Pocketbook

Radiology

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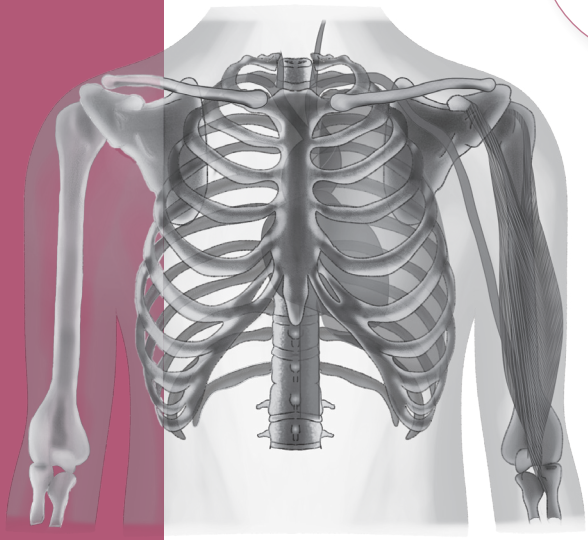
QUALITY
GUARANTEED
BY MEDICAL SPECIALISTS



Compendium
medicine

A completely new pocket on diagnostic imaging and radiographic findings in the most important acute diagnoses.

The Compendium Method®
Manual

In *Compendium Medicine* we use the same concise, visual and schematic description of the various medical specialties as much as possible. Everything is geared towards overview and structure, facilitating study and practice. We call this the Compendium Method.

Fixed layout

All our medical specialties are presented in the same, recognisable way and each has its own colour and icon. The pocketbooks have a fixed chapter structure. The table of contents of each pocketbook tells you exactly which topics are covered. The symbols in the corner of the page indicate the specialty or chapter.

- ATLS
- Anatomy
- Physiology
- Patient history
- Physical examination
- Diagnostics
- Treatment
- Differential diagnosis
- Conditions
- Clinical reasoning
- Appendixes
- References
- Abbreviations
- Index

Illustrations

The images provide at-a-glance insight into topics like anatomy or the typical patient. They are also intended for study and practice, for example by checking whether you can identify the letters in a picture without looking at the caption.

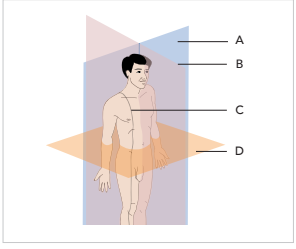


Figure 1 // Anatomical planes
A: Coronal/frontal **B:** Median **C:** Sagittal **D:** Axial/transverse

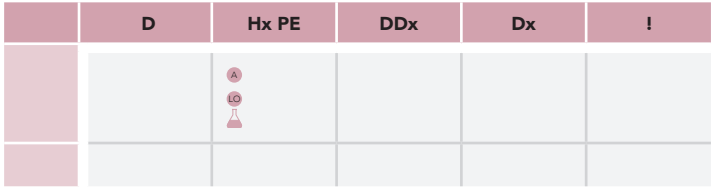
Conditions

Each condition in this pocketbook starts with a full-sentence definition, followed by a telegram-style explanation. For each condition the following icons (as applicable) are discussed. The icons are also useful when studying: you can cover the text and quiz yourself.

- D Definition
- E Epidemiology
- Ae Aetiology
- R Risk factors
- Hx Patient history
- PE Physical examination
- DDx Differential diagnosis
- Dx Diagnostics
- Tx Treatment
  - General
  - Paramedical care
  - Drug treatment
  - Invasive, non-medicated treatment
- P Prognosis
- ! Watch out/don´t forget

Tables

We make as much use as possible of tables, for example to compare conditions. In this way, the differences are immediately clear. Features that match are centred over the columns to which they apply. This allows you to see the similarities and differences right away.



Diagrams

→ = positive/yes/+ → = negative/no/-

Diagrams help you reason clinically starting from a particular symptom, using the green and red arrows as signposts. Always remember that the full differential diagnosis may consist of multiple diagnoses.

Icons & frames

Throughout this pocketbook you will find highlighted frames.

QR code	Note	Reference to another chapter
Alarm!	Description of the typical patient	Formula
Mnemonic		

Punctuation marks

The punctuation in our books also focuses on overview and ensures that the subject matters are covered concisely and effectively.

(--) Rare	(++) Most common	↓ Decrease
(-) Uncommon	→ Consequence	♀ Female sex
(+) Very common	↑ Increase/improvement	♂ Male sex

Abbreviations

We make extensive use of abbreviations, medical terms and symbols for scientific units and quantities. Below are some examples of the abbreviations used in this pocketbook.

sec	second/seconds	mo	month/months
min	minute/minutes	min.	minimum
hr	hour/hours	max.	maximum
d	day/days	e.g.	for example
wk	week/weeks	L	litres

Index

The pocketbooks include a comprehensive and easy-to-use index. It contains all the topics covered in the books so you can quickly navigate and find the information you are looking for.

Appendixes

In the pocketbooks you will find space for your notes. In addition, handy appendixes have been added; these contain specific information that you would like to have at hand and are therefore located at the back of the pocketbooks.

His/her

We realise that sex and gender identity are not binary and that there is more variation than just 'woman' or 'man'. For the sake of the readability, however, we have chosen to use the pronouns he/him when referring to anyone, regardless of sex or gender identity.

Want to know more about the Compendium Method? Scan the QR code.

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Contrast

Contrast agents

During imaging studies, patients may be administered a contrast agent. Contrast agents are chemical agents that provide better contrast and make it easier to differentiate tissues. Contrast agents are usually administered intravenously, as this enables assessment of e.g. abdominal organs or blood vessels and highlight pathology susceptible to contrast enhancement, such as tumours or vascular malformations. Contrast agents may also be administered orally or rectally to assess post-operative anastomotic leakage or assess the course of and passage through the digestive tract, for example. Contrast agents can also be injected intra-articularly to better assess intra-articular structures like the labrum. See table 1 for the most commonly used types of contrast agents and the corresponding imaging techniques and routes of administration.

When using contrast, patients may be scanned in several phases, following the contrast agent through the body as it passes various organs. The appropriate scanning phase therefore depends on the clinical question.

CONTRAST AGENT	IMAGING TECHNIQUES	SPECIFIC TARGET ORGAN	ROUTE OF ADMINISTRATION
Barium sulphate	Conventional (swallow test, dynamic rectal exam - DRE), CT	Digestive tract	Oral, rectal
Iodinated	CT, conventional (e.g. for choking or anastomotic leakage)	Varying, scan phase depends on contrast agent's route of administration	Intravenous, oral, urethral, intra-articular
Gadolinium	MRI	-	Intravenous, oral, intra-articular
Primovist		Liver/bile ducts	Intravenous

Table 1 // Various contrast agents with their corresponding imaging techniques and routes of administration

Guidelines for imaging during pregnancy

During pregnancy, the fetus is highly susceptible to the adverse effects of radiation and drugs. This is because rapid and frequent cell division takes place in an embryo/fetus, which makes DNA extra susceptible to iatrogenic damage from X-rays and other sources (see table 2). In addition to the fetus, any other rapidly dividing tissue, such as mammary tissue, has an increased risk of iatrogenic damage from X-rays. It is important to keep health risks for both mother and child in mind when requesting certain types of imaging.

Although the degree of sensitivity of these tissues depends on the stage of pregnancy, the X-ray recommendations are the same at each stage.

During X-ray imaging, avoid using a lead apron or lead screens. The current generation of X-ray cameras automatically adjust the radiation dose based on the amount of radiation reaching the detector plate (Automatic Exposure Control (AEC)). Using a lead apron/lead screens can increase scatter radiation. The number of rays reaching the detector plate will also decrease, prompting the X-ray camera to automatically increase the radiation dose.

Ultrasound devices of the radiology department use different settings compared to ultrasound devices used in obstetricts and by gynaecologists. Even though ultrasounds are considered safe during pregnancy, it is recommended not to directly image the fetus or use Doppler ultrasound to image adjacent structures during early pregnancy.

IMAGING MODALITY	RISKS DURING PREGNANCY	RISKS DURING BREASTFEEDING	CONSIDERATIONS
Conventional X-ray exam	Low radiation exposure → mildly teratogenic	None	Only if strictly necessary. Try to limit radiation exposure to a minimum.
Ultrasound	None		Can be safely used during pregnancy
CT scan • Child	High radiation exposure → teratogenic	None (if contrast is used - see below)	• Consider whether an ultrasound or MRI is a suitable alternative. If this is not possible, try to minimise radiation exposure. • Radiation dose depends on the type of scan and stage of pregnancy (e.g. CT for pulmonary embolisms with indirect foetal radiation before the end of the 3rd trimester vs. CT abdomen with direct radiation).
• Mother	During pregnancy and after delivery, mammary tissue is at risk of iatrogenic damage due to its proliferation in preparation for the lactation period	During pregnancy and after delivery, mammary tissue is at risk of iatrogenic damage due to its proliferation in preparation for the lactation period	
MRI scan	Can be safely used during pregnancy >18 wks. Possible risks for the child in the 1st trimester have not yet been fully investigated. Likely no risks at low magnetic field strength (≤1.5 Tesla).	None	• The risks posed by MRI during pregnancy have not yet been fully investigated. • MRI is always preferred over a CT scan in pregnant women, if possible
Contrast exam	For all types of contrast agent, carefully consider whether the exam must be performed during pregnancy and whether the use of contrast agent is necessary	For all types of contrast agent, carefully consider whether the exam must be performed during pregnancy and whether the use of contrast agent is necessary	
• Iodinated contrast agent (IV)	Probably safe. The risk of affecting foetal thyroid gland function seem small.	Safe. A small amount of contrast agent enters breast milk (iodine 1%, gadolinium 0.04%), and it is poorly absorbed by the neonate's gastrointestinal tract.	The use of contrast agent is not recommended unless it significantly improves the diagnostic process and therefore the foetal and/or maternal outcome
• Gadolinium-based contrast agent (IV)	Unknown. In patients, gadolinium is deposited in the brain. Effect on fetus unknown.		
Barium sulphate (oral)	Unknown	Unknown	The risks of barium sulphate are unknown, so it is generally not recommended in pregnant women. An iodinated oral contrast agent diluted with water can serve as an alternative.

Table 2 // Imaging risks during pregnancy

Radiologic signs of child abuse

Child abuse, also known as 'non-accidental injury' (NAI), is a difficult subject. Doctors rarely expect to find child abuse and do not want to assume that injuries are inflicted deliberately. Confronting the parents can also be challenging and the resulting investigation may have a significant impact on both the parents and the environment of the child. This is why it is important to recognise the signs of NAI on conventional imaging and conduct a thorough and repeated history, preferably including a collateral history with eyewitnesses (e.g. other parents) to the trauma.

On suspicion of child abuse, imaging can play a vital role. Situations in which to suspect child abuse:

- Injury inconsistent with the reported trauma mechanism;
- Injury in an unusual location;
- Injury inconsistent with the child's developmental stage;
- Long delay before seeking medical help.

If a particular fracture is inconsistent with the child's age (e.g. a femoral fracture in an infant), the person assessing the image should be extra alert to the possibility of child abuse (see table 3). In case of strong suspicions of child abuse, a comprehensive skeletal survey may be performed to identify occult or old fractures that support the suspicion.

Injuries raising the suspicion of child abuse are sometimes described as 'non-accidental injury' (NAI) in the radiological report.

It is important to always consider whether an injury is consistent with the trauma mechanism. For example, a transverse humeral fracture supposedly resulting from a fall is highly suspicious, while a direct impact injury (e.g. kick from a horse) is less suspicious.

When in doubt, consultation between the requesting physician and radiologist is important!

TYPE OF FRACTURE	TRAUMA MECHANISM	SPECIAL ATTENTION IS WARRANTED IN:
Combination of sternum fractures, scapula fractures, posterior rib fractures/spinous process fractures, skull fractures and/or brain injuries (subdural haematoma (SDH), subarachnoid haemorrhage and cerebral oedema)	Severe shaking/anterior-posterior force (ie. shaken baby syndrome) Slap on the back (fracture spinous process)	• All children, but pay special attention to children who are not yet able to walk or children who are regularly presented with injuries. • Impaired consciousness. This may be indicative of an SDH.
Metaphyseal corner fractures and avulsion fractures	Push and pull forces, shaking the child back and forth by holding the torso as the head and limbs move back and forth (shaken baby syndrome)	
• Multiple fractures in different stages of healing • Signs of fractures sustained at ages of the child	Repeated trauma	
Vertebral fractures, vertebral compression fractures	Compression (axial impact)	
Femur fracture, humeral fracture and radius/ulna fracture	High impact force, acceleration-deceleration forces	
Transverse or spiral fractures of the long bones	Rotational forces	

Table 3 // Radiologic signs of child abuse.
Red: very specific **Orange:** moderately specific **Yellow: l**ittle specific.

In children with fractures, always consider whether the trauma mechanism is consistent with the injury (see figure 1). Blaming a brother/sister or the absence of parents are warning signs in the patient history. Always double-check the patient history, ask about what happened several times, preferably speak to both parents separately and, if possible, have another adult testify in case of strong suspicions of child abuse.

Proper screening is also important, as some underlying conditions can closely resemble non-accidental injury on diagnostic imaging, such as haemorrhages in coagulopathy, skeletal abnormalities in connective tissue disorders (including osteogenesis imperfecta), metabolic diseases or skeletal dysplasia. Even normal anatomical variation may resemble (abusive) injuries (see section Trauma mimics).

For more information, see the section on Trauma mimics.

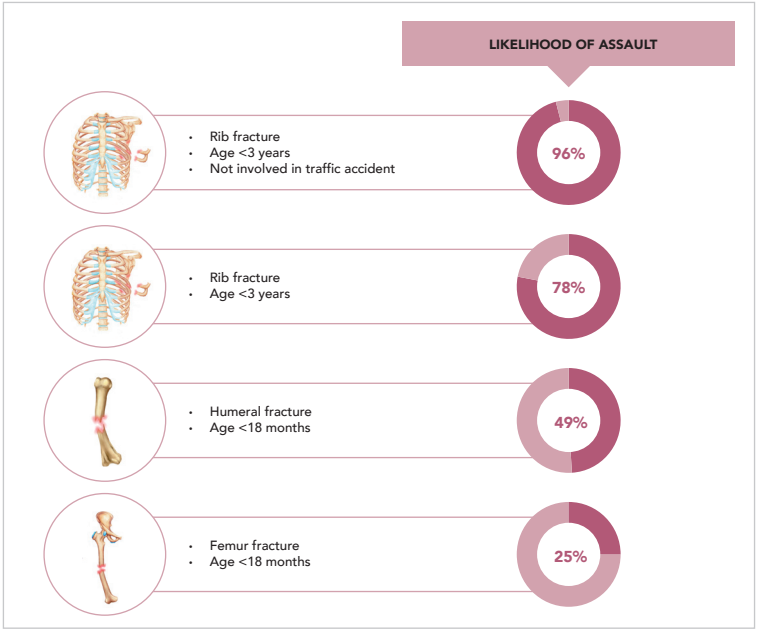

Figure 1 // Probability of child abuse based on fracture findings

Suspect **H**arm from **M**other **OR F**ather:
S: sternum, scapula, spine/vertebrae
H: humerus, head, hands*
M: multiple fractures, metaphyseal corner or other avulsion fractures
O: old fractures
R: ribs
F: femur*, feet*
* Especially suspicious in children who haven´t started walking.

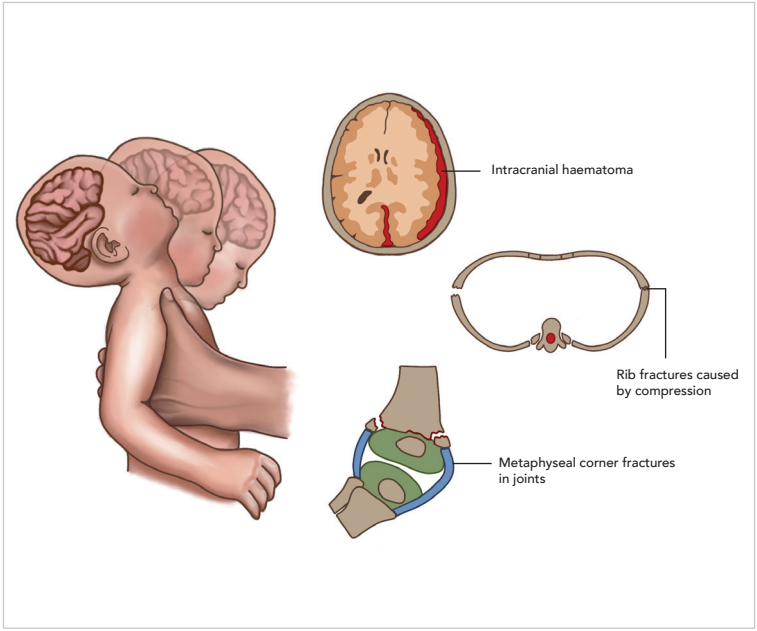

Figure 2 // Signs of shaken baby syndrome

Endovascular procedures

<table>
<tr><th></th><th>CVL</th><th>PICC LINE</th><th>MIDLINE CATHETER</th></tr>
<tr><td>Placement
• Insertion point</td><td>• Internal jugular vein
• Axillary/subclavian vein
• Superficial femoral vein</td><td colspan="2">• Brachial vein
• Brachiocephalic vein</td></tr>
<tr><td>• Catheter tip</td><td colspan="2">Superior/inferior vena cava</td><td>Axillary vein</td></tr>
<tr><td rowspan="3">Indications</td><td colspan="3">Long-term antibiotic (AB) use</td></tr>
<tr><td colspan="2">• Central access
• Parenteral nutrition
• Chemotherapy
• Central AB therapy</td><td rowspan="2">Venous access for at least ± 2 wks</td></tr>
<tr><td>• Haemodialysis
• Central venous pressure measurement (CVP)</td><td>Venous access for at least ±4 wks</td></tr>
<tr><td rowspan="2">Contraindications</td><td>Home treatment</td><td>Relative: PICC line via left arm in case of pacemaker/ICD due to conflict between catheter and leads</td><td></td></tr>
<tr><td></td><td colspan="2">Acute situation (CVL preferred)</td></tr>
<tr><td rowspan="3">Complications</td><td colspan="3">Thrombus risk ↑ (CVL preferred)</td></tr>
<tr><td colspan="2">• Arrhythmias
• Haemo-/pneumothorax</td><td></td></tr>
<tr><td colspan="3">• Arterial puncture
• Sepsis
• (Line tip) thrombosis</td></tr>
</table>

Table 4 // Types of venous access

A midline catheter is very similar to a PICC line, but is not centrally located because the tip of the catheter does not pass the axillary vein.

After the central line has been inserted, a chest X-ray should be made to assess its position and potential complication.

Not all forms of venous access are suitable for administering contrast during imaging, mainly due to the size of the lumen and the corresponding flow rate. Check this beforehand to avoid the risk of the line breaking in the patient.

Venous access

The peripheral venous catheter is a common form of venous access. For longer-term venous access or for certain medications, a more centrally placed line may be required (see figure 2). Depending on the indication, you can choose between a central venous line (CVL), peripherally inserted central catheter (PICC) line or midline catheter (see table 4). Depending on which medication is to be given through the line, one, two or three lumens can be chosen.

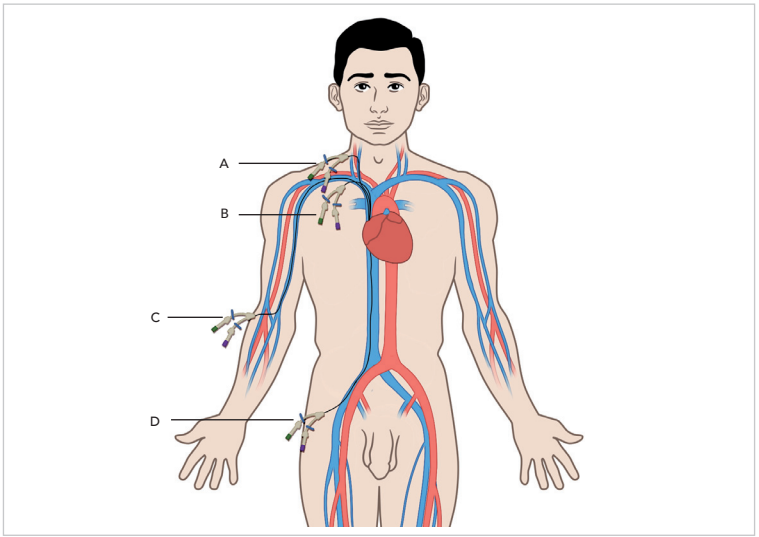

Figure 2 // A: CVL via jugular vein **B:** CVL via subclavian vein **D:** Femoral catheter via femoral vein **C:** PICC line via brachiocephalic vein

Acute pathology

CONDITION	D	Hx PE	DDx		Dx	!
Appendicitis (acute)	Acute inflammation of the wall of the vermiform appendix located in the extension of the caecum near Bauhin's valve.	PE Point tenderness over McBurney's point, psoas sign + Flask CRP ↑, leukocytes ↑	Adults: • Gastroenteritis • Cholecystitis • Right-sided diverticulitis • IBD (Crohn's disease/colitis ulcerosa) • Tubo-ovarian abscess (TOA)/pelvic inflammatory disease (PID) Children: • Gastroenteritis • Mesenteric lymphadenitis • Intussusception • (inflamed) Meckel's diverticulum		• Abdominal ultrasound: demonstrating appendicitis (pain near appendix, incompressible appendix, transverse diameter appendix >6 mm, wall thickening >2 mm, peri-appendicular inflamed fat, free fluid, appendiceal faecoliths (see figure 3). • CT abdomen with IV contrast if ultrasound is inconclusive despite strong suspicion: appendix diameter >6 mm, appendiceal faecoliths, peri-appendicular inflamed fat • Abdominal MRI in pregnant women and sometimes in children if ultra-sound is inconclusive despite strong suspicion: diameter of appendix diameter >6 mm, wall thickening, appendiceal faecoliths, restricted diffusion	• Complicated appendicitis: presence of faecoliths, disappearance of mucosal layer, abscess formation and/or suspected perforation • Free air secondary to perforation of the appendix is rare • In obese patients, a non-contrast CT abdomen may suffice because the intestinal loops are further apart due to mesenteric fat ↑, increasing the visibility of local inflammations. • Symptoms secondary to malignancy, e.g. mucinous cystadenoma
Cholecystitis	Acute inflammation of the gallbladder usually due to an obstructing gallstone in the neck of the gallbladder or cystic duct.	H Colic pain + PE Murphy sign + Flask CRP ↑, leukocytes ↑	• Cholecystolithiasis • Choledocholithiasis • Pancreatitis • Acute hepatitis • Appendicitis (retrocaecal or elevated caecum)		Abdominal ultrasound: demonstrating cholecystitis - sonographic Murphy sign, incompressible gallbladder (hydrops), gallstones, wall thickening (>3 mm) (see figure 4). Depending on the location of the obstruction, dilated bile ducts may also be seen in the liver and pancreas.	• Possible symptoms with an obstructing/passed stone in the choledochal duct (duct diameter >5 mm) • Gangrenous inflammation with abscess formation or perforation of the gallbladder. Cholecystolithiasis is an important risk factor for acute cholecystitis. In case of recurrent symptoms, elective cholecystectomy may be considered. • Acalculous cholecystitis: cholecystitis without obstructive concrement (2-18%)
Pancreatitis	Acute inflammation of the pancreas, usually caused by gallstones or alcohol consumption.	H Epigastric pain (radiating to back) PE Peritoneal excitation +/- Flask Lipase ↑, (amylase ↑), CRP ↑	• Ulceration • Cholecystolithiasis • Gastrointestinal perforation		• CT abdomen with IV contrast: oedematous pancreatic parenchyma, peripancreatic fat stranding, locoregional lymphadenopathy • Important: pancreatitis is primarily diagnosed based on clinical and lab findings. A CT can help assess severity and necrotising component approx. 3 days after onset of symptoms.	• Abdominal ultra-sound does not rule out pancreatitis and therefore has little added value. In biliary pancreatitis, ultra-sound can be used to detect gallstones. • In pancreatitis due to an obstructing stone near Vater's papilla, an ERCP may be performed by the gastroenterologist • Cave necrotising pancreatitis involv-ing extensive necrotising fluid collections due to the lytic properties of the released pancreatic enzymes

Tabel 5A // Acute pathology of the abdomen

In children, referred pain due to pneumonia can mimic abdominal conditions.

Inflamed fat is also known as *fat stranding*.

CONDITION	D	Hx PE	DDx		Dx	!
Diverticulitis	Inflammation of one or more (false) diverticula (bulging pouches in the intestinal wall) usually of the sigmoid and colon, but possibly also of the duodenum.	H Pain (mostly) in lower left abdomen, altered bowel habits, rectal bleeding PE T ↑ CRP ↑, leukocytes ↑	• Gastroenteritis • Obstipation • IBD (Crohn's disease/ colitis ulcerosa) • Appendicitis		• Abdominal CT: presence of diverticula, perifocal inflamed fat, free fluid and possible abscess formation • CT abdomen with IV contrast: diverticula with fat stranding, possibly (covered) perforation and abscess formation	• In Caucasian patients, diverticula are mainly (95%) localised in the sigmoid, in patients with an Asian background, they are mainly (75%) found in the ascending colon • In cases of suspected complicated diverticulitis (with abscess formation), CT abdomen is the first choice, as deep-seated abscesses are easier to miss on ultrasound
Mesenteric lymphadenitis	Inflammation of the lymph nodes of the abdominal cavity, occurs mostly in children <15 years of age.	Presentation similar to appendicitis: H Abdominal pain over McBurney's point, N+, V+ CRP ↑	• Appendicitis • Invagination • Obstipation		Abdominal ultrasound: rule out appendicitis, ≥3 enlarged lymph nodes in the lower abdomen (>5 mm)	Mesenteric lymphadenitis is a diagnosis of exclusion, self-limiting and often does not require treatment
Necrotising enterocolitis (NEC)	Life-threatening neonatal intestinal infection often associated with intestinal ischaemia. Does not occur outside the neonatal period.	H Rectal bleeding, (bilious) vomiting PE Abdominal distention and tenderness, enhanced vein definition, signs of shock	• Infectious enteritis/colitis • Spontaneous intestinal perforation • Volvulus • Intussusception • Meconium ileus • Cow's milk protein allergy • Hirschsprung or other congenital disorders		Abdominal X-ray:dilated intestinal loops, intestinal pneumatosis, air in portal veins and, in case of perforation, free air in the abdominal cavity	• Risk factors: preterm birth (< 32 wks), dysmaturity • High mortality (15-30%) • Granular faeces (stool with soap bubble sign on abdominal X-ray) does not occur in the first weeks after birth, so this could be consistent with intramural gas.

Tabel 5B // Acute pathology of the abdomen

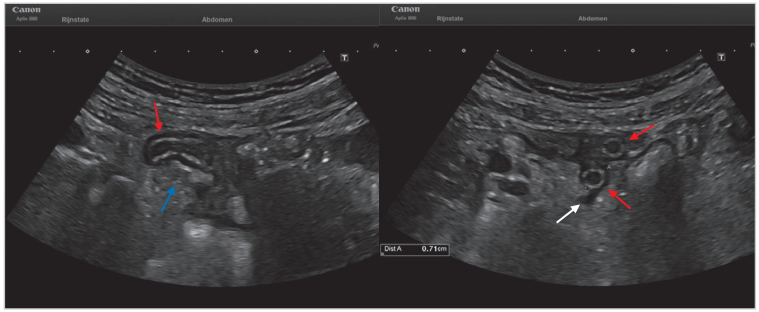

Figure 3 // Acute appendicitis with wall thickening (red arrow) up to 7.1 mm, peri-appendicular fat infiltration (blue arrow) and peri-appendicular fluid (white arrow)

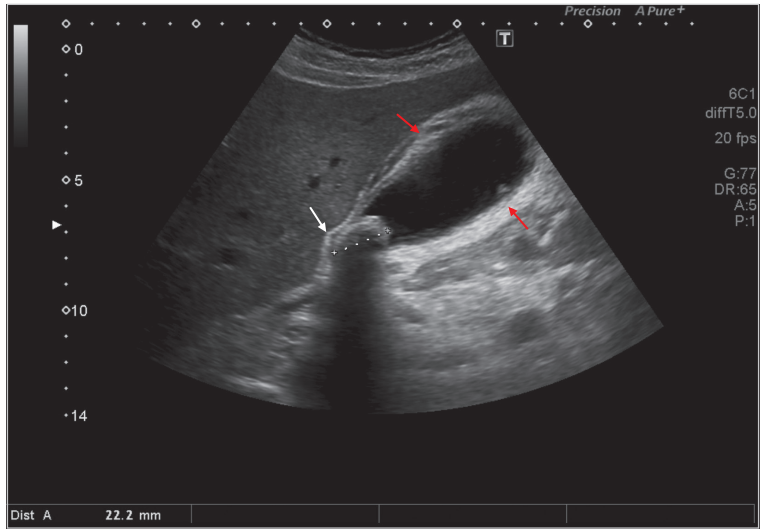

Figure 4 // Cholecystitis secondary to cholecystolithiasis.
Hydropic gallbladder with wall thickening (red arrow) secondary to an obstructing 22 mm stone in the neck of the gallbladder (white arrow).