: \_\_\_\_\_  99 Unknown/unspecified

**4**

**4.1 APPARENT INTENT**

01 Unintentional (accidental)  03 Assault/homicide  05 Natural  99 Unknown/unspecified

02 Suicide/self-harm  04 Legal intervention/ war operations  06 Undetermined

**4.2 MECHANISM OF INJURY**

01 Road traffic incident  02 Other transport incident  03 Blunt force (struck/hit by a person, animal or object)  04 Fall  05 Stab/cut  06 Animal bite  07 Drowning/submersion  08 Burn (smoke/fire/flames)  09 Burn (contact with heat/scald)  10 Poisoning  11 Suffocation, choking, hanging  12 Electrocution  13 Firearm discharge/gun shot  14 Explosive blast  15 Envenomation  77 Other: \_\_\_\_\_  99 Unknown/unspecified

**MODE OF TRANSPORT**

01 Car  02 Pick-up, van or minibus (<10-seater)  03 Truck/heavy transport vehicle  04 Bus (>10-seater)  05 Motorized 3-wheeler  06 Motorized 2-wheeler (motorcycles, moped, E-bikes)  07 Walking  08 Cycles (bicycles, tricycles)  09 Non-motorized vehicles (rickshaws, carts, etc.)  77 Other transport mode  99 Unknown/unspecified

**ROAD USER**

01 Pedestrian  02 Driver/rider (including bicyclists and motorcyclists)  03 Passenger  77 Other: \_\_\_\_\_  99 Unknown/unspecified

**COUNTER PART**

01 Pedestrian  02 Animal  03 Cycles (bicycles, tricycles)  04 Motorized 3-wheeler  05 Motorized 2-wheeler (motorcycles, moped, E-bikes)

06 Car, pick-up truck or van  07 Heavy transport vehicle or bus  08 Railway train or railway vehicle  09 Other non-motorized vehicle  10 Fixed stationary object  11 Non-collision transport incident  77 Other: \_\_\_\_\_  99 Unknown/unspecified

**5**

**INCIDENT SUMMARY NARRATIVE (FROM THE AUTOPSY REPORT, POLICE RECORDS, INQUEST DATA AND BYSTANDER REPORTS)**  
DESCRIBE THE CAUSE, NATURE AND CIRCUMSTANCES OF THE INJURY.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## APPENDIX 1: FORENSIC ANTHROPOLOGY

### A practical approach to the analysis and interpretation of skeletal remains (including an equipment list)

Forensic Anthropology is the field of study concerned with the examination of material believed to be human to answer medico-legal questions including those related to identification. In many parts of the world, for practical purposes, the forensic pathologist undertakes the work of the forensic anthropologist. He/she may attend a site where skeletal remains of suspected human origin are located.

#### Collection from the scene

- Recovering the remains, the province of forensic archaeology, is an expert field of its own, but is often undertaken by the forensic anthropologist. See suggested readings at the end of this Appendix. It is important to plan the process before starting.
- Photograph the skeletal remains as they are found (in situ), before they are touched or moved and the association between the remains and other possible evidence is lost. Ideally a site code should be included in the photograph but it is essential to include a linear scale. If no such scales are available, use something where size is recognisable (e.g. a pen, trowel, etc.).
- Record and consider the relationship of the remains to any clothing or other objects present.
- Package the skeletal remains, ideally in sturdy paper bags, for transport to a laboratory/mortuary. Special attention should be given to the protection of the skull (cranium and mandible). If possible, wrap the skull before placing it in a bag. The idea is to ensure that the skeletal remains arrive at the mortuary in the same state of preservation as they were recovered (i.e. no further fragmentation and without loss of teeth).
- Include a chain of custody form that details the transportation of the human remains from the scene to the mortuary.

#### At the mortuary

Before performing any kind of analysis, the material brought in from the scene must be properly prepared for examination. Preparation comprises the following steps:

- X-rays: if resources allow, any bones showing signs of having been affected by gunshots should be X-rayed for metallic objects invisible to the naked eye. X-rays are also very useful for observing certain bone pathologies.
- Cleaning: all the bones and teeth must be properly cleaned. Depending on the material in which the remains were buried, cleaning may involve washing (for example, if covered with mud) or dry brushing (for example, if covered with sand). A soft toothbrush can be used to remove dirt, with special care being taken with worn bones, the epiphyses of the long bones and the faces of the pubic symphyses. In cases in which the remains are not completely reduced to bone, an enzyme-active-water solution can be used to detach the soft tissue. A sample should be taken first, however, for possible genetic analysis.
- Teeth that are not permanently attached to the alveoli should be removed, washed and secured separately to prevent their loss.
- Once the remains have been washed, they should be allowed to dry, preferably away from sunlight. A fan can be used to speed up the process.

## Analysis

- Distinguish skeletal remains from other non-biological material and distinguish human from non-human skeletal material.
- These analyses can either be undertaken at the scene or in the laboratory/mortuary.

## Inventory of skeletal elements

- If the skeletal remains are human, lay the skeletal elements out in anatomical position.
- The presence of skeletal elements is recorded by means of a schematic diagram (see below) and/or inventory table. Both forms of recording should be accompanied by descriptive and explanatory notes which also include the details such as the code of the site, name of the assessor and date when the analysis was undertaken.

## Describe the preservation and condition of the remains:

- colour
- surface texture: greasy or dry; rough or smooth
- surface changes: for example, due to heat, weathering, plant roots, insects, soil/sediment characteristics, scavengers, and/or human activity
- shape changes: e.g. due to soil pressure, heat, dehydration, salt accumulation, scavengers, and/or trampling
- odour

## Determine the medico-legal significance of the remains

A number of factors need to be assessed to determine whether the remains are of medico-legal significance including:

- method of disposal
- markers of formal burial versus clandestine grave
- position of the body, for example the absence of a coffin or shroud or bone arrangements that indicate a secondary burial (that is, a re-burial)
- associated surface finds, for example clothing, weapons or identity cards
- the condition of bone, for example, 'greasy' or 'green' bone compared to highly degraded, weathered bone
- the presence or absence of burial artefacts
- markers of identity including the dentition or presence/absence and quality of restorations and assessment of dental attrition
- the presence of surgical or medical implants in or among the remains

## Time since death

Assessing the time since death of an individual based on the macroscopic assessment of the skeletal remains is unreliable as there are numerous variables that affect bone preservation. In order to determine how long ago the individual died (time since death), apart from generally unreliable estimates based on experience, it may be necessary to employ a scientific dating technique such as radiocarbon or post-bomb C14 dating. Due to the time involved in undertaking these analyses and cost factors, they are typically a last resort and not commonly used.

### Determining the minimum number of individuals

In cases where the remains are commingled and/or fragmentary it may not be possible to determine the exact number of individuals present. The minimum number of individuals (MNI) in any assemblage of bones is the minimum number of individuals necessary to account for all of the elements in the assemblage.

Duplication in bones will be apparent when laying-out the skeleton(s), and inconsistencies in bone size, colour, age, sex or even ancestry indicators may also suggest a multiplicity of individuals and commingling of their remains. The easiest way to assess MNI is to count the number of the most common individual skeletal element (e.g. left clavicle).

### Estimating the ancestry of the individual

Ancestry may be evaluated by assessing the presence or absence, or degree of development, of skeletal traits. Assessment of ancestry should be undertaken on adult remains because skeletal development is still occurring in children, and it is difficult to determine their ancestry. The region of the skeleton that most strongly reflects ancestral traits is the skull.

There are a number of cranial and post-cranial measurements that may be used to differentiate between populations. Depending on the preservation of the remains, a series of cranial measurements are taken and, resources permitting, entered into a computer package which provides an ancestry assessment with related likelihood percentages. See also the suggested reading.

### Estimating the sex of the individual

Sexual dimorphism of the human skeleton does not develop until after puberty. Therefore sex estimation of juvenile skeletal material based on morphological traits is very unreliable.

There are two approaches to estimating the sex of an adult from the skeleton. These involve the assessment of morphological features of the skeleton and/or the use of metric criteria in the form of indices (ratios of measurements) and/or discriminant functions (uni- or multivariate statistics). See suggested reading.

### Estimating the age of the individual

Examination of the skeletal and/or dental remains provides a more accurate age for younger as opposed to older individuals. In most cases age categories are presented as a range, with each range having different precision.

Foetus: 9 weeks to before birth  
 Infant: 0 - < 2 years  
 Child: 2 - 12 yrs  
 Adolescent: 13 - <20 yrs

- **Foetus:** before birth

- **Infant:** 0-3 years

- **Child:** 3-12 years

- **Adolescent:** 13-20 years



Juvenile (sub-adult)

- **Young adult:** 20-35 years
  - **Middle adult:** 35-50 years
  - **Old adult:** 50+ years
- } Adult

### Estimating the stature of the individual

Stature is estimated using maximum length measurements of long bones such as the femur, tibia, humerus, radius and/or ulna. Combinations of these bones can also be used for estimates. Measurements are taken on an osteometric measuring board to the nearest millimetre. Depending on the skeletal elements and the ancestry of the remains, a specific regression equation is employed to determine stature. See suggested reading.

### Skeletal variations and anomalies

Cranial and post-cranial anomalies and non-metric traits may prove valuable in individuation and are recorded and photographed where appropriate.

### Skeletal pathology

All skeletal alterations that may be pathological in origin are described in terms of location and appearance. This includes description of:

- position in relation to anatomical landmarks
- shape
- size, bone loss, bone formation
- texture, surface appearance

### Skeletal trauma

Skeletal trauma is described in terms of its location and appearance. Where possible, comment is made about the timing of the trauma which may be:

- ante-mortem: this conclusion requires signs of healing to be present
- peri-mortem: there are no signs of healing and the fracture needs to be differentiated from a post-mortem artefact. There may be sharp fracture margins, radiating fracture lines, straight fracture lines, or fractures tending to be oblique; the colour of fractured edges is the same as the surrounding bone, or
- post-mortem damage: animal activity, natural actions (for example freezing, fluvial action, abrasion, sun-bleaching, and root damage), marine exposure (for example bleaching, loss of bone cortex, algae or barnacles deposited), human actions (for example excavation techniques, trophy or souvenir remains, use as anatomical education sets, attempts to remove identifying features by acid or other means, religious/cultural activity such as 'skull-cap bowls').

### Reconstruction

In cases of fragmentary and/or damaged skeletal remains, reconstruction of the elements of particular bones should be undertaken to assist in the analysis, particularly the interpretation of trauma.

Reconstruction may involve the use of a hot-melt glue gun (requires electricity), super glue and/or dental wax to hold the fragments together.

### **Documentation**

A written and photographic record of all the skeletal remains should be completed. This should include:

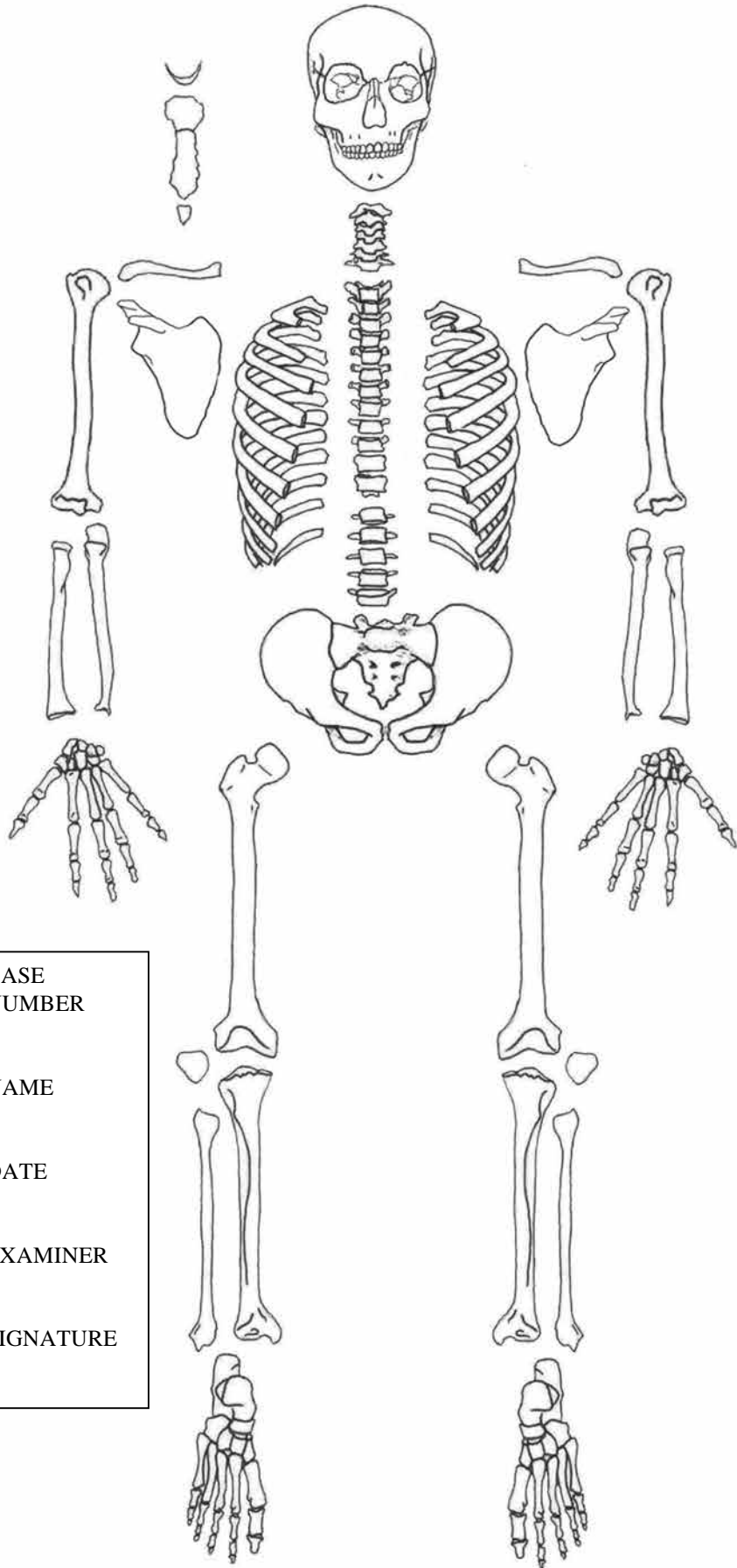
- An overall photograph of the remains laid out in the anatomical position
- Detailed photographs of any pathology or injury, including any skeletal abnormalities and other possible identifying features
- In the case of a cranium, six views should be recorded: anterior, posterior, left and right lateral, inferior and superior

Note: The case number and a linear scale should be included in all photographs. If the images are digital the photographs should be stored in an electronic folder labelled with the case number with appropriate back-up and network security systems in place.

### **Conclusion**

It often takes longer to analyze a full set of skeletal remains than a body, in part because it is done less often. It is therefore essential that sufficient time is allowed in the mortuary to clean, layout and analyze the remains, and to record the findings properly.

ANTHROPOLOGY RECORDING FORM  
INDIVIDUAL ADULT SKELETON



CASE  
NUMBER

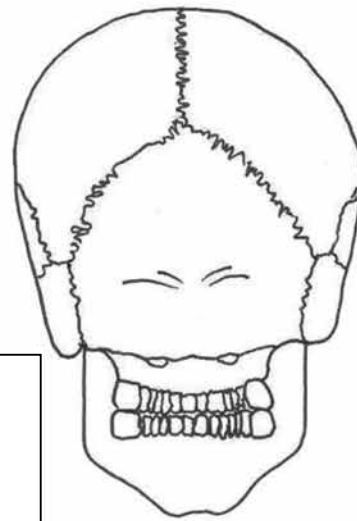
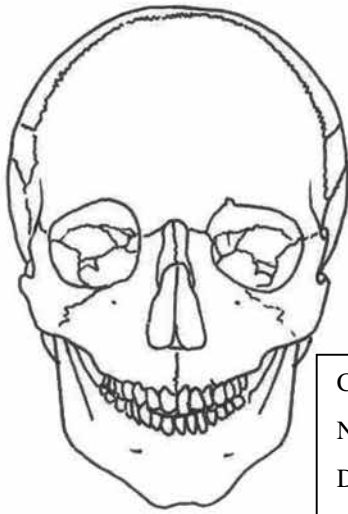
NAME

DATE

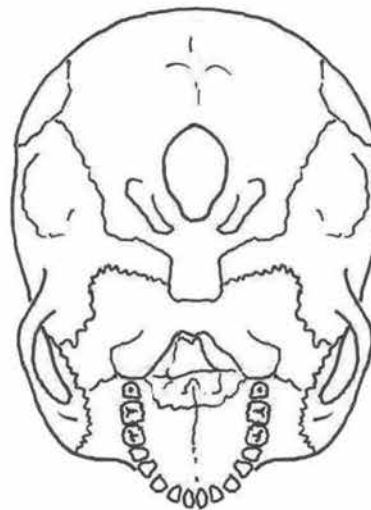
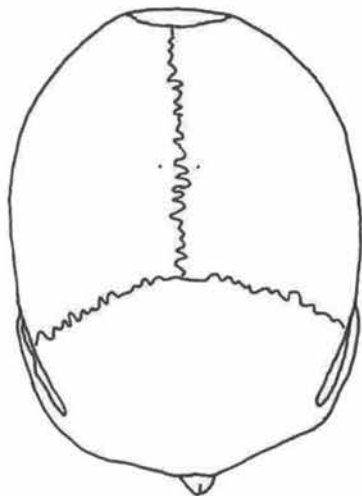
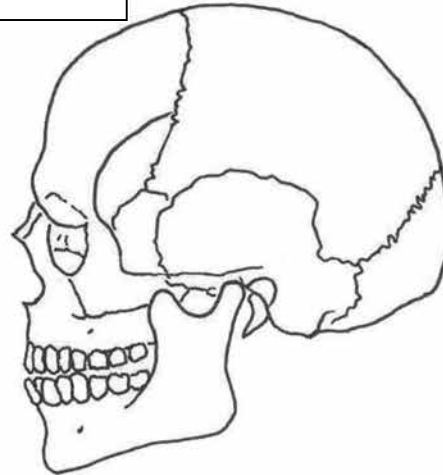
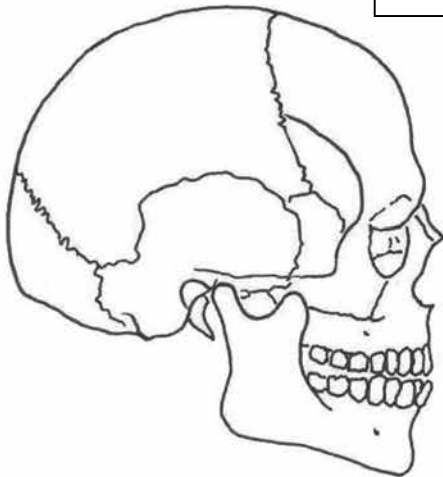
EXAMINER

SIGNATURE

ANTHROPOLOGY RECORDING FORM  
INDIVIDUAL ADULT SKULL



CASE NUMBER  
NAME  
DATE  
EXAMINER  
SIGNATURE





<b>Mapping and measuring equipment list</b>	
Plumb bob	wooden stakes/reinforced iron bars (depending on environment)
Line level	Flagging tape
2 x Metric tape (2.5 meters minimum)	Marker pens
4 x 5 metre tapes	1 x 1 metre drawing frame
String	Pencils, rubbers, clips
Nails	Whiteboard / photo board
Metric ruler	Large plastic numbers for labelling grid
North arrow	
<b>Excavation equipment list</b>	
Square point shovels	Aluminium foil
Trowels	Plastic and paper bags of various sizes
Brushes (stiff whisk and soft)	Containers and packing materials
Bamboo sticks/skewers	Photo board
Small dustpan or scoop	Sliding callipers
Spoons	Tweezers
Different sized sieves (2mm and 4 mm)	Buckets
Tarpaulin	
<b>Mortuary equipment list</b>	
Soft dry brushes – various sizes	Labels (for photographing)
Toothbrushes	Blue tac
Drop sheet or back sheets to lay skeleton out	Lab manual (standards for developing biological profile)
USB / hard drive (to back up data)	Recording forms – full skeleton (adult and juvenile), skull (adult and child), dental
Sieves of various sizes	Pens, pencils and rubbers
Buckets and/or containers	Permanent marker pens
Bubble-wrap	Sliding callipers
Masking tape	Paper and plastic bags of various sizes
Hot melt glue gun	Osteometric board (if it is not possible to carry a standard board, then create one using a tape measure and something with a rigid end)
Power point adapters	Tape measures
Superglue	Camera and spare batteries
Wooden skewers	Camera photographic sheet
Scales – different sizes	Step ladder
Arrows	

An important piece of equipment in forensic anthropology is an osteometric board. Because they are expensive to purchase, instructions on how to make one can be found at:

A Folding Osteometric Board (design © A. Chamberlain & C. Cox, University of Sheffield)

<http://www.shef.ac.uk/archaeology/research/osteometric-board>

### **Suggested Reading**

Bass, W.M. 1987. Human Osteology. Columbia: Missouri Archaeological Society.

Blau, S. and Ubelaker, D.H. (eds.) Handbook of Forensic Anthropology and Archaeology. California: Left Coast Press.

Dirkmaat, D. (ed.) 2012. A Companion to Forensic Anthropology. Wiley-Blackwell.

Krogman, W.M. and Iscan, M.Y. 1986. The Human Skeleton in Forensic Medicine. Illinois: Charles C. Thomas.

Scheuer, L., Black, S. and Schaefer, M.C. 2009. Juvenile Osteology: A Laboratory and field Manual. Academic Press.

Stewart, T.D. 1970. Personal Identification in Mass Disasters. Washington DC: Smithsonian Institute.

Stewart, T.D. 1979. Essentials of Forensic Anthropology. Illinois: Charles C. Thomas.

Ubelaker, D.H. 1999 (2<sup>nd</sup> ed.) Human Skeletal Remains. Taraxacum.

White, T.D. and Folkens, P.A. 2005. The Human Bone Manual. San Diego: Academic Press.



## **APPENDIX 2: FORENSIC ODONTOLOGY**

### **Introduction:**

Forensic odontology is the study of dental and related evidence which is relevant to legal proceedings. It is a specialized field of dentistry that involves collecting, preserving and analyzing dental and related evidence. The findings are then presented to the investigative or judicial authorities in the form of a medico-legal report, occasionally supplemented by the giving of oral evidence in court.

The scope of forensic odontology ranges from helping to establish the identity of an unknown deceased person, handling and analyzing bite mark evidence, to forming opinions about trauma affecting dental, oral and peri-oral tissues. Dental identification is considered to be the quickest and easiest human identification method, and is particularly effective in mass disasters.

It is essential that, if at all possible, death investigation authorities have the auxiliary services of a trained forensic odontologist. When this is not possible, the forensic pathologist should undertake the task of documenting dental evidence. It is for this latter circumstance that this appendix has been included.

Thus, the purpose of this appendix is to outline the essential steps that should be followed by forensic pathologists when they encounter a death requiring forensic odontological input, but a forensic odontologist is not available.

This appendix covers three areas of forensic odontology: identification, injury analysis and bite mark analysis. Bite mark analysis is beyond scope for a forensic pathologist and should only be undertaken by a forensic odontologist with special training and expertise. However, the pathologist may be able to ensure that sufficient records, especially photographs, are made and taken for possible later evaluation by the forensic odontologist.

### **1. Human identification**

Identification is based on the comparison of ante-mortem and post-mortem human characteristics. Those characteristics, either individually or collectively, are ideally unique and scientifically identified and recorded. Among those are dental characteristics.

Dental identification is based on comparing dental features present in the deceased, with dental features that are recorded in dental files of a person thought to be the deceased. Those features can be of dental treatment, or of dental conditions (such as mal-occlusion and dental anomalies) which are either recorded in the dental files, or apparent in radiographs, casts or portrait photographs of the person while alive.

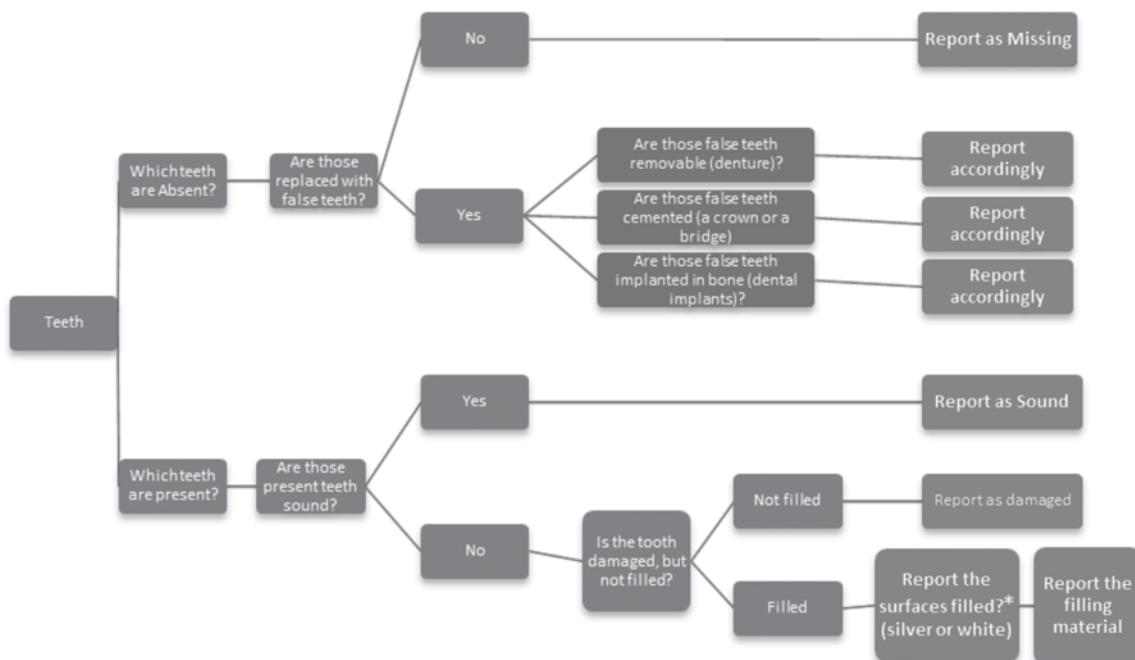
At the mortuary, the inspection and recording of post-mortem dental characteristics normally follows three steps: visual, radiological and photographic.

#### **1.1. Visual dental examination**

This is performed by visually examining every tooth, and recording its information in the dental chart. Ideally, two persons, an examiner and a transcriber, perform this procedure. Simply put, teeth can be

*present* or *absent*. When present, teeth can be *sound* or *filled*. And when absent, teeth can be *missing* or *replaced* with artificial (false) teeth.

The following flow-chart assists examiners in performing the examination in a logical sequence:



\*The tooth surfaces are;

- a. Occlusal (the upper surface)
- b. Mesial (the surfaces towards the mid-line. The alternative medical term is *medial*)
- c. Distal (the surface away from the mid-line. The alternative medical term is *lateral*)
- d. Buccal / labial (the surface toward the lips or the cheeks)
- e. Lingual (the surface towards the tongue or the palate)

## 1.2. Radiological examination

Whilst the visual examination yields large amount of dental identity information, it does not show information that is invisible to examiners, such as the teeth root(s), and the outline of fillings located on inter-dental surfaces. Such information can be obtained from radiographs.

Radiographs can be extra-oral or intra-oral; the latter is heavily relied upon in identification and age estimation. Therefore, dental radiographs are an integral part of the dental examination. As a common practice, all cases requiring forensic odontology opinion should, if at all possible, have at least:

- Two bite-wing radiographs of the right and left molars
- A peri-apical radiograph of each tooth which has
  - a large filling, where a root-canal treatment is suspected
  - a prosthesis, i.e. crown, bridge or implant

Radiographs should be labelled appropriately and attached to the findings of the visual examination.

### **1.3. Photography**

Although not part of the visual and radiological examinations, photography is invaluable as a record of the identifying characteristics for later comparison with records from a living person or if a second opinion is needed in the future. An additional reason for photography is for the examiner him/herself to be sure later that the findings described in the report are correct.

Occasionally, human identification can be supported by a method known as photographic superimposition, whereby a photograph of the face of the missing person (preferably with the front teeth showing) is superimposed onto a photograph of the skull of the unknown which is taken with the same viewing angle.

As a common practice, at least five photographs should be taken including the following views:

- Photograph of the upper jaw (occlusal view)
- Photograph of the lower jaw (occlusal view)
- Photograph of the anterior teeth while biting
- Photograph of the posterior teeth while biting (right view)
- Photograph of the posterior teeth while biting (left view)

More photographs are indicated when there are unique or unusual dental features, such as dental anomalies, fractured front teeth, or dental treatments that are unusual or are considered to indicate a specific cultural background.

## **2. Injury analysis**

Occasionally, a forensic odontology opinion is needed during the post-mortem examination when certain injuries are detected. Those injuries can be to oral soft tissues or to teeth and jaw bones.

### **2.1. Injuries to oral soft tissues**

Hematoma and lacerations on the lips, cheeks and tongue can indicate external trauma. Laceration of the labial frenum, and tooth indentations on the cheek mucosa indicate external force or pressure. Those injuries are best viewed when the facial skin is reflected from the neck upwards.

### **2.2. Injuries to teeth and jaw bones**

Fractures to teeth, alveolar process of the jaws, and/or the jaws can be useful in reaching opinions about the occurrence of the injuries. Such injuries can also be useful in estimating the force used in their infliction.

## **3. Bite marks**

Bite marks are patterned injuries that are caused by the teeth of humans or animals. During post-mortem examination, it is important to accurately document any bite mark, as such injuries might be

useful in future criminal proceedings. As mentioned above, the evaluation of bite marks requires specialist forensic odontological expertise.

Comparisons with the suspect's teeth are often attempted. However, the flexibility of the victim's skin allows distortion of the bite mark's measurements, and while the marks are made in three dimensions, these are reduced to two for comparison purposes thus introducing further artefact and potential for error. Thus, any conclusions based on such comparisons should be made with extreme caution. In some parts of the world, courts will not now allow such evidence because of the number of wrong convictions which have resulted from reliance on bite mark comparisons. Whether this is because of inherent flaws in such evaluations, or because in particular cases the evaluation was poorly undertaken is a matter of controversy.

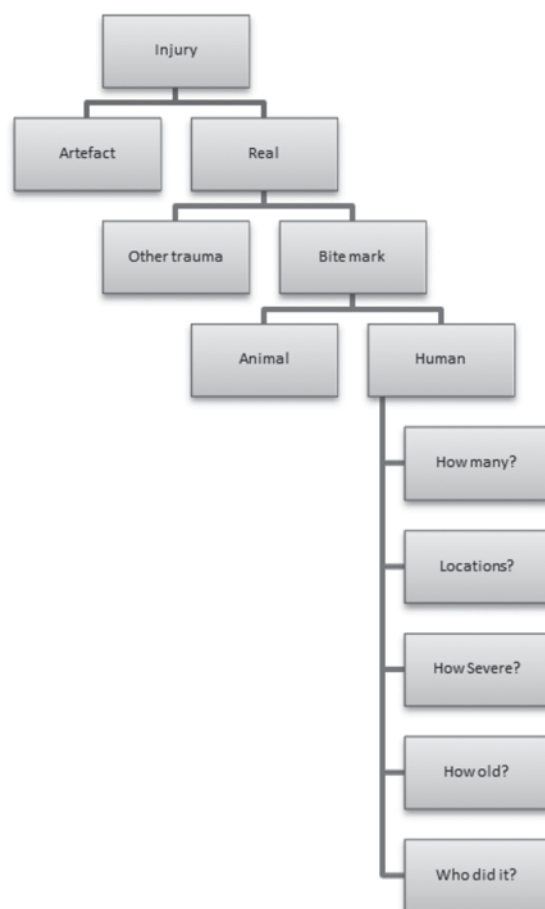
Bite mark features (as with other injuries) will gradually disappear with healing (in the living) or with decomposition (in the dead). Therefore a bite mark should be documented as early as possible.

### 3.1. Recognition

A bite mark is a patterned injury that consists of all, or some, of the following features:

- Two opposing arches (sometimes one arch depending on the curvature of the body part).
- Lacerations caused by the indentations of teeth.
- A central area of ecchymosis or bruising.

The following is a flow chart showing the approach to an injury suspected of being a bite mark:



### 3.2. Management

A bite mark should be documented by two methods:

- DNA swabs, using the double swab technique
- Photography, taking a set of photographs in the following order:
  - A general photograph showing its anatomical location
  - A close up photograph without the scale
  - A close up photograph with the scale (the standard is ABFO No. 2)

(An experienced forensic odontologist may be able to take impressions, preferably with silicone impression materials. This documentation method is used when the teeth indentations in the bite marks are reasonably deep. Only an experienced forensic odontologist should consider any attempt at comparing the bite mark with the dentition of an accused person in a particular case.)

<b>Instruments and Equipment for Forensic Odontology</b>	
Identification and DVI	Item
	Dental mirror
	Dental explorer
	Dental tweezers
	Tissue tweezers
	Hemostat
	Mouth gag (Doyens or Fergusons Mouth Gag)
	Blade handle
	Blades
	Periosteal elevator, small and large
	Extraction forceps for ALL teeth
	Straight elevators
	Digital SLR camera, with a wide angle and macro lenses, and a ring-flash
	X-ray machine (Nomad® Pro Hand-held)
	Dental X-ray films
	Dental X-ray processor
	View box
Bite mark	Sterile cotton swabs for DNA collection
	Normal saline
	Rulers (ABFO No. 2 ruler)
	Carry bag suitable for deployment





### APPENDIX 3: SUGGESTED CONTENTS OF AN AUTOPSY REPORT

The autopsy report is the permanent written record of the findings and results of the autopsy examination and the relevant opinions that flow from it. It is common practice to use a standard proforma or template, and the reader could develop their own template based on what follows below.

The autopsy report can generally be divided into several sections.

- a. Identification – Details of the identity and how this was established for the deceased person autopsied.
- b. Circumstances of death – Brief background of the circumstances surrounding the death of the deceased including who provided the information and the date, time and place of death.
- c. Date, time and place of the autopsy– Details of persons present at the autopsy and name of prosecutor/pathologist.
- d. External examination –

    Clothing: Description of clothing. Details can be included or reference made to other reports on the examination of the clothing.

    General: General description of the body including body height, weight, age; condition of body, presence of body hair (length and colour).

    Identification: Detailed description of external marks on the body such as tattoos, surgical scars, birthmarks, etc.

    Signs of emergency and medical treatment.

    Injuries: Detailed description of external injuries – types, size, details of edges of wounds, shape, orientation, location, signs of healing, associated foreign bodies or debris, associated swelling, bleeding/bruising, involvement of underlying structures.

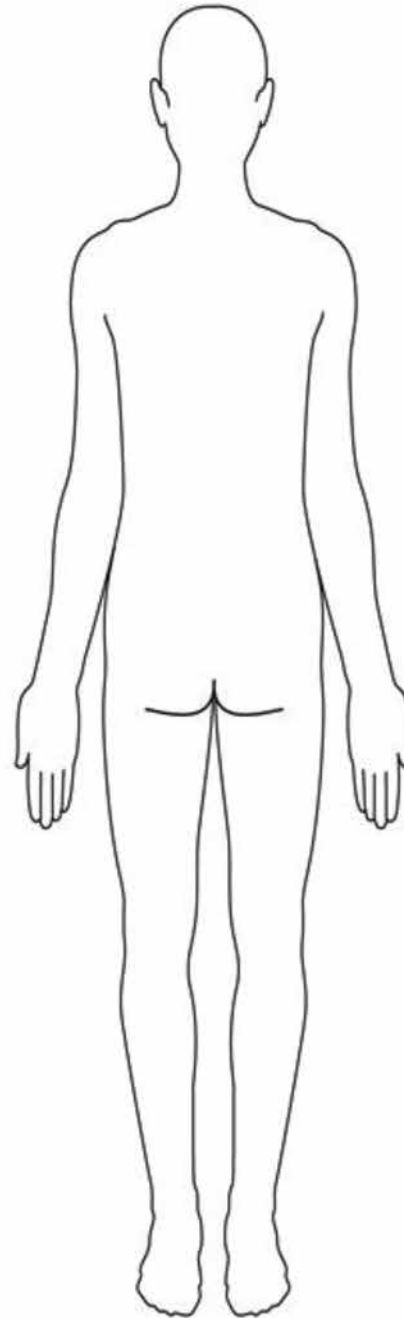
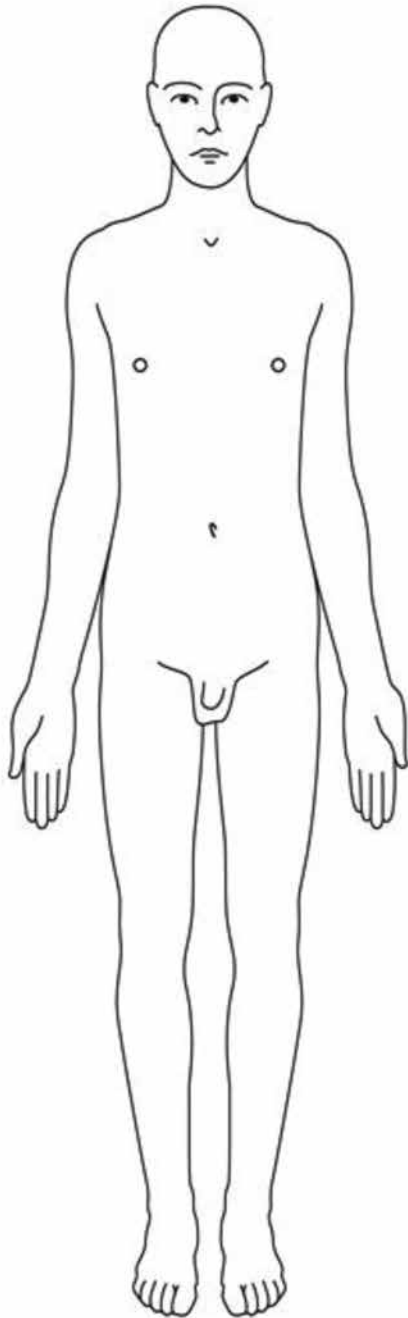
- e. Internal examination –

    Detailed description of internal organs including weight and other measurements of major organs where indicated. Detailed description of internal injuries; types, size, and location.

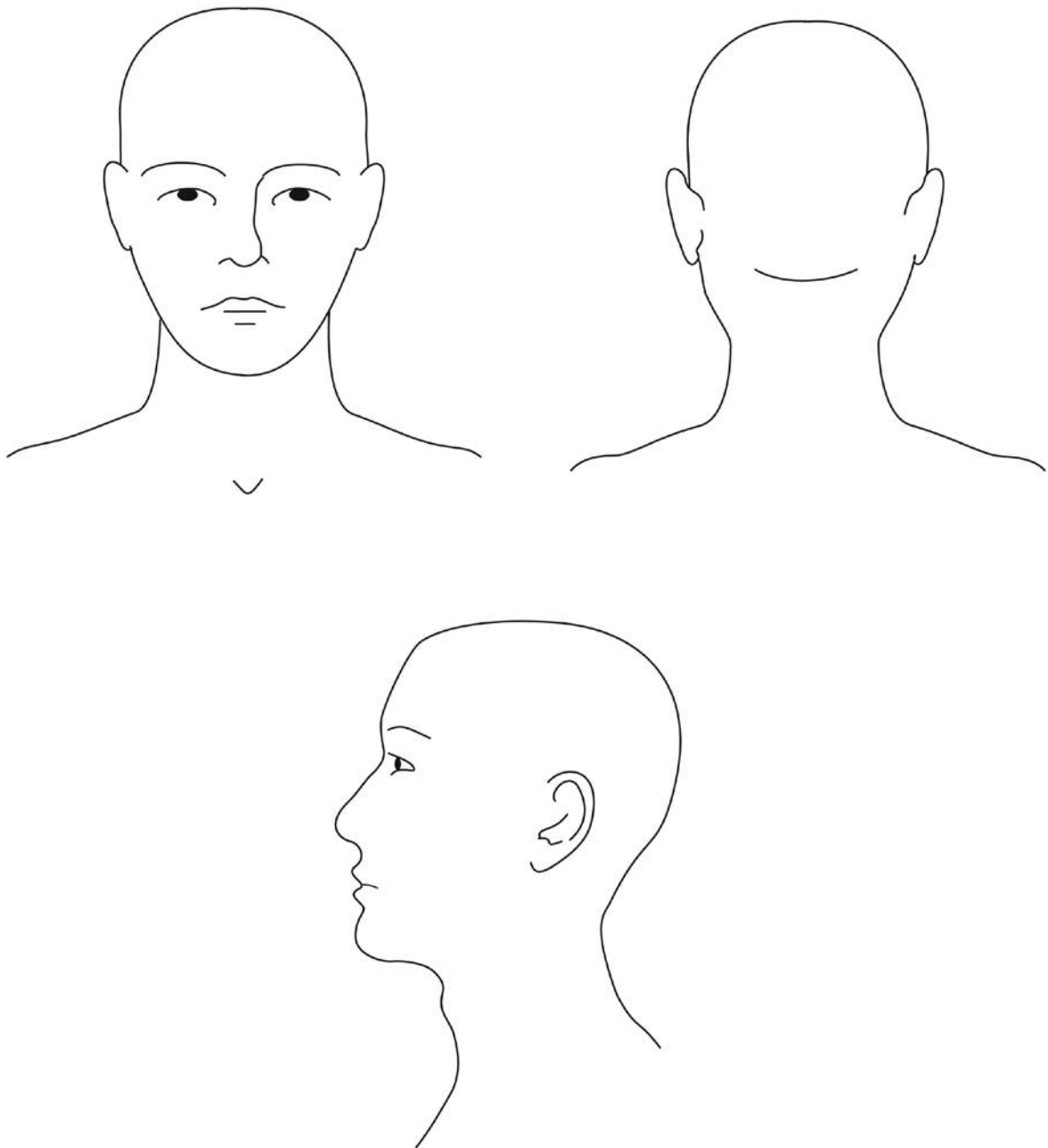
    Skeletal system

- f. Samples retained and further testing (e.g. histology, toxicology) – Record of samples and specimens collected and retained together with details of chain of custody, further examination undertaken and their results.
- g. Summary of findings – Summary of anatomical findings and other relevant positive or negative findings specific to the circumstances and cause of death.
- h. Cause of death – Statement of the cause of death following the autopsy examination
- i. Comments and opinions – Statement of opinions related to the issues surrounding the death should be included when indicated. If these opinions rely on information in addition to the autopsy itself, this information and its source should be identified.

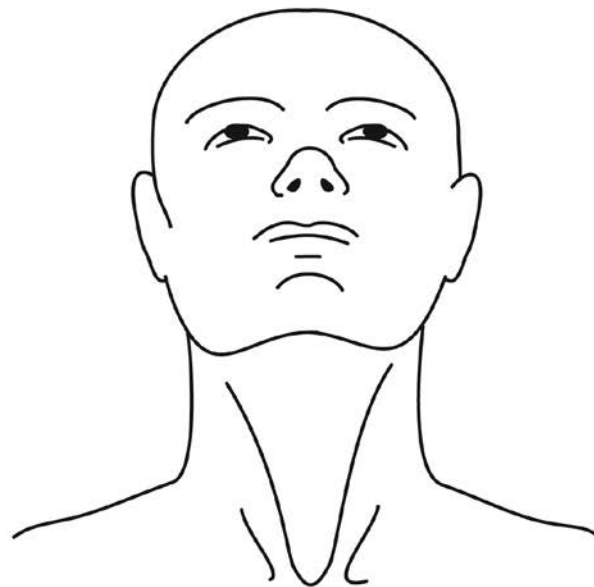
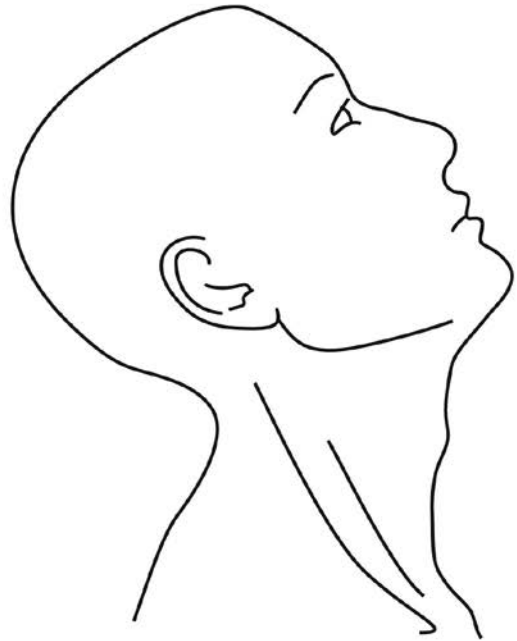
**APPENDIX 4: LINE DIAGRAMS FOR RECORDING INJURIES AND OTHER OBSERVATIONS**



Template 2



Template 3





## **APPENDIX 5: REPATRIATION OF REMAINS ACROSS NATIONAL BORDERS**

### **Background**

It is not uncommon for tourists or foreign visitors to die unexpectedly in a foreign country. By international convention such individuals are subject to the laws of the land with regards to medico-legal requirements for autopsies. Sensitivity to the feelings of and careful communications with the next of kin with regards to such requirements must be ensured.

### **Return of bodies**

Upon the completion of autopsies, bodies should be released to the next-of-kin or their designated representatives for repatriation purposes. It is important to make clear that such arrangements are costly and family members should be advised to confirm with their insurers on how such costs should be met.

### **General requirements**

Documents required for the transport of bodies across national borders include:

- a. Death Certificate containing the Cause of Death written in accordance with WHO ICD conventions
- b. Certificate stating that no infectious diseases are present, particularly those on the list of Notifiable and Contagious Diseases

### **Specific requirements**

These may vary from country to country and also upon the 'carrier' involved. It is not uncommon that the bodies will have to be transported embalmed in sealed coffins. Some states do not allow the transport of HIV or hepatitis infected bodies. Others allow such transport only if embalming is done by 'accredited' individuals.

Cremated remains may be transported but will also need to be accompanied by documentation including a Death Certificate and a Cremation Certificate.

## APPENDIX 6: MANAGEMENT OF DEAD BODIES AFTER DISASTERS

Managing the dead properly following disasters is essential for two purposes:

1. Identifying the dead
2. On some occasions, investigating the disaster

It is not well understood that achieving these purposes has more to do with organisational and management competence than with technical forensic competence. Because failure to achieve the above purposes reflects poorly on the forensic service in the eyes of then public and government, the forensic service needs to research, prepare and rehearse its response to a multiple fatality event.

Of considerable assistance in the research and preparation phase is the Interpol Disaster Victim Identification Guide (Interpol, 2009). This is a 55 page guide written for experts. It does not replace the considerable work needed in all jurisdictions to develop the local plans for responding to a multi-fatality disaster. Included in the Guide is the 18-page DVI form set. This is a highly effective, well recognized tool which has standardized many of the technical aspects of the DVI response in many parts of the world. It divides the response into five phases: scene; post mortem evidence collection; ante mortem data collection; reconciliation and identification; and debrief. At the risk of repetition, this technical tool is only useful if the framework within which it will be used has been organized, documented and rehearsed beforehand.

It will soon become apparent, as the forensic service starts understanding its response to a multi-fatality disaster, that the number of dead and the circumstances of the disaster will at some point overwhelm the capacity of the service. This eventuality can and must be prepared for. See Management of Dead Bodies after Disasters: A field manual for first responders (PAHO, WHO, ICRC 2016)

The two approaches, Interpol DVI and PAHO/WHO/ICRC Management of Dead Bodies, are designed for events of different scale – but they can be used together. There will be many disaster situations where elements of both approaches should be combined for the most appropriate response. The two approaches ‘talk to’ or complement each other. It is NOT the case that one should always follow one or other approach.

The purpose of this Appendix is to remind the reader as strongly as possible that the forensic mortuary needs to be very familiar with both these approaches. The forensic mortuary must have a documented plan in place setting out its response to multi-fatality events of different sizes and different kinds. This will often require leadership to ensure that links are established with other agencies, including police and the National Disaster Response Agency if there is one. These links must be established before the disaster to ensure that the proper co-ordination mechanisms are in place.



## APPENDIX 7: SELF ASSESSMENT QUESTIONS

The following questions are aimed at pathology trainees and consultants. They are intended to stretch the mind beyond simple regurgitation of what is in this manual. The questions could be used as the basis of a group discussion in a tutorial or meeting, perhaps preceded by some writing to address the questions.

1. 'The family of the deceased has a right to know the results of the autopsy'. Discuss.
2. Discuss the circumstances in which a family might wrongly visually identify a body as being their relative (when in fact it is not).
3. A 45 year old man has been found dead in a police cell. The family suspect he was tortured. The police say that he was well when last seen alive, but he was found dead on the floor of the cell two hours later during a routine check. You are responsible for the medico-legal death investigation of this case. What are your responsibilities in this case? What is the importance of 'reviewability' in this case, and what should you do to make sure that your medico-legal investigation, including the autopsy, is reviewable? What will you do to make sure that you discharge your responsibilities properly in this case?
4. Research what is involved in embalming a body, and the uses, advantages and disadvantages of embalming as a solution to the storage of bodies where there is no refrigeration.
5. Describe in detail the procedures that should be followed in the visual identification of a deceased person. Do you think it is a reliable form of identification? If so, why? If not, why not?
6. What is a post-mortem artefact? What are the possible artefacts that can arise during movement of the body from the scene to the mortuary, admission and storage in the mortuary, and during the course of an autopsy?
7. Write the detailed procedures that should apply in your mortuary for the taking of histology and toxicology samples.
8. A pathologist was overheard in a café talking to a colleague saying: 'All this emphasis on quality management is a waste of time. I know how to do an autopsy and what to do with the results. Quality management just produces a huge amount of administration for no real benefit'. Discuss.
9. Have you ever made mistakes in your medical or pathology practice? What were they? Why did they occur? How would you prevent them occurring in the future? (If you have not made any mistakes you are unique!)
10. What are the advantages and disadvantages of the different main autopsy incisions which can be made?
11. What is the reviewability of an autopsy? Why is it important? What can be done to maximise the reviewability of an autopsy?
12. Write the detailed procedures for the taking of microbiology samples that should apply in your mortuary.
13. Summarize the different hazards that staff in mortuaries are exposed to. What steps can be taken to minimise the effect of these hazards?
14. Discuss the concepts of duty, responsibility and accountability in relation to working in a mortuary, whether as a pathologist or a technician.
15. There has been a bus crash resulting in the deaths of 23 men, women and children. The police are at the scene and have rung you for advice. You are the forensic doctor. How will you work with the police? What should be the approach to managing the scene, mortuary, ante mortem data collection, and reconciliation phases of dealing with this disaster?



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### **Psycho-social health of staff while maintaining confidentiality**

A Guide to Debriefing at VIFM at <http://www.vifm.org/about-us/vifm-publications/>>

### **Chemical and radiological hazards in the mortuary**

Radiation: [www.remm.nlm.gov/deceased.htm](http://www.remm.nlm.gov/deceased.htm)

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