Matthias Hübler
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Complications and Mishaps in Anesthesia

Cases
Analysis
Preventive Strategies

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Preface

Experience is like a lantern shining on our back.
It lightens the path lying behind us.
Confucius (551–479 BC)

Do we learn enough from our errors?

Probably yes, but we are not learning enough from the errors of others! Our knowledge increases during our professional life as we master more and more critical situations. This is called experience. Unfortunately, it takes time before we reach a certain level of experience. We just need too many events, and we need errors to happen: errors trigger emotions which trigger learning. Errors are very useful if we are ready to accept personal failure as part of our life.

Working in anesthesiology very often means working alone or working in small teams. The occasions when we can learn from errors of others are limited. Thus, we are learning enough from our errors but not enough from the errors which others experience. The first intention of this book is to reduce this gap by sharing with you our experiences with complications and mishaps in our daily anesthetic practice. The basis of the presented cases were real life events. They were modified such that recognition is impossible. Similarities with real persons are therefore purely incidental. Learn from our errors and do it better!

Doing it better is not easy… The second intention of this book is to assist you to reduce errors. The given tips or clues are not limited to medical facts but also include organizational and nontechnical factors and skills. Latter aspects are included in the case debriefings. In most cases more than one aspect could be discussed, but we focused the debriefings and limited the discussions per case, also to avoid redundancies.

Learning by error is important, but why? Because emotions are involved, negative or positive ones. These emotions influence our perception, our thinking, and our interpretation. Situations, circumstances, and facts immediately become part of our long-term memory. Accessing information, which was stored emotionally, is easy and fast. So the intention of this book is to stimulate you emotionally while presenting the facts – while you learn. The cases therefore tell you the story behind the scenes. These epic parts provide detailed information of the circumstances. Try to get emotionally involved and feel with the protagonists! Maybe you will later remember the facts because you still think about the story behind the scenes.

The second edition of the book was published in 2012 in German. The American edition was completely revised and new aspects of the rapid changing medical knowledge were included. Also, medicolegal and specific professional aspects were adapted.

We hope that you like this new concept of a different kind of textbook. We wish you interesting, stimulating, and maybe even entertaining reading – and learning. Eventually it helps to increase patient safety and improve patient care, because you may not have to experience some of the errors and mishaps yourself.

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Names and Their Meanings

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The names of the main protagonists in this book each have a deeper meaning. For the interested reader, here a list of additional information.

Alexander (Case 27)
Greek name derived from the words alexo (protect) and andros (man), therefore meaning the "protector of men."

Andrew (Case 23)
Greek origin, meaning courageous, manly, strong. Courage is a virtue that turns ordinary men into heroes. Courage is one of the four cardinal virtues, which are the foundation of all other virtues.

Aric (Case 28)
Aric is a variant of Eric, which is a composite of the Norse elements "ei" (ever) and "rikr" (ruler). Its meaning is "one ruler."

Armstrong (Case 2)
The meaning is obviously strong armed. He is a fighter and "the one who fights on his own."

Baldwin (Case 13)
Derived from the Germanic words "bald" (= brave) and "win" (= friend). In our case Baldwin stands for bravery. The brave takes risks that can be avoided and he is willing to carry out difficult and unpleasant tasks.

Benjamin (Case 19)
Hebrew: "son of right." Benjamin also has the meaning "lucky fellow."

Berenice (Case 30)
Berenice has the meaning "bearer of victory." The name has Greek origin incorporating the word nike (victory) and phero (bring).

Blue (Case 20)
Besides standing for a color, it means also "sad."

Buster (Case 16)
Buster is a slang word for a "person who breaks things." It means also "fellow."

Canute (Case 29)
Canute is the Anglicized form of the Old Norse named Knut. It derives from the word "chnuz" (daring).

Casey (Case 9)
The name is more often used for girls than for boys, as in our case. It is derived from the Celtic word "cathasaigh" with the meaning "vigilant, wakeful." As vigilance is the continuous concern for the safety of others, the concern for the safety of others is likewise a constant motivation for vigilance.

Cassidy (Case 27)
Cassidy is Irish derived from the Gaelic name Caiside meaning "clever" or "curly haired." Obviously, the named was not picked because the sharp-witted Dr. Cassidy has curls.

Cedric (Case 22)
Celtic origin with the meaning "friendly, likeable."

Charles (Case 2)
Charles is the English version of the old high German name Karl with the meaning "husband" as well as "free man." In our case Charles is a synonym for freedom. Freedom implies the chance to act independent of external influences.

Clare (Case 10)
Clare is the English form of Clara which is derived from the Latin name Clarus (bright, clear). In our case Clare stands for clarity. Clarity is a result of our attention. The German philosopher Christian Garve states:

"Nature keeps a constant balance between the dark and the bright side of our imagination. Once clarity increases in one part, other parts fall into deep darkness. Every rapprochement of the soul to an object will at the same time increase the distance to all others."

Conall (Case 24)
Conall is an old Gaelic name. The meaning is being strong and brave like a bear. The name is used in several Irish legends.

Conner (Case 25)
Conner is a Celtic name with the meaning "hound lover." It is also associated with the meaning "strong will."

Constantine (Case 3)
Latin: "constant one, not changing, steadfastness." Steadfastness is the resistance against obstacles. Resistance against legal obstacles might often be regarded as stubbornness.

Damel (Case 1)
Damel is of English-American origin and means "a strong-willed man." In our case Damel stands for "determinedness."

René Descartes defined four basic principles in his work "Discourse on the Method": "principle of prudence, determinedness, composure and leisure."

In times of changes from old to new knowledge, it is mandatory for Descartes to hold on to these principles to assure actual survival. The principle of determinedness means to hold on to the likely and persistently declare it as true, but not be paralyzed to act.

Dado (Case 30)
Dado derives from the Spanish verb "dar" (given).

By the use of our senses we become aware of things that are given. Our sensibility provides perceptions and with our understanding they can be thought. Only the unity of sensibility and understanding does result in cognition (Immanuel Kant).

Damian (Case 5)
The word Damianos is Greek and has the meaning "master, overcome, tame." According to Socrates, Daimonion is the inner voice of practical reason and of conscience. This keeps us from indecorous and unreasonable deeds.

Deborah (Case 17)
Deborah means "bee" in Hebrew. Deborah is as busy as a bee.

Diana (Case 9)
Diana is the name of the Roman goddess of the moon, the hunt, forests, and childbirth. She was known for her strength and was often a lone fighter.

Doxa (Case 32)
Australian female name. In our case the name is related to the Greek word "doxa," meaning opinion or belief from which the term orthodoxy derives. Greek human sciences differentiated between knowledge (Episteme) and opinion (Doxa). The science of knowledge (epistemology) is based on facts, truth, and objectivity and differs fundamentally from opinion, subjectivity, prejudice, and emotions.

Eldridge (Senior Physician, Present in Many Cases)
Eldrigde is of Germanic origin. The meaning is old counselor, ruler. The second origin of Eldridge is Old English. Here, the meaning is fearful and terrible. We would like to skip this meaning for our book, although for some senior physicians it might be true.

Elen (Case 26)
Elen is the Welsh form of Helen. In the chapter it refers to the Greek word "elenchos," which means asking and testing. Elenchos is a central technique of the Socratic method in which by debate, critical thinking and formation of new ideas are achieved.

Emerson (Case 8)
Emerson is the son of Emery. It has the meaning brave as well as "the powerful."

Emery (Case 7)
Derived from the Norman name Emmerich with the meaning "powerful ruler."

Ernest (Case 26)
Ernest is an English name of German origin. It is derived from the word "eornost" meaning earnest, seriousness, steadfastness, and battle to the death. Seriousness is often associated with the deliberateness, which is the ability to judge independent of current emotions. So action is guided by serious thoughts.

Faith (Neurosurgeon, Case 32)
The name Faith was adopted by the Puritans in the seventeenth century. In the chapter it stands for confidence and self-confidence. We have confidence because we expect a positive development. Loss of confidence results in insecurity.

Ferdinand (Case 21)
Derived from the Germanic words "frith" (protection) and "nanth" (courage), giving the name the meaning of "brave guardian."

Finn (Case 4)
Finn MacCumhail was a legendary Irish hero. As a surname Mark Twain used it in his novels. The meaning in the case is "young hero."

Greg (Case 15)
Derived from the Greek word gregoros (alert, vigilant). In our case it stands for alertness.

Hardy (Senior Physician, Case 14)
It is derived from the Middle English hardi (brave, hardy).

Harold (Case 16)
Derived from the Germanic words "chario" (army) and "waltan" (rule) and means "leader of the army."

Hugh (Case 18)
It is the English version of the name Hugo. It is derived from the Germanic word "hug" (mind), giving "Hugh" the meaning of a "minded spirit."

Imogen, Called Imo (Case 23)
The English name Imogen derives from Innogen, meaning "innocent." Innocence is defined either by the absence of guilt or as a state in which a person has no possibility to act immoral because he or she not aware of the presence of good and bad.

Justice (Case 3)
The meaning of the name is obvious. It implies fairness.

Leander (Case 18)
It is Greek in derivation and has the meaning "man of the people."

Leto (Case 12)
Greek for forgotten or hidden. In Greek mythology Leto was the mother of Apollo and Artemis.

Mallory (Case 17)
The name Mallory has French origin meaning "unfortunate" or "ill omened."

Marid (Case 31)
The origin of Marid is Arabic with the meaning rebellious. Here, we used it differently: in Arabic "ana marid" has the meaning "I am sick."

Martin (Case 17)
Mars is the Latin god of war. Martin derives from the Latin word "martinus" meaning "of war, warlike."

Maverick (Cases 6 and 7)
The name is English in origin. Maverick is used to describe somebody who is independent and nonconformist in his thoughts and action.

Unbranded cattle on a farm are also called Maverick.

Miriam (Case 27)
Miriam in Hebrew means "rebellious."

Niac (Case 17)
Niac is a variation of the African name Nyack. The name's meaning is "one who is persistent." Persistence is to endure and to overcome difficulties. In accordance to the German philosopher Friedrich Paulsen, persistence is a form of courage and is the strength of our own will to endure all kinds of complaints.

Pia (Case 14)
Female version of the Latin name Pius meaning "pious" and "dutiful."

Perk (Case 32)
Perk has its origins in the English-American language. The name is of the meaning "one who is cheerful and jaunty." Cheerful is close to humor and often the first step of laughing. Humor can be very useful to reduce interpersonal tensions and de-escalate various situations. But humor can become insulting in the form of "schadenfreude."

Pru (Case 11)
Pru is the short version of Prudence. Its origin is Latin (prudentia) and implies the meanings restrained and prudent.

Sage (Case 24)
The English word sage denotes either a spice or a "wise person."

Salvador (Case 19)
Salvador is derived from the Latin word "salvare" (to save). Salvador means saviour.

Sophie (Case 22)
Greek, "wisdom." According to Socrates, one is only wise if he knows the limitation of his human wisdom and is able to distinguish between things he knows and the things he doesn't know.

Spiegel (Case 33)
Spiegel is the German word for mirror. As an exception, a noun as a name is used in this case. Mirror refers to "mirror neurons" which were first described in the 1990s by the research group of Giacomo Rizzolatti. The group discovered that in the brains of primates the same neurons get activated by either performing an action or by solely observing it. Mirror neurons seem to be pivotal to feel empathy and compassion. We can only be empathic because we can mirror the feelings of others to our own neuronal system.

Sven (Case 16)
Derived from the Old Norse word "sveinn" which means "young man" or "young warrior."

Theresa (Case 2)
The name has Greek origin although its meaning is not exactly defined. Often translated as hunter in our case, it means observation (in Greek: parateresis). By observing things we direct our attention to objects and activities and discover their nature.

Tristan (Case 26)
Based on the Celtic name Trystan meaning "tumult," "riot," or "clash of arms."

Valentine (Case 26)
The Latin name Valens means "strong, healthy, vigourous."

Abbreviations

A	Arteria
ABG	Arterial blood gas
ACC	American College of Cardiology
ACCP	American College of Chest Physicians
ACE	Angiotensin-converting enzyme
ACGME	Accreditation Council for Graduate Medical Education
ACh	Acetylcholine
AChR	Acetylcholine receptor
ACLS	Advanced cardiac life support
ACT	Activated clotting time
ADH	Antidiuretic hormone
a-fib	Atrial fibrillation
AHA	American Heart Association
AIRS	Anesthesia Incident Reporting System
5-ALA	5-aminolevulinic acid
ALI	Acute lung injury
aPTT	Activated partial thromboplastin time
ARDS	Acute respiratory distress syndrome
ARDSNET	ARDS network
ASA	American Society of Anesthesiologists
ASAT	Aspartate aminotransferase
ASS	Acetylsalicylic acid
AT III	Antithrombin III
ATLS	Advanced Trauma Life Support
BE	Base excess
BIPAP	Biphasic positive airway pressure
BIS	Bispectral index
BMI	Body mass index
BNP	B-type natriuretic peptide
BP	Blood pressure
BW	Body weight
C	Compliance
$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate
CaO_2	Arterial oxygen content
$Ca(OH)_2$	Calcium hydroxide
CAS	Central anticholinergic syndrome

CBC	Complete blood count
CBF	Cerebral blood flow
CCS	Canadian Cardiovascular Society
cCT	Cranial computer tomography
cGMP	Cyclic guanosine monophosphate
CHD	Chronic heart disease
CHE	Cholinesterase
CHF	Congestive heart failure
CIRS	Critical incident reporting system
CK	Creatine kinase
CK-MB	Creatine kinase, muscle-brain isoenzyme
CMT disease	Charcot–Marie–Tooth disease
CO	Cardiac output
CO_2	Carbon dioxide
$CO_{2\text{-ET}}$	End-tidal carbon dioxide
CO-Hb	Carboxyhemoglobin
COI	Critical oxygen index
COPD	Chronic obstructive pulmonary disease
CP	Cricoid pressure
CPAP	Continuous positive airway pressure
CPP	Cerebral perfusion pressure
CPR	Cardiopulmonary resuscitation
CRNA	Certified Registered Nurse Anesthetist
CRP	C-reactive protein
CSF	Cerebrospinal fluid
CT	Computer tomography
CTG	Cardiotocography
CVC	Central venous catheter
CVP	Central venous pressure
CQI	Continuous quality improvement
CVVH	Continuous venovenous hemofiltration
D&C	Dilatation and curettage
DDADP	Desmopressin
$\dot{D}O_2$	Oxygen delivery
DBS	Double burst stimulation
DGAI	German Society of Anesthesiology and Intensive Care
DIVI	German Interdisciplinary Society of Intensive Care and Emergency Medicine
DSA	Digital subtraction angiography
DVT	Deep venous thrombosis
DSG	German Sepsis Society
ECF	Extracellular fluid
EF	Ejection fraction
EMLA	Eutectic mixture of local anesthetics
EMT	Emergency medical team
ENT	Ear, nose, and throat
ER	Emergency room
EVD	Extraventricular drain

FEV_1	Forced expiratory volume in 1 s
F_iO_2	Inspiratory oxygen fraction
FORDEC	Facts–options–risks–decision–execution–check
FRC	Functional residual capacity
G6PD	Glucose-6-phosphate dehydrogenase
γGT	Gamma-glutamyltransferase
GCS	Glasgow Coma Scale
GOT	Glutamate oxaloacetate transaminase
GFR	Glomerular filtration rate
GI	Gastrointestinal
Hb	Hemoglobin
H_2CO_3	Carbonic acid
HCO_3	Hydrogen carbonate
HCT	Hematocrit
Heliox	Mixture of helium and oxygen
HES	Hydroxyethyl starch
HFNEF	Heart failure with normal left ventricular ejection fraction
HPV	Hypoxic pulmonary vasoconstriction or human papillomavirus
HR	Heart rate
HRV	Heart rate variability
HMSN	Hereditary motor and sensory neuropathy
I:E	Ratio inspiration to expiration
ICB	Intracerebral bleeding
ICP	Intracerebral pressure
ICU	Intensive care unit
ID	Inner diameter
Ig	Immune globulin
INR	International normalized ratio
iPEEP	Intrinsic positive end-expiratory pressure
IPPV	Intermittent positive pressure ventilation
IV	Intravenous
KOH	Potassium hydroxide
LA	Local anesthetic
Laser	Light amplification by stimulated emission of radiation
LDH	Lactate dehydrogenase
LED	Light-emitting diode
LMWH	Low molecular weight heparin
LOC	Level of consciousness
LOI	Limiting oxygen index
MAC	Minimal alveolar concentration or monitored anesthesia care
mADH	Mitochondrial aldehyde dehydrogenase
MAO	Monoamine oxidase
MAP	Mean arterial pressure
MEN	Multiple endocrine neoplasia
MET-Hb	Methemoglobin
MG	Myasthenia gravis
MH	Malignant hyperthermia
MI	Myocardial infarction

MMA	Methyl methacrylate
MMR	Vaccine immunization vaccine against measles, mumps, and rubella
MOCA	Maintenance of certification in anesthesiology
MRI	Magnetic resonance imaging
mV	Millivolt
N	Nerve
NA	Noradrenaline
nAChR	Nicotinic acetylcholine receptor
Na_2CO_3	Sodium carbonate
NADPH	Nicotinamide adenine dinucleotide phosphate hydrogenase
NaOH	Sodium hydroxide
Nd:YAG	Neodymium-doped yttrium aluminum garnet
Nd:YAG-KTP	Nd:YAG potassium titanyl phosphate
NG	Nasogastric
NIBP	Noninvasive blood pressure
NNP	Sodium nitroprusside
NNT	Number needed to treat
NPO	Nothing by mouth
NO	Nitric oxide
N_2O	Nitrous oxide
NPPE	Negative pressure pulmonary edema
NSAID	Nonsteroidal anti-inflammatory drugs
OB	Obstetrician
OCR	Oculocardiac reflex
OI	Oxygen index of flammability
OMS	Oral and maxillofacial surgery
OR	Operating room
ORIF	Open reduction internal fixation
PA	Posteroanterior
$PaCO_2$	Arterial partial pressure of CO_2
PAC	Pulmonary artery catheter
PACU	Postanesthesia care unit
P_AO_2	Alveolar partial pressure of O_2
PaO_2	Arterial partial pressure of O_2
Paw	Airway pressure
PCB	Psoas compartment block
PCC	Psoas compartment catheter
PEEP	Positive end-expiratory pressure
PGI_2	Prostacyclin (also called prostaglandin I_2)
PiCCO	Pulse contour continuous cardiac output
PMMA	Polymethyl methacrylate
PO	Per os (orally)
POD	Postoperative day
PONV	Postoperative nausea and vomiting
P_{Peak}	Peak pressure
PRAC	Pharmacovigilance Risk Assessment Committee
PRIND	Prolonged reversible ischemic neurologic deficit

PTC	Post-tetanic count
PTSD	Posttraumatic stress disorder
PVC	Premature ventricular contraction *or* polyvinyl chloride
Py	Pack year
$\dot{Q}$	Perfusion
R	Resistance
R	Ramus
RAE	Tube tracheal tube developed from W.H. Ring, J.C. Adair, and R.A. Elwyn
RBC	Packed red blood cells
RIFLE	Risk, injury, failure, loss, and end-stage kidney disease
RRP	Recurrent respiratory papillomatosis
RSI	Rapid sequence induction
SAH	Subarachnoid hemorrhage
SaO_2	Arterial oxygen saturation
SCCM	Society of Critical Care Medicine
SIRS	Severe inflammatory response syndrome
SNP	Sodium nitroprusside
SOP	Standing operating procedure
SpO_2	Partial oxygen saturation
SR	Sinus rhythm
ST	Sinus tachycardia
SVR	Systemic vascular resistance
T	Time constant
T_3	Triiodothyronine
T_4	Thyroxine
TEA	Thoracic epidural anesthesia
TEE	Transesophageal echocardiogram
TIA	Transitory ischemic attack
TIVA	Total intravenous anesthesia
TNF-α	Tumor necrosis factor-α
TOF	Train of four
TSH	Thyroid-stimulating hormone
TTE	Transthoracic echocardiogram
TUR, TURP	Transurethral resection (of the prostate)
UGI	Upper gastrointestinal
UTI	Urinary tract infection
$\dot{V}d / \dot{V}t$	Relative dead space ventilation
$\dot{V} / \dot{Q}$	Ventilation–perfusion ratio
$\dot{V}O_2$	Oxygen consumption
VT	Tidal volume
vWF	von Willebrand factor
vWJS	von Willebrand–Jürgens syndrome
WBC	White blood count
WFNS	World Federation of Neurological Surgeons

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Case 1: Retained Placenta

1

Matthias Hübler, Mike Hänsel,
and Karen B. Domino

Contents

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1.1 Case Introduction

>> Julia Mase had always been healthy, and didn't expect pregnancy or birth to change that. At 30 weeks, she was quite surprised to hear her obstetrician say that she should go to the hospital. The baby was fine, but contractions were beginning.

Lying in bed, Julia watched the cardiotocography (CTG) writing a long line of strong and regular contractions. She was told that she had amnionitis; she received antibiotics, magnesium sulfate, verapamil, and a drip to stop the contractions. The cramps in her pelvis felt better, but for the past 2 days, she had begun to feel increasingly ill; the first wave of chills began this morning.

During morning rounds, she was told the infection was worsening, and they would have to induce labor. Shortly thereafter, she was brought to the labor and delivery ward.

Six hours later her son was born, weighing 1,000 g. He was doing well; however, he needed a little extra support with his breathing, Julia was told. She saw him briefly before the neonatologist took him to the neonatal ICU. Although the delivery was much less difficult than expected, Julia was now very tired and sleepy. She vaguely overheard someone mention anesthesia, but she had no clear recollection of what happened next.

After 10 years working in this hospital, Dr. Damel, the on-call anesthesiologist, knew the origin of the numbers which most commonly appeared on his phone. "Labor and Delivery" he

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thought to himself and informed Corinne, the anesthesia technician. They set off for the labor floor, which was at the other end of the medical center, 5 min at a brisk pace.

"*We need to do an immediate D&C for a retained placenta*," *announced the obstetrician* (*OB*) *as Dr. Damel entered the room. The OB had been working in the hospital as long as he had, and Dr. Damel had learned to trust her judgment.*

As technician Corinne wheeled an anesthesia machine into the patient's labor/delivery room and set it up, Dr. Damel reviewed the patient's medical records. The OB was in a big hurry, as the patient was bleeding. There was no time for a complete preoperative evaluation and informed consent. The patient was 29 years old, 5' 6" tall, and weighed 80 kg. At first glance, the following lab results were abnormal:

- *Hb*: *9 g/dl* (*norm 11.9–17.2 g/dl*)
- *HCT*: *26 %* (*norm 37–47 %*)
- *Leukocytes*: *11.0/mcl* (*norm 3.8–9.8/mcl*)
- *Potassium*: *2.9 mEq/l* (*norm 3.8–5.2 mEq/l*)
- *TSH*: *6.2 mU/l* (*0.5–4.5 mU/l*)
- T_3: *2.0 pmol/l* (*2.8–7.1 pmol/l*)
- T_4: *4 µg/dl* (*norm 4.5–11.2 µg/dl*)

1.1.1 How Do You Interpret These Lab Values?

1.1.1.1 Anemia

During pregnancy, plasma volume increases dramatically, by about 45 %. The erythrocyte volume increases as well, but only by about 20 %, far less than the plasma. Therefore, anemia is commonly seen in pregnant women.

However, hemoglobin values under 10 g/dl (HCT <30 %) usually indicate iron deficiency anemia. In the presented case, at the time of the impending D&C, one must assume that the HCT was also low due to blood loss.

1.1.1.2 Leukocytosis

The leukocytosis was probably due to amnionitis.

1.1.1.3 Hypokalemia

Hypokalemia is often found in patients taking diuretics. In this case, hypokalemia is most likely a result of the β_2-agonist therapy. β_2 stimulation causes K^+ ions to move intracellular – an effect often seen in severely injured or trauma patients. The preoperative increased catecholamine levels stimulate the β-receptors and cause potassium influx into cells. However, total body potassium is unchanged.

1.1.1.4 Hypothyroidism

Mild hypothyroidism is often seen in pregnant women, usually due to iodine deficiency secondary to the elevated requirement for iodine during pregnancy.

Rescheduling an elective operation because of hypothyroidism is only done in cases with severe symptomatic deficiency. Rescheduling isn't an option in emergency operations.

1.1.2 Why Shouldn't Potassium Be Administered?

Preoperative potassium administration must be done with care, if at all, due to the dangers associated with giving potassium too quickly (such as cardiac arrest). It should only be considered if the total body potassium is reduced, such as when potassium is excreted, as with diuretics. Potassium administration is not indicated for Julia because the total body potassium is normal and the hypokalemia was due to the intracellular influx of potassium.

According to current practice, potassium administration is only indicated in severely ill patients (CHD, existing arrhythmia, digitalis therapy), or in high-risk operations (cardiac or thoracic surgery, major vessel procedures). Patients without such risk factors can tolerate a potassium level as low as 2.5 mEq/l. Furthermore, chronic hypokalemia is better tolerated than acute hypokalemia. In chronic hypokalemia, the resting potential tends to normalize over time, whereas in acute changes of extracellular potassium levels, there is no time for equilibration, causing an increased risk for cardiac arrhythmias.

>> The patient didn't appear to be much different from the many other postpartum patients Dr. Damel had seen. She was obviously exhausted

from the birth and was asleep. Her complexion hinted at her anemia. The obstetric nurse had already positioned her legs in the stirrups and was prepping for the operation. Anesthesia technician Corinne finished checking the anesthesia machine and hooked up the standard monitoring: *ECG*, *pulse oximeter*, *and a blood pressure cuff*.

1.1.3 Which Form of Anesthesia Would You Choose?

In anesthesia literature, there is consensus that pregnant and laboring patients are at increased risk of aspiration of gastric contents. For this reason, general anesthesia with "rapid sequence induction" (RSI) is generally performed. The goal of the RSI is to secure the airway as fast as possible (Sects. 8.1.2, 8.1.3, 8.1.4, and 8.1.5).

After preoxygenation with 100 % oxygen for 3 min, anesthesia is induced by a hypnotic agent followed immediately by a fast-acting muscle relaxant (succinylcholine or rocuronium).

The Sellick maneuver (cricoid pressure) is generally applied to prevent regurgitation of gastric contents. However, its use is somewhat controversial. Studies [4] have shown that:

- The applied pressure is usually not high enough to close the esophagus.
- Relaxation of the lower esophageal sphincter occurs as a reflex to the pressure.
- Forced vomiting could cause rupture of the esophagus.

It is important to remember that a RSI should only be used when an easy airway is expected. If a difficult intubation is expected, an awake fiberoptic intubation or a regional anesthetic should be considered.

>> *After the preparations were finished*, *Dr. Damel went to the patient to evaluate her and obtain informed consent. Julia Mase*, *however*, *was so exhausted that a discussion was not possible. He glanced at the monitor and saw*:

- *HR*: *130/min*
- *Blood pressure*: *140/80 mmHg*
- S_pO_2: *74 %*

1.1.4 What Is Your Most Important Action Now?

Due to the tachycardia and the poor oxygen saturation, the most important action is to improve the oxygenation. Follow the ABC-rule:

- A(irway): open airway (check tracheal tube).
- B(reath): give oxygen.
- C(heck): also, auscultation of the lungs is essential.

Simultaneously, check the location and function of the pulse oximeter to rule out artifact or malfunction.

>> *The* S_pO_2 *appeared correct*, *with a good wave form. With spontaneous breathing and 100 % oxygen administered by a tight-fitting mask*, *her* S_pO_2 *increased to 91 %. Dr. Damel delegated the mask holding to Corinne*, *the anesthesia technician*, *and auscultated the patient's lungs. The breath sounds were equal and symmetric with no bronchospasm. There were*, *however*, *discontinuous high crackles*. "*She's losing too much blood – we must remove the placenta immediately – put her to sleep now*!" *yelled the OB*.

Dr. Damel took the mask back and injected 120 mg propofol, *then 80 mg succinylcholine. The anesthesia technician Corinne applied cricoid pressure. After waiting a minute until the muscle fasciculations ceased*, *the* S_pO_2 *decreased to 85 %. Dr. Damel took the laryngoscope and began placing it into her mouth*. "*No*!" *he thought in panic when he realized her mouth only opened about 3 cm*, *and only the tip of the epiglottis was visible*.

1.1.5 What Do You Do Next?

The most common causes of difficult laryngoscopy are usually:

- Insufficient depth of anesthesia/muscle relaxation
- Suboptimal patient positioning

Both should be checked (and corrected). Improving positioning might be achieved by raising the head to the sniffing position. In this case, if visualization of the larynx is not improved, then the patient should be ventilated by mask ventilation with a peak pressure of <20 cm H_2O.

If not applied earlier, a second person should apply cricoid pressure to prevent insufflation of the stomach.

>> Position optimization with the help of a pillow did not improve the visualization of the larynx. With S_pO_2 of 80 %, Dr. Damel aborted the intubation attempt and began careful mask ventilation, while Corinne, the anesthesia technician, continued cricoid pressure. As the oxygen saturation slowly reached 90 %, he turned to Corinne and asked "Please get the difficult airway kit from the OR!" The OR nurse then applied cricoid pressure.

1.1.6 Which Airway Adjuncts Can Help You to Intubate in This Situation?

There are numerous airway and intubation assist devices on the market, such as a variety of types of laryngeal mask airways, Fast Track laryngeal mask airway, C-Track, various blades, videolaryngoscopes, fiberoptic bronchoscopes, and Glidescopes. A general recommendation cannot be given about which instrument to use. The decision is best left up to the individual anesthesia provider, as the optimal choice depends on individual experience and the particular patient and situation.

The highest priority in the presented case is securing the delivery of oxygen and simultaneously preventing aspiration. Since simple intubation is not possible, a laryngeal mask airway (ProSeal) may be chosen because these are easy to use, can be quickly inserted, and allow insertion of a gastric tube. The procedure is anticipated to be very brief.

With the countless possibilities available, one must also consider allowing the patient to wake up and then perform an awake fiberoptic intubation. The unexpected difficult airway is a rare, but dreaded, complication in anesthesia. It is important to thoroughly know the American Society of Anesthesiologist's (ASA) Difficult Airway Algorithm [1] and to have a difficult airway cart immediately available.

The use of various intubation assist devices should be regularly practiced in order to be proficient in their use in an emergency situation. In addition to the training, the proper equipment must be immediately available. The additional pressure of time constraints during emergencies increases mistakes, so procedures are better performed when standardized.

The ASA's Difficult Airway Algorithm is important to keep in mind in the event of an unexpected difficult intubation [1]. In addition to memorizing the various steps of this algorithm, it is also important to individualize the ASA's algorithm to fit your own practice based upon your skills and available equipment. An example of such an algorithm is shown in Fig. 1.1.

>> After a few minutes, anesthesia technician Corinne returned out of breath. In the meantime, Dr. Damel continued to mask ventilate the patient and gave 150 mg propofol in divided doses to maintain anesthesia.

He decided to use a ProSeal™ LMA, which proved to be difficult to insert with the restricted mouth opening; opting for a stylet after finger guidance didn't work.

The patient was easily ventilated using the ProSeal™ LMA. A gastric tube was inserted and drained 500 ml of gastric contents. The patient was given fentanyl 200 µg IV. The OB began the D&C, which took 15 min. Anesthesia was maintained with 1 MAC sevoflurane. Due to blood loss, which was very difficult to estimate, the patient received 500 ml of 5 % albumin.

1.1.7 What Should Be Done During Postoperative Care?

Due to the oxygenation difficulties, the patient should remain intubated and be admitted to the ICU for mechanical ventilation. The airway must be secured by an endotracheal tube, perhaps with the help of a fiberoptic bronchoscope.

The ICU team needs to know that extubation must be carried out with a difficult intubation cart handy, and with an anesthesiologist standing by.