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Introduction

'When things go wrong in paediatric anaesthesia' was the working title of this book. Despite his conviction that every anaesthetic should be performed as perfectly as possible, during his professional career the author has observed numerous patients in whom the clinical course was suboptimal, and even some in whom it resulted in harm. In the majority of these cases, at least at some time point, a different clinical decision or an alternative action would have completely changed the outcome.

Based on case presentations, this book aims to give advice on how to avoid some of the most common clinical pitfalls, and to enable anaesthetists to provide safe care to our small patients, following the motto of Albert Einstein, 'A clever person solves a problem, a wise person avoids it.'

The author has spent over 40 years in clinical medicine, training in a university hospital and in several district hospitals. Ultimately, he was responsible for the section of paediatric anaesthesia in a major teaching hospital in Switzerland. The most inspiring time in his professional life was an 18-year period he spent with Professor Thomas M. Berger, a paediatrician, a gifted neonatologist and a great teacher. In many situations, this strong collaboration between an anaesthetist and a paediatrician/neonatologist enabled the author to reach a clear view of the best course of action and to come to conclusions that hopefully are relevant in helping others to learn.

Some of the adverse events described occurred many decades ago, and only fragments of the story could be remembered. In the more recent cases, where more detail is provided, every effort was made to track down the patient and to ask for permission from patient and/or parents to include the individual history in this book. The author is inestimably grateful to all of them for their support in improving the perioperative care of future generations of children.

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2 Concepts and Strategy

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General Safety Rules: Identification of the Patient and the Type of Surgery

Case

Many decades ago, a 6-year-old boy was scheduled for the removal of pins from his right elbow. After inhalational induction, the airway was secured with a laryngeal mask airway (LMA). The child was allowed to breathe spontaneously, an NSAID was given and wound infiltration by the surgeon was planned.

After skin disinfection and draping, surgery started on the right elbow, where a scar was clearly visible. In the meantime, the anaesthesia team filled out the protocol, and realized that, in contrast to the surgical list, the anaesthetist had written 'pin removal left elbow' at the preoperative visit. The senior anaesthetist advised the trainee to correct the protocol, because, as a general rule, the surgical list was assumed to provide the correct facts. However, despite surgical exploration down to the bone, no pins could be seen or palpated, and the surgeon requested to see the x-ray. This x-ray revealed that the reduction and fixation of the fracture had been performed on the left elbow. Obviously, the indication of the site on the surgical list was wrong. Surgery proceeded on the opposite side, and the parents were informed about the error.

Discussion

This case of **wrong-site surgery** illustrates the importance of high-quality team performance. At first glance, wrong-site surgery seems to be a surgical problem. However, in this case, the anaesthesia team could have intervened and therefore has to share the blame. Whenever the slightest discrepancies are noted, alarm bells should ring and the situation has to be re-evaluated. This was not done in this case.

In those days, no use was made of a **patient identification** bracelet, or a formal checklist, or marking of the operation site. None of these was thought to be necessary. Patient identification is of paramount importance. The author is aware of a situation in which rectal premedication with midazolam 15 mg was given to the 3-month-old baby on the arm of the nanny and not to the 5-year-old patient playing hidden in a corner of the room. The children's nanny had a sociocultural background that would not allow her to object to decisions of medical personnel. The author was impressed by this event and subsequently insisted, against the traditional attitude in his institution, that an identification bracelet must be introduced.

The use of a simple **surgical checklist** before skin incision, a so-called 'time-out', would have prevented this event without any doubt. Checklists are a strategy to improve patient safety and perioperative care (Treadwell *et al.* 2014). The introduction of a surgical safety checklist has even been shown to reduce hospital mortality (van Klei *et al.* 2012). If the

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(b)

Figure 2.1a Right elbow with a scar following a mosquito bite.

Figure 2.1b X-ray of left elbow with pins. In this more recent case, surgery was performed on the correct site.

baseline quality of the perioperative process is high, however, the additional impact of a checklist may be small, and it may not necessarily further improve outcome. This has been shown in adult (Urbach *et al.* 2014) and in paediatric populations (O'Leary *et al.* 2016). The delicious irony of the study findings is that, since the mean outcome remained unchanged, there must have been improvement in some institutions, whereas in others the implementation of a checklist in a formerly perfectly functioning system worsened outcome. With this in mind, it is probably good to concentrate on a few, really important checklists (Grigg 2015). The author believes that an inundation with checklists (especially with those in which electronic checkboxes are ticked on a screen) will not necessarily contribute to improvement of safety (de Vries *et al.* 2009).

Almost a decade ago, the author began to work through a very simple oral **checklist before the induction of anaesthesia**: patient, intervention, absent allergies, drawn-up medications (hypnotic, relaxant and atropine), anaesthesia machine with tubing, and airway equipment (laryngoscope with the correct blade and the correctly sized tube). This improved safety, because in numerous cases something could be added or improved.

Finally, it is always smart to have a look at the site of surgery before surgery starts. In the presented case, the anaesthetist would not have palpated any pins. This would have been unusual after an elbow fracture and, consequently, the x-ray would have been checked. In addition, such an evaluation might also allow some prediction of the potential duration of surgery.

Summary and Recommendations

This case of wrong-site surgery emphasizes the importance of a high-quality, standardized process in perioperative care.

Following a preoperative checklist (so-called 'time-out') would surely have prevented this complication.

Wrong-site surgery is not a complication caused exclusively by the surgeon. In most cases, it is the consequence of insufficient team performance. In the presented case, the anaesthesia team noted the discrepancy but, unfortunately, none of the members spoke up to stop the start of surgery.

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Case 2.1: General Safety Rules

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Adequate Anaesthetic Plan

Case

Many decades ago, an 8-month-old boy, weighing 8 kg, presented with a rapidly growing cavernous haemangioma involving the neck and face on the right side. The surgical plan was to ligate the external carotid artery, and then, if feasible, partially resect the haemangioma. Both a low platelet count, $20\,000/\mu$ l, and an elevated prothrombin time were known preoperatively.

A moderately experienced anaesthesiology trainee was in charge, intermittently supervised by a senior staff member. Anaesthesia was induced with ketamine and succinylcholine; enflurane and repeated boluses of ketamine and alcuronium (a non-depolarizing muscle relaxant with some potential for histamine release) were used for maintenance. Monitoring included a precordial stethoscope, ECG and the new oscillometric blood pressure monitoring device Dinamap. The described incident happened well before the introduction of pulse oximetry into clinical practice, continuous capnography was not yet available, and invasive blood pressure monitoring had never been used in children in this institution before.

First, venous access was achieved by surgical cut-down at both elbows, and two units of platelets (about 70 ml each) were administered. Shortly after incision at the neck, the Dinamap could not record 'interpretable values' and was thought to be malfunctioning. Noise impeded the use of the precordial stethoscope. Only minutes later, the surgeon could no longer feel the pulsating carotid artery used for orientation. This was followed by bradycardia with wide complexes on the ECG screen.

The supervising anaesthetist rushed in and suggested the administration of Lanoxin, a digitalis preparation, and left to calculate the dose. The trainee remembered that he had used dopamine in adults in cases with cardiovascular instability and started a dopamine drip. Surgery was cancelled, and the infant was transferred to the ICU. Despite the fact that circulation could be restored, the pupils remained dilated and the patient died.

Discussion

This case highlights the importance of an **adequate anaesthetic plan** and the understanding of the pathophysiology of the underlying disease. The anaesthesia team was not aware of congestive heart failure caused by massive hypercirculation through large haemangioma vessels (Fig. 2.2). Fluid overload by approximately 20 ml/kg of platelet concentrates led to circulatory collapse in this frail patient. Today, hyperdynamic pump failure would be documented by echocardiography prior to surgery and would therefore be known to the anaesthetist. Undoubtedly, such a complex case would be done by a senior staff member and not by a superficially supervised young trainee. It is well known that the experience of

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Case 2.2: Adequate Anaesthetic Plan



Figure 2.2 Another large haemangioma related to increased cardiac output. A photo of the boy from the presented case is unfortunately not available.

the anaesthetist and the age of the patient are the main predictors of complications (Habre *et al.* 2017).

From today's point of view, **invasive monitoring**, including an arterial line, would be considered standard for such a case. In addition, vasoactive drug drips, e.g. dopamine or noradrenaline, would be prepared before starting the case. In those days, oscillometric blood pressure monitoring was a new technology, and invasive blood pressure monitoring, both in adults and in children, was mainly used in cardiac centres. In this institution, it had never before been used in children. At the time, many practitioners felt that arterial and central venous lines could not be used in small children. Physicians working in university centres, except perhaps for those with experience in dedicated cardiac units, shared this attitude. Surgical cut-downs were often performed for the insertion of venous lines. Pulse oximetry did not yet exist, and capnography was not available.

In summary, from today's perspective, a team with insufficient experience started the case without being adequately equipped and prepared. This case impressively shows that the customary standard in an institution does not necessarily meet the desirable standard. This emphasizes the importance of continuous exchange between institutions. What was standard practice yesterday may no longer be acceptable today.

Kasabach–Merrit syndrome is characterized by giant haemangioma(s) and thrombocytopenia, often complicated by hyperdynamic cardiac failure (Kumar *et al.* 2013, Wang *et al.* 2014). Recently, beta-blockers, especially propranolol, have become the first-line treatment for cutaneous (Kum & Khan 2014) as well as subglottic (Hardison *et al.* 2016) haemangiomas. For these conditions, treatment with surgical excision or laser therapy has become rare. Initially, the patient should be monitored, since hypotension, bradycardia and hypoglycaemia can occur. Obviously, beta-blockers should not be used in patients with high-output cardiac failure.

Summary and Recommendations

The presented case illustrates that an insufficiently prepared and equipped team can contribute to a bad outcome. To be fair, the described events should be seen in their historical context, when the approach taken was the accepted standard of care.

Another important conclusion that can be drawn from this case is the fact that when blood pressure cannot be measured, it is usually not a technical problem, but blood pressure is really low and urgent treatment is needed.

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Chapter 2: Concepts and Strategy

The key message of this case is that every anaesthetist should continuously examine his or her own practice. Improvements in the field of anaesthesiology will continue to be made. What was standard practice yesterday may no longer be good enough today.

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