Long-term Outcome After Surgical Ligation for Treatment of Congenital Portosystemic Shunts in Dogs

H.J.H. GERRITS BSc

Master thesis, Department of Small Animal Medicine, Utrecht University, Supervisor: A. Kummeling

Abstract

Objectives: To report long-term clinical outcome in dogs treated for congenital portosystemic shunting (CPSS) with complete or partial ligation and to develop a scoring system to determine persistent shunting. Also to report the predictive value of pre-operative albumin, white blood cell count, fasting plasma ammonia concentration and fasting plasma bile acid concentration for the long-term outcome, and to determine the percentage of persistent and recurrent shunting in a group of patients that came back for a long-term follow up.
Study Design: Retrospective study.
Animals: 167 dogs with surgical attenuation of an intra- or extrahepatic CPSS.
Procedure: Medical records of dogs with CPSS treated by ligation were reviewed pre- and postoperative short and long-term. Long-term information was obtained by telephone interviews with veterinarians and questionnaires sent to the owners. With use of the questionnaires a CPSS scoring system was developed. A randomized group of 21 dogs came back for a control visit for persistent or recurrent shunting. Logistic regression analysis was used to determine the predictive value of pre-operative albumin, white blood cell count, fasting plasma ammonia concentration and fasting plasma bile acid concentration for persistent shunting after surgery.
Results: Preoperatively the majority of the dogs suffered from decreased activity, decreased appetite, gastrointestinal signs and signs of hepatic encephalopathy. Dogs which had the ammonia metabolism tested (fasting plasma ammonia concentration, ammonia tolerance test), all had an abnormal ammonia metabolism. The fasting plasma bile acid concentration was above reference for the majority of dogs that were tested. During surgery the majority of the shunts were partially ligated. The postoperative mortality rate (< 1 month) was 11%. During the routine control visits after surgery all dogs of the study population were clinically improved. With the use of the questionnaires a basic scoring system for CPSS was developed. Preoperative a mean CPSS score of 43 (SD 27) was calculated, postoperative the mean CPSS score was 11 (SD 13). This improvement in CPSS score was significant ($P < 0.001$). During the extra control visit of the randomized group of dogs, 58% of the dogs had no shunting, 16% had asymptomatic shunting and 26% had symptomatic shunting. The CPSS score was also calculated for these dogs, which corresponded with the shunting classification.
Conclusions: Complete or partial surgical ligation is an effective technique to improve the quality of life of dogs with CPSS. Owners are very satisfied with the result of the surgery. A basic clinical scoring system is developed to help diagnose portosystemic shunting, which is promising for the future.

Introduction

A congenital portosystemic shunt (CPSS) is an anomalous vascular connection between the portal vein and the systemic venous circulation. This connection causes portal blood to flow directly into the systemic circulation, without being subjected to the liver parenchyma and hepatic metabolism. The portal vein normally provides 80% of the blood flow and 50% of the oxygen content to the liver. This portal blood will be delivered to the hepatocytes and cleansed by the reticuloendothelial system. When this path is interrupted by a CPSS, blood will

reach the systemic circulation before this hepatic cleansing.(Berent & Tobias, 2009; Van den Bossche et al., 2012) When blood bypasses the liver of the young affected animal, there is a decrease in delivery of hepatotrophic factors to the liver such as insulin, insulin-like growth factors, glucagon and hepatocyte growth factor.(van den Ingh et al., 1995) Particularly insulin and glucagon are important. This results in poor hepatic development, decreased protein production, reticuloendothelial dysfunction, altered fat and protein metabolism, hepatic atrophy and eventually hepatic failure. This causes a large range of different clinical signs, which will be discussed later.(Berent & Tobias, 2009)

Studies that are conducted to evaluate outcome in animals with CPSS after treatment, need a practical, reliable and simple system to evaluate clinical performance and to establish the diagnosis of persistent or recurrent clinical portosystemic shunting (PSS). The goal of this retrospective study is to evaluate clinical signs in dogs with CPSS before and after surgical treatment and to develop a scoring system to detect persistent or recurrent CPSS based on clinical performance after surgery. The dogs that were included in this study were operated at Utrecht University Department of Small Animal Medicine, during the last 10 years. The recovery of the dogs with CPSS after surgery was classified after measuring plasma bile acid concentrations and ammonia tolerance testing. The long-term clinical outcome of the dogs was evaluated with the use of quality of life questionnaires that were sent to the owners. The input from the owners was translated into a clinical scoring system for recovery. Each owner was also contacted and asked to visit the policlinic Hepatology in Utrecht for the determination of the presence of recurrent or persistent CPSS, using the ammonia tolerance test. These results were to optimize the scoring system.

An additional research goal for this retrospective study is to report the predictive value of pre-operative albumin, white blood cell count, fasting plasma ammonia concentration and fasting plasma bile acid concentration for persistent shunting after surgery.

At the moment a randomized, multicenter study is conducted to prospectively compare partial attenuation of CPSS in dogs by ligation and by cellophane banding, with or without a second surgical intervention to perform complete closure by ligation. Our evaluation of the long-term outcome in dogs with CPSS and the development of a scoring system based on quality of life questionnaires will help to compare the outcome in dogs after ligation and cellophane banding of their shunt.

Intra- and extrahepatic shunting

CPSS can be classified into intrahepatic (IH) and extrahepatic (EH) shunts based on their anatomical location.(Berent & Tobias, 2009) CPSS occurs mostly in dogs and sporadically in cats, humans and other species. Because of inbreeding of purebred dog populations, the incidence of genetic disorders has increased. Therefore CPSS is mainly found in purebred dogs. EH CPSS is more common than IH CPSS.(Berent & Tobias, 2009; Hunt, 2004) IH CPSS is mostly seen in large dogs, whereas EH CPSS is more common in small dogs.(van Steenbeek et al., 2012)

Intrahepatic CPSS

IH CPSS can be positioned centrally in the liver, or at the left or right side. This is based on the portal vein branch that is giving rise to the shunting vessel.(Krotscheck et al., 2007) The left divisional IH CPSS is considered to be caused by incomplete closure of the embryonic ductus venosus. The ductus venosus runs through the liver connecting the vena porta with the vena cava. This makes sure that blood from the placenta flows directly to the vital organs of the fetus. The ductus venosus should close within the first days after birth.(Krotscheck et al., 2007; van Steenbeek et al., 2012) In dogs, closure normally occurs within six to nine days.(Lamb & Burton, 2004)

Extrahepatic CPSS

EH CPSS are developmental anomalies that result in a shunting vessel between the portal vein (or the veins that contribute to the portal vein, such as the splenic vein, the gastroduodenal vein and the mesenteric

veins) and the caudal vena cava or the azygos vein.(van Steenbeek et al., 2012) The EH CPSS shunt is called portocaval (PC) when the shunting vessel merges into the caudal vena cava. The EH CPSS is called portoazygos (PAZ) when the shunting vessel merges into the azygos vein.(Berent & Tobias, 2009) The age at diagnosis in dogs with EH PC CPSS is significantly lower than that of dogs with EH PAZ CPSS.(Van den Bossche et al., 2012)

Epidemiologic factors associated with shunt location

Multiple studies have been performed to determine if breed, sex and country of origin are associated with the anatomical location of CPSS.(Hunt, 2004; Krotscheck et al., 2007; Tobias & Rohrbach, 2003; Van den Bossche et al., 2012) Type of breed has a significant effect on the anatomy of CPSS.(Hunt, 2004)

Intrahepatic CPSS

IH CPSS is mainly found in dogs such as the Irish wolfhound, Golden retriever, Labrador retriever, Australian cattle dog and Old English sheepdog.(Krotscheck et al., 2007; Tobias & Rohrbach, 2003; van den Ingh et al., 1995; van Steenbeek et al., 2009) According to Krotscheck et al. (2007), the division of left, right and central IH CPSS is associated with the country of origin. The prevalence of the different divisions seemed to be equal in Australia but in the United States the prevalence of right and central IH CPSS combined was similar to the prevalence of left IH CPSS. Overall, the left IH CPSS is more common than the right and central IH CPSS. Besides the country of origin, there also seems to be a relationship between sex and anatomical location of the shunt. According to Krotscheck et al. (2007), the sex distribution for the right IH CPSS was 71% male and 29% female, for the central IH CPSS was 64% male and 36% female and for the left IH CPSS the sex distribution was 47% male and 53% female.(Krotscheck et al., 2007)

Extrahepatic CPSS

EH CPSS is mainly found in small-breed dogs such as the Cairn terrier, Yorkshire terrier, Jack Russell terrier, Dachshund, Miniature Schnauzer, Maltese terrier, Shih Tzu and Bichon Frise. (Hunt, 2004; Mertens et al., 2010; O'Leary et al., 2014; Tobias & Rohrbach, 2003; van den Ingh et al., 1995; van Straten et al., 2005). The EH PC CPSS is found to be more common than the EH PAZ CPSS.(Berent & Tobias, 2009; Hunt, 2004) Hunt (2004) found that the Bichon Frise with EH CPSS were significantly more likely to be female than male. This may indicate some sex-linkage of the affected gene of the Bichon Frise. No significant difference was found between male and female in other predisposed breeds. (Hunt, 2004)

Looking at IH CPSS and EH CPSS together, breeds that are not predisposed to CPSS seem to be significantly more likely to have unusual or inoperable shunts than dogs from predisposed breeds.(Hunt, 2004) The major predisposed breeds are also not the same from country to country, as the Australian cattle dog is over-represented in Australia and the Yorkshire terrier is over-represented in North America.(Hunt, 2004; Tisdall, 1994)

Clinical signs

Most animals with CPSS show clinical signs within the first year of age, although this depends on the anatomical location of the shunt. Dogs with EH PAZ CPSS are usually diagnosed later in life and show less severe clinical signs.(Sura et al., 2007; Van den Bossche et al., 2012; van den Ingh et al., 1995) The severity of the clinical signs also depends on the volume of blood bypassing the liver. (Berent & Tobias, 2009) The clinical signs result from hepatic dysfunction due to the poor hepatic development or from the release of intestinal products directly into the systemic venous circulation (such as ammonia). Affected animals often show retarded growth, are in poor condition, have decreased endurance and decreased activity. Most animals with CPSS show signs of hepatic encephalopathy (HE). (van den Ingh et al., 1995)

Hepatic Encephalopathy

The pathogenesis of HE is complex and largely unknown. When liver function is altered or portosystemic shunting occurs, toxic substances accumulate in the systemic

circulation and affect the central nervous system (CNS) and cerebral function. Ammonia is considered to be the most important toxic substance and the main factor responsible for HE, but more than 20 different compounds can be found.(Berent & Tobias, 2009; Ciecko-Michalska et al., 2012; Felipo, 2013) Ammonia is generated from urea from dietary protein by anaerobic and coliform bacteria in the large intestine. Ammonia will then be absorbed in the portal circulation and is normally converted by hepatocytes to urea via the urea cycle, and to a smaller extent by forming glutamine with glutamine synthetase.(Center & Magne, 1990; Gerritzen Bruning et al., 2006; Ruland et al., 2010) In patients with CPSS, ammonia bypasses the detoxification inside the hepatocytes, which results in hyperammonemia.(Gerritzen Bruning et al., 2006; Ruland et al., 2010) Ammonia is assumed to influence several mechanisms leading to development of hepatic encephalopathy such as: brain edema, impaired blood-brain barrier and changes in neurotransmission.(Ciecko-Michalska et al., 2012; Montgomery & Bajaj, 2011; Skowronska & Albrecht, 2012) The urea cycle, which takes place in the liver, normally removes ammonia from the portal blood. This will not occur in dogs with CPSS. As the brain is not equipped with an effective urea cycle, the excessive amount of ammonia is removed mainly through the pathway of glutamine synthesis,(Ciecko-Michalska et al., 2012) which comprises glutamine synthetase that is localized exclusively in the Alzheimer type 2 astrocytes, a type of CNS glial cell.(Montgomery & Bajaj, 2011) Glutamine synthetase catalyzes the conversion of ammonia to glutamine. The hyperammonemia in dogs with CPSS causes increased conversion to glutamine within the astrocytes, which causes astrocyte swelling due to the osmotic effects of glutamine. This leads to cerebral edema.(Butterworth, 2002; Ciecko-Michalska et al., 2012; Montgomery & Bajaj, 2011) The astrocyte swelling is also believed to cause molecular events such as activation of inhibitory and impairment of excitatory neurotransmitter systems, resulting in neural inhibition.(Albrecht & Jones, 1999; Montgomery & Bajaj, 2011) Simultaneously, ammonia causes an increased permeability of the blood-brain barrier.(Montgomery & Bajaj, 2011) Ammonia modulates the transcellular passage of low-to medium-size molecules, by affecting their carriers located at the blood-brain barrier.(Skowronska & Albrecht, 2012) This also results in cerebral edema and in intracranial hypertension.(Montgomery & Bajaj, 2011) Furthermore, ammonia is responsible for an increased transport of aromatic amino acids across the blood-brain barrier. During hyperammonemia, increased brain glutamine production is followed by increased glutamine efflux from the brain, resulting in increased inward transport of these aromatic amino acids. The increased transport of the aromatic amino acids affects neurotransmission by altering intracerebral synthesis of catecholamines, and producing false neurotransmitters.(Skowronska & Albrecht, 2012)

The signs of HE include depression, ataxia, circling, head pressing, convulsions, salivation and alterations in consciousness and personality.(Felipo, 2013; van den Ingh et al., 1995) These neurological signs are often episodic, with abnormal periods of a few days and normal periods of several days or weeks. The neurological signs show progressive severity. (van den Ingh et al., 1995) Decreasing the blood ammonia concentration reduces the signs of HE. However the degree of encephalopathy is not only associated with the blood ammonia levels. This suggest that other neurotoxins are also important.(Berent and Tobias, 2009) Another explanation for the blood ammonia levels that do not correlate with the degree of encephalopathy, is the increase of permeability of the blood-brain barrier. This apparent ease with which ammonia moves from blood to brain offers an explanation for the increased brain-blood concentration ratios and the sometimes imperfect correlation observed between the severity of neurological symptoms and blood ammonia concentrations. (Butterworth, 2002) A predisposing factor for HE is high blood ammonia due to a high

protein diet. Also sedatives may stimulate the development of HE.(Ciecko-Michalska et al., 2012)

Other clinical signs
Other clinical signs related to hepatic dysfunction are gastrointestinal signs like anorexia, vomiting and diarrhea, and polyuria, polydipsia and dysuria. Polyuria and polydipsia are mostly caused by deranged neuroendocrine functions. The dysuria is caused by deposition of ammonium urate crystals or calculi in the urinary tract. (van den Ingh et al., 1995) Affected animals also often have coagulopathies, as the liver shows a decreased production of clotting factors.(Berent & Tobias, 2009; Kummeling, et al., 2006)

Diagnosis
The diagnosis of CPSS is made on clinical signs of HE, biochemical profiles, and medical imaging. The two most commonly used biochemical tests for screening and diagnosis of CPSS are the fasting ammonia concentration and the fasting bile acid concentration. The fasting ammonia concentration can be extended to a rectal ammonia tolerance test and the fasting bile acid concentration is often combined with the postprandial bile acid concentration (bile acid stimulation test). The reference interval for the fasting ammonia concentration is 24 – 45 µmol/L. The reference interval for the fasting bile acid concentration is < 10 µmol/L.(Gerritzen Bruning et al., 2006; Paepe et al., 2007) The choice of which test will be used depends on the availability and accessibility to perform the test, and on the veterinarian's individual preference and experience. (Gerritzen Bruning et al., 2006)

Rectal ammonia tolerance test
Ammonia is the only neurotoxin that can be routinely measured in dogs with HE.(Paepe et al., 2007) Blood samples for the fasting ammonia concentration are taken after at least 12 hours of fasting.(Gerritzen Bruning et al., 2006; Ruland et al., 2010) When performing the ammonia tolerance test, ammonium chloride is administered per rectum (2 mL/kg) after determination of the fasting ammonia concentration. Venous blood samples will be taken again 20 minutes and 40 minutes after administration of the ammonium chloride. More than a twofold increase in plasma ammonia concentration, and a value that is also above 45 µmol/L, indicates hepatic insufficiency and/or CPSS.(Utrecht University Department of Small Animal Medicine) Blood samples taken for testing the ammonia concentration need to be handled with care. The sample needs to be put in a closed EDTA-coated tube on crushed ice, because otherwise the ammonia will evaporate.(Gerritzen Bruning et al., 2006)

Pre- and postprandial bile acid concentration
Bile acids are synthesized from cholesterol within the hepatocytes in the liver. The liver maintains a large reserve capacity so even severe hepatic failure does not result in insufficient bile acid production. After synthesis bile acids are conjugated in the liver, excreted into the biliary tract and stored in the gallbladder. After a meal, the bile acids from the gallbladder are excreted into the duodenum because the bile acids are important for absorption of lipids. Afterwards, bile acids will be reabsorbed in the distal ileum and return to the liver through the portal circulation. In this enterohepatic circulation, more than 95% of the bile acids are removed from the portal blood by hepatocytes and recycled back into the biliary system.(Center & Magne, 1990; Center et al., 1991; Center, 1993; Paepe et al., 2007; Ruland et al., 2010) In case of CPSS, the bile acids are not completely removed from the portal blood after administering a meal. There is an increase in plasma bile concentration.(Ruland et al., 2010) To determine bile acid concentrations as a liver function test, serum is collected after 12 hours of fasting and 2 hours after feeding (postprandial).(Center et al., 1991) A sufficient amount of food with enough proteins and fat is necessary to initiate the enterohepatic bile acid cycle by emptying the gallbladder.(Center, 1993) When the postprandial bile acid concentration is above 40 µmol/L the test is positive which may indicate CPSS.(Utrecht University

Department of Small Animal Medicine) In dogs with CPSS, the fasting serum bile acid concentration can be within normal limits, whereas the postprandial value is almost always abnormal. Therefore, a normal pre- or postprandial value does not exclude CPSS, though it is very unlikely that animals with both normal pre- and postprandial values suffer from CPSS.(Winkler et al., 2003)

Medical Imaging

Diagnostic imaging of the abdomen is commonly performed in dogs suspected of CPSS, next to the biochemical profiles. There is a large variation in the morphology of CPSS, so a preoperative detailed characterization of the vascular anatomy facilitates shunt identification during exploratory laparotomy. This potentially reduces the operative time and morbidity associated with surgery. The two used forms of diagnostic imaging are abdominal ultrasonography and computed tomography (CT). Abdominal ultrasonography is a non-invasive widely available technique which can detect shunting and the direction of the blood flow. It does not require general anesthesia. A disadvantage of abdominal ultrasonography is that detection of the origin and the insertion of the shunt is difficult. CT however makes it possible to detect the origin and insertion of the shunting vessel. Another benefit of CT is that also insertions in the thorax, in case of portoazygos shunting, are possible to detect. The disadvantage of CT is that general anesthesia is necessary and it is expensive. Kim et al.(2013) showed that CT was 5.5 times more likely to correctly confirm the absence or presence of CPSS compared to abdominal ultrasonography.(Kim et al., 2013)

Treatment

After clinical diagnosis, it is very important to start treatment to prevent worsening of the clinical signs. There are several medical treatments to manage the clinical signs of CPSS (medical management: low protein diet such as liver diet or kidney diet, lactulose), but this is not curative. To cure CPSS surgical occlusion of the shunting vessel is necessary.(Hunt et al., 2004) A variety of surgical techniques have been described for occlusion of CPSS. The three most popular techniques are complete or partial ligature occlusion, ameroid ring constrictor (ARC) placement and cellophane banding. Both the ARC and cellophane banding provide a gradual attenuation of the shunting vessel by causing a fibrous tissue reaction.(Falls et al., 2013) The dogs in this study population are surgically treated by complete or partial ligature occlusion. Probably the best option is complete ligation of the shunt but in the majority of dogs complete closure is not possible. This is because of underdevelopment of the portal circulation and in this case the shunt is partially ligated.(Hunt, et al. 2004) In most dogs clinical signs disappear or improve after shunt attenuation, even in dogs without complete closure of the shunt or despite persistent shunting. However, clinical signs do not disappear in all dogs or may recur after initial successful outcome with absence of PSS. Recurrence and persistence of clinical signs and of PSS has been described in all different techniques that are developed to close or attenuate CPSS. However, for the surgical treatment of CPSS there is a lack of convincing evidence to recommend one treatment over another. Therefore randomized prospective studies with an adequate amount of cases are needed to compare existing treatments in order to determine which are associated with the best outcome for dogs.(Tivers, 2012)

Predictive values

Prediction of long-term outcome after surgical ligation of CPSS in dogs is difficult but very interesting. The outcome is most likely related to hepatic and vascular proliferation after surgical ligation. Multiple studies have been performed to evaluate the prognostic value of a number of factors, like shunt localization, plasma albumin and white blood cell count. (Kummeling, et al., 2004; Kummeling et al., 2012; Mehl et al., 2005; Papazoglou et al., 2002) According to Kummeling et al.(2012), the postoperative recovery rate was significantly higher in dogs with EH CPSS (66%), compared to

dogs with IH CPSS (31%). This suggests that the type of CPSS is predictive for the outcome after ligation.(Kummeling et al., 2012)
Mehl et al.(2005), Papazoglou et al.(2002) and Kummeling et al.(2012) studied the predictive value of pre-operative plasma albumin.(Kummeling et al., 2012; Mehl et al., 2005; Papazoglou et al., 2002) Albumin is synthesized exclusively by hepatocytes. Dogs with CPSS have reduced hepatic synthesis of albumin because of poor hepatic development, which causes hypoalbuminemia.(Center & Magne, 1990) Mehl et al.(2005) found that low preoperative plasma albumin is a predictive factor for postoperative persistent shunting, and thus for an unsuccessful long-term outcome. An absolute serum albumin concentration that could be associated with persistent shunting after surgery could not be determined.(Mehl et al., 2005) Papazoglou et al.(2002) has identified hypoalbuminemia as a negative prognostic indicator for the short-term outcome. Because anesthesia more likely induces hemodilution in patients, hypoalbuminemia is worse in the postoperative period than before surgery and contributes to the short-term outcome.(Papazoglou et al., 2002)
Next to the predictive value of preoperative plasma albumin, Mehl et al.(2005) also found that a high preoperative white blood cell count is a predictive factor for postoperative death.(Mehl et al., 2005) The increased white blood cell count in dogs with CPSS may be associated with intestinal bacteria that have translocated into the portal blood being diverted away from the liver and directly into the systemic circulation, and with impaired reticuloendothelial function. (Koblik & Hornof, 1995)

Procedure

Study Population
Dogs surgically treated for a single CPSS by ligation at the University of Utrecht, between 2003 and 2013 were included. Dogs with CPSS that underwent surgery but for which ligation was not possible were not included in this study. In total 167 dogs were included, 129 (77%) dogs had EH CPSS, 38 (23%) dogs had IH CPSS.

Medical Records Review
Data extracted from the medical records included breed, date of birth, age at surgery, sex and management before and after surgery. Clinical signs like neurological and gastrointestinal signs, and signs of the urinary tract, activity level, retarded growth and appetite were recorded both pre- and postoperatively. Pre- and postoperative total white blood cell (WBC) concentration, serum albumin, fasting bile acid, fasting ammonia and if performed, the ammonia tolerance test were recorded. Intraoperative information extracted from the medical records included shunt location (intrahepatic and extrahepatic, portocaval and portoazygous) and degree of shunt attenuation. Postoperative data recorded included short-term postoperative deaths (<1 month) as well as 4-40 week postoperative ammonia tolerance testing and fasting bile acid concentrations.

Follow-up
Outcome information was obtained by a telephone interview with the referring veterinarian, whether the dog was still alive, death or euthanized. If the dog died, information was obtained about when the event occurred and if the circumstances around the death were known. Owners of dogs that were still alive, or died or were euthanized after at least one year postoperative were called and asked to participate in this study. All owners agreed to participate and to fill in the quality of life questionnaire.
The questionnaire was developed by the Royal Veterinary College in London, and was translated into Dutch. Questionnaires to evaluate quality of life before and after the surgery were sent to the owners. The questionnaires included questions about the presence and severity of clinical signs related to hepatic encephalopathy, gastrointestinal and urological signs. Also medical management, activity level, body condition, interaction and their quality of life were scored (see attachment 2).
The questionnaires were used to develop a scoring system to detect persistent shunting

after CPSS surgery. The scoring system is developed to translate a variety of clinical signs into one, individual score that can be used as a clinical tool. Staging of the symptoms was performed by the owner, ranging from 0 to 4 (0=never, 1=less than a month, 2=monthly, 3=weekly, 4=daily). The score was calculated by the sum of 19 different clinical signs. Seventeen different signs were scored and the score was multiplied with factor 1, 2 or 3 based on the importance or clinical significance of the signs. The presence of seizures is a class 1 sign, which is multiplied by 3. Head pressing, ataxia, disorientation, aggression, salivation, collapse, unresponsiveness, apparent blindness, fatigue/weakness and circling are class 2 signs, they are multiplied by 2. Vomiting, diarrhea, polyuria, hematuria, dysuria and decreased appetite are class 3 signs, they are multiplied by 1. When a dog is positive for urolithiasis or urethral obstruction 2 points are added to the score. When a dog has retarded growth 4 points are added to the score, when the owner is in doubt if the dog has retarded growth, 2 points are added to the score. The score that comes out of this system is an individual score for CPSS.

A randomized group of 21 dogs came back to Utrecht University for an extra control visit. After anamnesis and physical examination, fasting ammonia and fasting bile acid plasma concentrations were determined. When the fasting ammonia concentration was < 100 µmol/L, the ammonia tolerance test was performed. 40 minutes (t=40) after rectally administering ammonia, plasma ammonia was determined again to determine if there was portosystemic shunting.(Master Thesis B.G.J. Bolscher, Utrecht University Department of Small Animal Medcine) These results were compared to the results during the last control visit after surgery. The owners collected a urine sample, which was analyzed for ammonium urate crystals.

Statistical analyses

The predictive value of the fasting ammonia concentration for persistent shunting after CPSS surgery was tested with logistic regression analysis. The significance level was $P < 0.05$. The logistic regression analysis was performed 3 times because of the 3 different anatomical locations of CPSS.

Data required for the analysis is pre-operative fasting ammonia concentration and presence of persistent shunting after CPSS surgery. The presence of persistent shunting after surgery was determined with the ammonia metabolism; the fasting ammonia concentration and if necessary the ammonia tolerance test. The individual predictive value of the fasting bile acid concentration, albumin and the white blood cell count for persistent shunting was tested in the same manner as the fasting ammonia concentration.

To test the improvement in the CPSS score before and after surgery, Wilcoxon Signed Rank tests were performed.

Data analyses were performed using IBM SPSS Statistics, version 20.

Results

Medical Records Review

Study Population

All information found in the medical records of the dogs of the study population can be found in attachment 1. 167 dogs were included, 129 (77%) dogs had EH CPSS, 38 (23%) dogs had IH CPSS. 92 (71%) dogs with EH CPSS had a portocaval (PC) shunt and 37 (29%) dogs had a portoazygous (PAZ) shunt. 22 (58%) dogs with IH CPSS had left divisional IH CPSS, 13 (34%) dogs had right divisional IH CPSS and 3 (7.9%) dogs had a centrally positioned IH CPSS. The median age at surgery of dogs with EH PC CPSS was 10.5 months (range, 4 – 67 months), of dogs with EH PAZ CPSS 20 months (range, 3 – 78 months) and the median age at surgery of dogs with IH CPSS was 8.5 months (range, 4 – 54 months). Sex distribution was 54 (59%) females and 38 (41%) males with EH PC CPSS, 26 (70%) females and 11 (30%) males with EH PAZ CPSS and 18 (47%) females and 20 (53%) males with IH CPSS (left: 11 female, 11 male; Right: 6 female, 7 male; Central: 1 female, 2 male). Breed distribution in dogs with EH CPSS included dogs from 26 different breeds, such as 19 (15%) Maltese dogs (17 PC, 2 PAZ), 17 (13%) Jack Russell

Terriers (13 PC, 4 PAZ), 13 (10%) Yorkshire Terriers (9 PC, 4 PAZ), 11 (8.5%) Cairn Terriers (10 PC, 1 PAZ), 9 (7%) Dachshunds (6 PC, 3 PAZ), 6 (4.6%) Miniature Schnauzers (4 PC, 2 PAZ), 6 (4.6%) Chihuahuas (3 PC, 3 PAZ), 5 (3.9%) Pugs (4 PC, 1 PAZ), 4 (3.1%) West Highland White Terriers (3 PC, 2 PAZ), 3 (2.3%) Norfolk Terriers (3 PAZ), 3 (2.3%) Shih Tzus (2 PC, 1 PAZ) and 19 (15%) 'Other Breeds' (10 PC, 9 PAZ). 14 dogs with EH CPSS (11%) were crossbreeds (11 PC, 3 PAZ).
Breed distribution in dogs with IH CPSS included dogs from 18 different breeds such as 7 (18%) Golden Retrievers, 5 (13%) Bernese Mountain Dogs, 3 (7.9%) Labrador Retrievers, 3 (7.9%) Cane Corsos, 2 (5.3%) Irish Wolfhounds, 2 (5.3%) Bearded Collies, 2 (5.3%) Shih Tzus and 11 (29%) 'Other breeds'. 3 dogs with IH CPSS (7.9%) were crossbreeds.

Preoperative Data
A large amount of information was obtained from the medical records of all the dogs of the study population (Table 2). Medical management was applied to multiple dogs before they came to Utrecht University.
Medical management includes a low protein diet, lactulose and antibiotics. Retarded growth, decreased activity, decreased appetite and gastrointestinal signs are symptoms that were present in a large amount of the dogs. The gastrointestinal signs include vomiting and diarrhea. Most dogs with CPSS show signs of hepatic encephalopathy (HE). Signs of HE were scored according to a clinical gradation system for HE in dogs. (Table 1)

Table 1. Clinical gradation system for HE in dogs *(Rothuizen, 1993)*

Grade HE	**Symptoms**
0	No clinical signs of HE
1	Sopor(lazy, indolent), character changes, polyuria
2	Ataxia, disorientation, compulsive movements, apparent blindness, ptyalism
3	Stupor, severe ptyalism, incidental seizures
4	Coma, no responsiveness

The fasting plasma ammonia concentration, the fasting plasma bile acid concentration, the plasma albumin concentration and the total WBC concentration was available for the majority of the dogs of the study population. A small amount of dogs also had the ammonia tolerance test for diagnosis of CPSS.

Table 2. Preoperative medical records data

	EH PC CPSS (92 dogs)	**EH PAZ CPSS (37 dogs)**	**IH CPSS (38 dogs)**
Medical management	38 dogs (41%) - 17 dogs low protein diet - 7 dogs lactulose - 13 dogs low protein diet and lactulose - 1 dog antibiotics	14 dogs (38%) - 13 dogs low protein diet - 1 dog lactulose - 6 dogs low protein diet and lactulose - 1 dog low protein diet and antibiotics - 1 dog low protein diet, lactulose and antibiotics	23 dogs (60%) - 10 dogs low protein diet - 1 dog lactulose - 12 dogs low protein diet and lactulose
Retarded growth	37 dogs (40%)	17 dogs (47%)	20 dogs (53%)
Decreased activity	76 dogs (83%)	24 dogs (65%)	30 dogs (79%)
Decreased appetite	47 dogs (51%)	14 dogs (38%)	17 dogs (45%)
Gastrointestinal signs	57 dogs (62%) - 33 dogs vomiting - 7 dogs diarrhea - 17 dogs vomiting and diarrhea	22 dogs (59%) - 15 dogs vomiting - 7 dogs vomiting and diarrhea	17 dogs (44%) - 13 dogs vomiting - 4 dogs vomiting and diarrhea
Hepatic encephalopathy	83 dogs (90%) - 8 dogs HE 1 - 62 dogs HE 2 - 12 dogs HE 3 - 1 dog HE 4	31 dogs (84%) - 14 dogs HE 1 - 13 dogs HE 2 - 4 dogs HE 3	36 dogs (95%) - 12 dogs HE 1 - 22 dogs HE 2 - 2 dogs HE 3
Fasting plasma ammonia concentration (reference interval: 24 – 45 µmol/L)	Available for 86 dogs (93%) - Median: 153 µmol/L - Range: 22 - >286 µmol/L - 79 dogs (92%) above reference - 10 dogs > 286 µmol/L	Available for 36 dogs (97%) - Median: 97 µmol/L - Range: 27 - >286 µmol/L - 31 dogs (86%) above reference - 1 dog > 286 µmol/L	Available for 34 dogs (89%) - Median: 162 µmol/L - Range: 44 - >286 µmol/L - 33 dogs (87%) above reference - 4 dogs > 286 µmol/L
Ammonia tolerance test	Performed in 11 dogs (12%) - 11 tests positive - 0 tests negative	Performed in 10 dogs (27%) - 10 tests positive - 0 tests negative	Performed in 3 dogs (7.9%) - 3 tests positive - 0 tests negative
Fasting plasma bile acid concentration (reference interval: < 10 µmol/L)	Available for 57 dogs (62%) - Median: 105 µmol/L - Range: 3 – 615 µmol/L - 55 dogs (96%) above reference	Available for 30 dogs (81%) - Median: 95 µmol/L - Range: 2 – 465 µmol/L - 29 dogs (97%) above reference	Available for 21 dogs (55%) - Median: 35 µmol/L - Range: 2 – 380 µmol/L - 18 dogs (86%) above reference
Plasma albumin concentration (reference interval: 26 – 37 g/L)	Available for 84 dogs (91%) - Median: 24 g/L - Range: 11 – 31 g/L - 63 dogs (75%) beneath reference	Available for 35 dogs (95%) - Median: 26 g/L - Range: <9 – 30 g/L - 16 dogs (46%) beneath reference - 1 dog < 9 g/L	Available for 30 dogs (79%) - Median: 20 g/L - Range: 8 – 30 g/L - 27 dogs (90%) beneath reference
Total WBC concentration (reference interval: 4.5 – 14.6 × 10^9/L	Available for 58 dogs (63%) - Median: 18 × 10^9/L - Range: 7.5 – 42.6 × 10^9/L - 39 dogs (67%) above reference	Available for 21 dogs (57%) - Median: 14 × 10^9/L - Range: 6.4 – 26.5 × 10^9/L - 10 dogs (48%) above reference	Available for 21 dogs (55%) - Median: 15 × 10^9/L - Range: 8.3 – 35.4 × 10^9/L - 12 dogs (57%) above reference

Intraoperative Data

Of all 92 dogs with EH PC CPSS 70 (76%) dogs were partially ligated and 22 (24%) were completely ligated during surgery. 1 dog of the 22 dogs that were completely ligated was partially ligated in the first surgery and completely ligated in a second surgery. Of all 37 dogs with EH PAZ CPSS, 23 (62%) dogs were partially ligated and 13 (35%) were completely ligated during surgery. Degree of attenuation in 1 dog is unknown. Of the 13 dogs that were completely ligated, 1 dog was only partially ligated during the first surgery and completely ligated in a second surgery. Of all 38 dogs with IH CPSS, 36 (95%) dogs were partially ligated and 2 (5%) dogs were completely ligated during surgery. Of the 2 dogs that were completely ligated, 1 dog was partially ligated during the first surgery and completely ligated during a second surgery.

Postoperative Data

19 (11%) dogs of the study population of 167 dogs died in the short-term (<1 month) postoperative period (12 (13%) of 92 dogs with EH PC CPSS, 3 (8.1%) of 37 dogs with EH PAZ CPSS and 4 (10%) of 38 dogs with IH CPSS). Of the 80 dogs with EH PC CPSS that survived > 1 month, 75 (94%) dogs came back for a control visit (4 – 40 weeks p.o.). Of the 34 dogs with EH PAZ CPSS that survived > 1 month, 30 (88%) dogs came back for a control visit (4 – 28 weeks p.o.). Of the 34 dogs with IH CPSS that survived > 1 month, 29 (85%) dogs came back for a control visit (4 – 24 weeks p.o.). Findings during the control visits are described in table 3. Multiple dogs were still receiving a form of medical management. Decreased activity, decreased appetite, gastrointestinal signs and signs of hepatic encephalopathy were again described. The fasting plasma ammonia concentration was available for almost all dogs that came back for a control visit. The majority of these dogs also had the ammonia tolerance test. The fasting plasma bile acid concentration was also available for a large amount of dogs. The plasma albumin concentration and the total white blood cell concentration were available for a small amount of dogs.

Table 3. Postoperative medical records data

	EH PC CPSS (75 dogs)	**EH PAZ CPSS (30 dogs)**	**IH CPSS (29 dogs)**
Medical management	22 dogs (29%) - 19 dogs low protein diet - 1 dog lactulose - 2 dogs low protein diet and lactulose	10 dogs (33%) - 9 dogs low protein diet - 1 dog low protein diet and lactulose	14 dogs (48%) - 11 dogs low protein diet - 3 dogs low protein diet and lactulose
Decreased activity	6 dogs (8%)	3 dogs (10%)	3 dogs (10%)
Decreased appetite	5 dogs (6.7%)	2 dogs (6.7%)	1 dog
Gastrointestinal signs	17 dogs (23%) - 14 dogs vomiting - 2 dogs diarrhea - 1 dog vomiting and diarrhea	4 dogs (13 %) - 3 dogs vomiting - 1 dog diarrhea	5 dogs (17 %) - 5 dogs vomiting
Hepatic encephalopathy	3 dogs (4%) - 2 dogs HE 1 - 1 dog HE 2	3 dogs (10%) - 2 dogs HE 1 - 1 dog HE 2	7 dogs (24%) - 4 dogs HE 1 - 3 dogs HE 2
Fasting plasma ammonia concentration (reference interval: 24 – 45 µmol/L)	Available for 77 dogs (103%)* - Median: 15 µmol/L - Range: <7 - 282 µmol/L - 10 dogs (13%) above reference - 7 dogs <7 µmol/L	Available for 29 dogs (97%) - Median: 15 µmol/L - Range: <7 - 33 µmol/L - No dogs above reference - 3 dogs <7 µmol/L	Available for 29 dogs (100%) - Median: 63 µmol/L - Range: 12 - >286 µmol/L - 18 dogs (62%) above reference - 1 dog >286 µmol/L
Ammonia tolerance test	Performed in 68 dogs (88%)** - 19 tests positive - 49 tests negative	Performed in 24 dogs (83%)** - 9 tests positive - 15 tests negative	Performed in 23 dogs (79%)** - 14 tests positive - 9 tests negative
Fasting plasma bile acid concentration (reference interval: < 10 µmol/L)	Available for 61 dogs (81%) - Median: 8 µmol/L - Range: 1 - 440 µmol/L - 26 dogs (43%) above reference	Available for 25 dogs (83%) - Median: 7 µmol/L - Range: 1 – 51 µmol/L - 9 dogs (36%) above reference	Available for 22 dogs (76%) - Median: 54 µmol/L - Range:1 – 340 µmol/L - 16 dogs (73%) above reference
Plasma albumin concentration (reference interval: 26 – 37 g/L)	Available for 28 dogs (37%) - Median: 28 g/L - Range: 5 – 33 g/L - 4 dogs (14%) beneath reference	Available for 15 dogs (50%) - Median: 28 g/L - Range: 12 – 36 g/L - 3 dogs (20%) beneath reference	Available for 13 dogs (45%) - Median: 26 g/L - Range: 18 – 30 g/L - 6 dogs (46%) beneath reference
Total WBC concentration (reference interval: 4.5 – 14.6 × 10^9/L	Available for 13 dogs (17%) - Median: 13 × 10^9/L - Range: 7.6 – 15.7 × 10^9/L - 2 dogs (15%) above reference	Available for 5 dogs (17%) - Median: 9 × 10^9/L - Range: 8 – 13.8 × 10^9/L - No dogs above reference	Available for 4 dogs (14%) - Median: 14 × 10^9/L - Range: 11.8 – 19.1 × 10^9/L - 1 dog above reference

** 75 dogs came back for a check-up to Utrecht University and all were tested for the fasting plasma ammonia concentration, the other 2 dogs were tested at home during a study of another veterinary master student.*

*** The percentage of dogs that had the ammonia tolerance test was calculated over the group of dogs that also were tested for the fasting plasma ammonia concentration*

Predictive values

In testing for the predictive value of preoperative fasting ammonia concentration, for the presence of persistent shunting after CPSS surgery, for EH PC CPSS 66 dogs were included (OR = 1.003, *P* = 0.384), for EH PAZ CPSS 24 dogs were included (OR = 1.002, *P* = 0.793), and for IH CPSS 25 dogs were included (OR = 1.006, *P* = 0.384). No significant association was found between pre-operative fasting ammonia concentration and presence of persistent shunting after surgery in the 3 different groups.

The predictive value of the pre-operative fasting bile acid concentration for the presence of persistent shunting after CPSS was tested. For EH PC CPSS 41 dogs were included (OR = 1.000, *P* = 0.897). For EH PAZ CPSS 19 dogs were included (OR = 1.004, *P* = 0.537). For IH CPSS 17 dogs were included (OR = 1.006, *P* = 0.449). No significant association was found between pre-operative fasting bile acid concentration and presence of persistent shunting after surgery in the 3 different groups.

The predictive value of pre-operative albumin for the presence of persistent shunting after CPSS surgery was tested. For EH PC CPSS 63 dogs were included (OR = 0.969, *P* = 0.626). For EH PAZ CPSS 22 dogs were included (OR = 0.979, *P* = 0.817). For IH CPSS 23 dogs were included (OR = 0.940, *P* = 0.490). No significant association was found between pre-operative albumin and presence of persistent shunting after surgery in the 3 different groups.

The predictive value of pre-operative white blood cell count for the presence of persistent shunting after CPSS surgery was tested. For EH PC CPSS 40 dogs were included (OR = 0.984, *P* = 0.757). For EH PAZ CPSS 15 dogs were included (OR = 1.107, *P* = 0.414). For IH CPSS 16 dogs were included (OR = 1.092, *P* = 0.488). No significant association was found between pre-operative white blood cell count and presence of persistent shunting after surgery in the 3 different groups.

Questionnaires

All referring veterinarians and owners of dogs in the Netherlands that did not die short-term post-operatively (<1 month after surgery) were contacted by telephone to find out if the dogs were still alive.

In total referring veterinarians of 114 CPSS dogs were contacted, 64 dogs had EH PC CPSS, 30 dogs had EH PAZ CPSS and 20 dogs had IH CPSS. One dog with EH PC CPSS was euthanized 3 months after surgery because of persisting signs. 14 dogs died or were euthanized later in life because of other reasons, of which 5 dogs had EH PC CPSS, 3 dogs had EH PAZ CPSS and 6 had IH CPSS.

In 34 cases it was unknown if the dog was still alive, 16 dogs with EH PC CPSS, 4 dogs with EH PAZ CPSS and 14 dogs with IH CPSS, due to change of veterinary clinic.

In total 92 owners were contacted by telephone, 52 owners of dogs with EH PC CPSS, 26 owners of dogs with EH PAZ CPSS and 13 owners of dogs with IH CPSS. Forty-seven owners of dogs expected to be alive, with EH PC CPSS, 24 with EH PAZ CPSS and 11 with IH CPSS were contacted and send a quality of life questionnaire. The questionnaire translated in Dutch can be found in attachment 2.

Of the dogs that died or were euthanized(> 1 month postoperatively), 5 owners of dogs with EH PC CPSS, 2 owners of dogs with EH PAZ CPSS and 2 owners of dogs with IH CPSS were contacted and sent a quality of life questionnaire.

Nine owners of dogs with EH PC CPSS, 4 owners of dogs with EH PAZ CPSS and 8 owners of dogs with IH CPSS could not be contacted by telephone. Although it was unknown if the dog was still alive, they were also send a quality of life questionnaire. Eighteen dogs with EH PC CPSS, 4 dogs with EH PAZ CPSS and 9 dogs with IH CPSS were lost to follow-up. A total of 112 quality of life questionnaires were sent to all different owners, 61 EH PC CPSS, 30 EH PAZ CPSS and 21 IH CPSS.

In total 64 (57%) questionnaires were received back, 43 EH PC CPSS, 13 EH PAZ CPSS and 8 IH CPSS. Of the dogs that were known to be euthanized or died later in life 5 questionnaires were received back, 3 questionnaires of dogs with EH PC CPSS, 1 with EH PAZ CPSS and 1 dog with IH CPSS.

The questionnaires were used to develop a scoring system to translate a variety of clinical signs into one, individual score that

can be used as a clinical tool. The results of the quality of life questionnaires can be found in attachment 3. The median follow-up period for the 64 questionnaires was 1652 days (range 52 – 3889 days). The mean pre-operative CPSS score is 43(SD 27). The mean post-operative CPSS score is 11(SD 13). The difference pre- and postoperative showed a significant improvement ($P < 0.001$). When the difference was analyzed separately in the extrahepatic shunts and the intrahepatic shunts, the scores postoperatively in both groups had also significantly improved (EH CPSS $P<0.001$, IH CPSS $P=0.018$).

If the signs mentioned in table 4 were present (before or after surgery), the owners qualified the impact of this specific sign on their dog's life on a scale from 0, no impact to 10, severe impact. The average impact on the dog's life was calculated using both the impact before and after surgery.

Table 4. Impact of signs on quality of life

Sign	**Average Impact**
Seizures	7.7
Head pressing	6.1
Circling	6.0
Disorientation	6.2
Aggression	4.9
Collapse	5.1
Ataxia(wobbling)	6.5
Unresponsive episodes	5.9
Blindness	7.0
Lethargy/weakness	5.4
Vomiting	5.4
Diarrhea	3.8
Decreased appetite	4.9
Difficulty urinating	6.9
Hematuria	3.1
Ptyalism	7.4
Polyuria/polydipsia	5.0

Forty-two of 64(66%) owners treated their dog with diet, medication or both before surgery (medical management). According to the owners the mean clinical improvement with medical management was 5.3(scale 0-10; n=40), with no improvement in 3 dogs (score 0) and a maximum improvement in 3 dogs (score 10). Willingness to eat the diet was scored with a 6.7 on average (scale 0-10) and medical management hardly showed any negative effect on the dog's quality of life (mean score 0.9, scale 0-10). Post-operatively, at the moment of taking the questionnaire or the death of the dog, 13 of 60(22%) dogs still received conservative treatment.

General improvement after surgery was scored with an 8.3 on average (scale 0-10, n=59). Body condition after surgery was improved on average according to the owner with 6.6 (scale 0-10, n=49). The mean difference in body condition score before and after surgery is +2.4 (scale 1-10, n=53). The mean quality of life before CPSS surgery was diagnosed or before any treatment was given was 2.4 (scale 0-10, n=62). The mean quality of life before surgery with medical management was 3.7 (scale 0-10, n=41). The mean quality of life at this moment after surgery was 8.7 (scale 0-10, n=61). The mean score for owners to still by worried about the health of their dog is 2.9 (0=not worried at all, 10=could not be more worried, n=60). The mean score for owners to be satisfied with the result of the surgery is 9.1 (0=not satisfied at all, 10=could not be more satisfied, n=62).

Long-term outcome

Of all 167 dogs that underwent shunt ligation between 2003 and 2013, 46 dogs were lost to long-term follow-up; 26 dogs with EH PC CPSS, 3 dogs with EH PAZ CPSS, and 17 dogs with IH CPSS. In the rest of the study population 35 dogs had died at the time this study was performed; 19 dogs with EH PC CPSS, 6 dogs with EH PAZ CPSS, and 10 with IH CPSS. Therefore it was concluded that the overall survival rate at the time of our study was 75% in EH CPSS dogs (71% in EH PC CPSS and 82% in EH PAZ CPSS) and 52% in dogs with IH CPSS. Dogs were randomly chosen for a long-term check-up out of 80 surviving CPSS dogs with a minimum follow-up period of 6 months after surgery to obtain a total amount of 21 visits. The sample included 14 dogs with EH PC CPSS, 5 dogs with EH PAZ CPSS and 2 dogs with IH CPSS.

The long-term results of the patients that came back for the check-up can be found in attachment 4. Clinical signs of HE were present in 8 (38%) dogs (5 with EH PC

CPSS, 2 with EH PAZ CPSS and 1 with IH CPSS). In 6 dogs (5 with EH PC CPSS and 1 with IH CPSS) HE was scored as a grade 1 and in 2 dogs (with EH PAZ CPSS) as a grade 2 according to table 1 (Rothuizen, 1993).

The median fasting ammonia concentration (reference interval, 24-45 μmol/L) in the 21 dogs was 31 μmol/L (range, 8 - 201 μmol/L) with 5 dogs (24%) above reference. In 18 dogs of which fasting ammonia concentration was measured < 100 μmol/L, an ammonia tolerance test was performed. Of the 18 tests 7 (39%) were positive, indicating portosystemic shunting.

The median value of fasting bile acid concentrations (reference level, <10 μmol/L) was 15 μmol/L (range, 1-285 μmol/L). Twelve dogs (57%) showed values above reference.

Using the clinical signs, the measurements of fasting bile acids, fasting ammonia, and the ammonia tolerance test from the medical records, it was determined when there was symptomatic, asymptomatic, or no shunting short-term after surgery in each dog (table 5). During the last routine control visit after surgery of the 21 dogs 9 (33%) dogs had no shunting, 4 (29%) dogs had asymptomatic shunting and 6 (29%) dogs had symptomatic shunting. In 2 dogs the degree of shunting at that time is unknown because no ammonia tolerance test was performed.

During the long-term control visit in this study it was also determined if the dogs had symptomatic shunting, asymptomatic shunting or no shunting, to compare short-term and long-term outcome after surgery. The results of the questionnaires were also used to determine if there was still suspicion of shunting. Two questionnaires were not received back. Of the 19 dogs with questionnaires and known outcome, 11 (58%) dogs had no shunting, 3 (16%) dogs had asymptomatic shunting and 5 (26%) dogs had symptomatic shunting. Of the 11 dogs with no shunting, the mean CPSS score was 12.2, of the 3 dogs with asymptomatic shunting, the mean CPSS score was 19.3 and of the 5 dogs with symptomatic shunting, the mean CPSS score was 21.4. These differences were not significant.

Using table 6, the status of the patient; no recovery, partial recovery or complete recovery, was also determined. Of the group of 21 patients that came back to the clinic, 6 (29%) dogs had no recovery, 4 (19%) dogs had partial recovery and 11 (52%) dogs were completely recovered after CPSS surgery.

Table 5. Classification of shunting after CPSS surgery

Clinical Signs[1]	**Abnormal ammonia metabolism**[2]	**Classification**
+	+	Symptomatic Shunting
-	+	Asymptomatic Shunting
+	-	No Shunting
-	-	No Shunting

[1] Positive(+): HE grade 1-4, weekly vomiting, diarrhea and decreased appetite, periods of urologic signs
Negative(-): HE grade 0, no or less than weekly vomiting, diarrhea and decreased appetite, no urologic signs
[2] Positive(+): Fasting ammonia > 100 µmol/L or a positive ammonia tolerance test (more than a twofold increase in plasma ammonia concentration with reference to the fasting ammonia concentration, this value also needs to be above 45 µmol/L
Negative(-): Fasting ammonia < 46 µmol/L and a negative ammonia tolerance test (no increase or less than a twofold increase in plasma ammonia concentration with reference to the fasting ammonia concentration.

Table 6. Status of the patient after CPSS surgery

Clinical Signs[1]	**Abnormal liver metabolism**[2]	**Classification**
-	-	Complete Recovery
-	+	Partial Recovery
+	-	Partial Recovery
+	+	No Recovery

[1] Positive (+): HE class 1-4, weekly vomiting, diarrhea and decreased appetite, periods of urologic signs
Negative (-): HE grade 0, no or less than weekly vomiting, diarrhea and decreased appetite, no urologic signs
[2] Positive (+): Fasting bile acids > 10µmol/L, fasting ammonia > 100 µmol/L or a positive ammonia tolerance test (more than a twofold increase in plasma ammonia concentration with reference to the fasting ammonia concentration, the value also needs to be above 45 µmol/L
Negative (-): Fasting ammonia < 46 µmol/L and a negative ammonia tolerance test(No increase or less than a twofold increase in plasma ammonia concentration with reference to the fasting ammonia concentration)

Discussion

The aim of this study was to obtain long-term outcome data for 167 dogs that were surgically treated by ligation for CPSS at Utrecht University between 2003 and 2013. This retrospective study was designed to support a randomized, multicenter prospective study that is conducted to compare partial attenuation of CPSS by ligation and by cellophane banding.
In addition to the descriptive information and the information obtained with the questionnaires, different pre-operative variables were evaluated to note if there was association with post-operative persistent shunting and thus with the long-term outcome.
In this study 77% of the dogs were diagnosed with EH CPSS and 23% of the dogs were diagnosed with IH CPSS. EH CPSS is found to be more common than IH CPSS, which is consistent with the outcome in other studies.(Berent & Tobias, 2009; Hunt, 2004) EH CPSS can be divided in EH PC CPSS and EH PAZ CPSS. EH PC CPSS is found in 71% of the dogs with EH CPSS and EH PAZ CPSS in 29% of the dogs. In this study EH PC CPSS is more common than EH PAZ CPSS, which is also consistent to what is found in other studies.(Berent & Tobias, 2009; Hunt, 2004) IH CPSS is positioned centrally in the liver, at the left or the right side. 58% of the dogs had left divisional IH CPSS, 34% had right divisional IH CPSS and 8% had centrally positioned IH CPSS. The left divisional IH CPSS is more common than right divisional and centrally positioned IH CPSS. Also the right divisional IH CPSS is more common than the centrally positioned IH CPSS. Although the division of left, right

and central positioned IH CPSS is associated with country of origin according to Krotscheck et al. (2007), they also found that overall the left divisional IH CPSS is more common.(Krotscheck et al., 2007) This is also confirmed in other studies and is consistent with what is found in this study.(van den Ingh et al., 1995; White et al., 1998) A possible explanation for this finding is the embryological origin of the left divisional IH CPSS. The left divisional IH CPSS is considered to be caused by incomplete closure of the embryonic ductus venosus.(Krotscheck et al., 2007; van Steenbeek et al., 2012)

Type of breed has a significant effect on the anatomy of CPSS. EH CPSS is mostly seen in small dogs. Most common breeds with EH CPSS in this study are Maltese dogs, Jack Russell Terriers, Yorkshire Terriers, Cairn Terriers and Dachshunds. IH CPSS is mostly seen in large dogs. Most common breeds with IH CPSS in this study are Golden Retrievers, Bernese Mountain Dogs, Labrador Retrievers, Cane Corsos and Irish Wolfhounds. This division between large and small breeds may indicate an inherited basis for the disease. The genetic basis of CPSS in dogs is not clear yet but many authors have demonstrated that congenital shunts are more frequently diagnosed in purebred dogs, that a number of breeds are predisposed and that EH CPSS and IH CPSS are rarely seen in the same breed.(Hunt, 2004; Krotscheck et al., 2007; Tobias & Rohrbach, 2003; Tobias, 2003; van Steenbeek et al., 2013; van Straten et al., 2005)

An equal frequency of affected males and females for both EH and IH CPSS was reported by Hunt (2004) and van Straten et al. (2005). Krotscheck et al. (2007) however found a relationship between sex and anatomical location of the IH CPSS. In our study the sex distribution for EH PC CPSS was 59% female and 41% male and for EH PAZ CPSS the distribution was 70% female and 30% male. This suggests, especially for PAZ, that EH CPSS may be more common in females, which is not consistent with foregoing studies. The sex distribution for IH CPSS was 50% female and 50% male with left divisional IH CPSS, 46% female and 54% male with right divisional IH CPSS and 1 female and 2 males with centrally positioned IH CPSS. This outcome shows no relationship between sex and anatomical location of the IH CPSS, as found by Krotscheck et al. (2007). There is an equal frequency of affected males and females for IH CPSS, which is consistent with the foregoing studies of Hunt (2004) and van Straten et al. (2005).(Hunt, 2004; Krotscheck et al., 2007; van Straten et al., 2005)

The age at surgery in dogs with EH PC CPSS was in former publications lower than that of dogs with EH PAZ CPSS.(Sura et al., 2007; Van den Bossche et al., 2012) In this study the median age at surgery for dogs with EH PC CPSS was 10.5 months and for dogs with EH PAZ CPSS the median age at surgery was 20 months. This appears to be consistent with earlier findings. A possible explanation for the higher median age at surgery for dogs with EH PAZ CPSS is the milder clinical signs in these dogs. This could cause a later onset of clinical signs and thus a later age at diagnosis. Dogs with EH PAZ CPSS have milder clinical signs presumably because of intermittent occlusion of the shunting vessel by diaphragmatic compression during normal respiration or gastric distension after a meal.(Sura et al., 2007)

At Utrecht University, dogs with CPSS will receive medical management during the period between the first examination and the CPSS surgery, so the clinical status of the patient will be as good as possible during surgery. A small amount of dogs already received medical management before the first visit to the clinic, prescribed by the own veterinarian. This may have had influence on the clinical status and the blood values of these dogs during the first examination at the clinic of Utrecht University. Also at the moment of the first examination after surgery, a small amount of dogs were still receiving medical management. This also may have had influence on the status of these dogs.

A lot of information was obtained by a medical records review of all dogs treated with surgical ligation for CPSS from 2003 to 2013. In this study, the findings before and after surgery have been described but possible differences were not statistically analyzed yet. A large amount of dogs were

admitted with growth retardation during the first examination. 40% of the dogs with EH PC CPSS, 46% of the dogs with EH PAZ CPSS and 53% of the dogs with IH CPSS had retarded growth. This may be due to decreased appetite and gastrointestinal problems that are common in dogs with CPSS. Decreased appetite was present in 51% of the dogs with EH PC CPSS before surgery and in 6.7% of the dogs after surgery. 38% of the dogs with EH PAZ CPSS had decreased appetite before surgery, after surgery 6.7%. 45% of the dogs with IH CPSS had decreased appetite before surgery and only 1 dog still had decreased appetite after surgery. This outcome shows that appetite increases because of the surgery. Gastrointestinal signs like vomiting and diarrhea were present in 62% of the dogs with EH PC CPSS during first examination before surgery and in 23% of the dogs after surgery. 59% of the dogs with EH PAZ CPSS had gastrointestinal signs before surgery, after surgery 13%. 45% of the dogs with IH CPSS also had gastrointestinal signs, 17% had still signs after surgery. Gastrointestinal signs also seem to improve because of surgery. This information about appetite and gastrointestinal signs after surgery may explain why growth retardation reduces after surgery. Unfortunately there was not enough information about growth after surgery in the medical records of the dogs of this study population.

The majority of the dogs in this study population had decreased activity during first examination. After surgery there was a large improvement and only a small amount of dogs still had decreased activity. Before surgery 83% of the dogs with EH PC CPSS had decreased activity, after surgery 8%. 65% of the dogs with EH PAZ CPSS had decreased activity before surgery, after surgery 10%. 79% of the dogs with IH CPSS had decreased activity before surgery, 10% after surgery.

Most dogs with CPSS show signs of hepatic encephalopathy (HE) because of high ammonia levels in their blood. 90% of the dogs with EH PC CPSS showed signs of HE before surgery, these signs differ from grade 1 to grade 4. After surgery 4% of the dogs still showed signs of HE, grade 1 and 2. 84% of the dogs with EH PAZ CPSS showed signs of HE before surgery, these signs differ from grade 1 to grade 3. After surgery 10% of the dogs still showed signs of HE, grade 1 and 2. 95% of the dogs with IH CPSS also showed signs of HE before surgery, differing from grade 1 to grade 3. After surgery, 24% of the dogs still had signs of HE, grade 1 and 2. Signs of HE decrease after surgery because blood will now be cleansed by the reticuloendothelial system in the hepatocytes. The outcome seems to show a large improvement in signs of HE after surgery. In comparison with other studies, the percentage of HE before surgery is very high in this study population. In previously published reports clinical signs of HE at the time of presentation were ranging from 45% to 79%.(Falls et al., 2013; Harvey & Erb, 1998; Hurn & Edwards, 2003; Winkler et al., 2003; Worley & Holt, 2008) The high amount of dogs with clinical signs of HE in this study is due to the fact that more clinical signs were interpreted as HE, such as polyuria, character changes and indolence.

Different blood values were measured before and after surgery to confirm CPSS and to examine the status of the patient. Measurement of the fasting plasma ammonia concentration and the ammonia tolerance test are a very important tool to diagnose CPSS and to examine if there is still shunting after surgery. The median fasting plasma ammonia concentration before surgery for dogs with EH PC CPSS is 153 µmol/L, after surgery the median concentration was 15 µmol/L. For dogs with EH PAZ CPSS the median concentration is 97 µmol/L before surgery and 15 µmol/L after surgery. For dogs with IH CPSS the median concentration is 162 µmol/L before surgery and 63 µmol/L after surgery. The outcome after surgery for EH CPSS seems to be better than the outcome after surgery for IH CPSS. In healthy dogs, the fasting plasma ammonia concentration may not reach above 45 µmol/L. Dogs with EH CPSS meet this standard after surgery, but this does not apply for IH CPSS. This outcome suggests that surgical ligation is more effective for EH CPSS than for IH CPSS. It is a possibility that regeneration of the liver is a more difficult process in dogs with IH CPSS, the exact reason for this is unknown. During the study

the predictive value of the pre-operative fasting plasma ammonia concentration for the presence of persistent shunting after surgery was investigated. No significant association was found for the 3 different groups.

The ammonia tolerance test (ATT) was performed in a small amount of dogs before surgery and in the majority of dogs after surgery, to check the hepatic metabolism. For all 3 different types of shunts, EH PC CPSS, EH PAZ CPSS and IH CPSS, the tests performed before surgery were 100% positive. For dogs with EH PC CPSS, 28% of the tests performed after surgery were positive, for dogs with EH PAZ CPSS, 38% turned out positive and for dogs with IH CPSS, 61% of the tests performed after surgery were positive. These results show that surgery has a positive effect on the outcome of the ammonia tolerance tests; however the outcome again seems to be better for EH CPSS than for IH CPSS. This means that recovery of hepatic metabolism after surgery is higher for EH CPSS than for IH CPSS. This agrees with the outcome of the fasting plasma ammonia concentration.

The fasting plasma bile acid concentration is also a test used for diagnosis of CPSS. This test is often combined with the postprandial plasma bile acid concentration. This bile acid stimulation test is not performed in the dogs of this study population because it is difficult to combine this test with the ATT. It also is not necessary to perform both the ATT and the bile acid stimulation test. The fasting plasma bile acid concentration is measured before and after surgery. For dogs with EH PC CPSS the median concentration before surgery was 105 µmol/L, the median concentration after surgery was 8 µmol/L. For dogs with EH PAZ CPSS the median concentration before surgery was 95 µmol/L, the median concentration after surgery was 7 µmol/L. For dogs with IH CPSS the median concentration before surgery was 35 µmol/L, the median concentration after surgery was 54 µmol/L. The outcome after surgery again seems to be better for EH CPSS than the outcome after surgery for IH CPSS, as already seen for plasma ammonia and the ATT. In healthy dogs, the fasting plasma bile acid concentration may not reach above 10 µmol/L. Dogs with EH CPSS meet this standard after surgery, but this does not apply for IH CPSS. The fasting plasma bile acid concentration for IH CPSS, before and after surgery, also does not correspond to each other. The median concentration before surgery is relatively low comparing to EH CPSS. However the median concentration after surgery is high in relation to the median concentration before surgery. A possible explanation is liver damage due to the surgery. Bile acids will not only increase due to CPSS, also liver damage causes an increase in plasma bile acids. During IH CPSS surgery liver parenchyma has to be dissected from the shunt to be able to ligate the shunt, this is not the case in EH CPSS surgery. Acute damage to hepatic tissue should be healed within the time before the control visit (1-3 months after surgery), but possibly some chronic damage may still be present. Another possible explanation for the high plasma bile acid concentration after surgery could be that the majority of the dogs did not have a 12-hour fasting period before performing the test. During the study the predictive value of the pre-operative fasting plasma bile acid concentration for the presence of persistent shunting after surgery was investigated. No significant association was found for the 3 different groups.

Plasma albumin is measured in the majority of dogs before surgery and in a small group of dogs after surgery. Dogs with CPSS have reduced hepatic synthesis of albumin because of poor hepatic development, which causes hypoalbuminemia. For dogs with EH PC CPSS the median for plasma albumin before surgery was 24 g/L, after surgery the median was 28 g/L. For dogs with EH PAZ CPSS the median before surgery was 26 g/L, after surgery 28 g/L. For dogs with IH CPSS the median before surgery was 20 g/L, after surgery 26 g/L. The reference interval for albumin is 26 – 37 g/L. Before surgery only the median for EH PAZ CPSS falls within this range. After surgery both dogs with EH CPSS and dogs with IH CPSS meet the standard for plasma albumin. Note that the median values for IH CPSS seem to be lower than the ones for EH CPSS. Dogs with IH CPSS usually have larger shunts before surgery.

Hepatotrophic factors will bypass the liver in a greater amount than with the smaller EH CPSS. This may be causing less hepatic development and a decreased albumin production in relation to EH CPSS. During the study the predictive value of the pre-operative plasma albumin for the presence of persistent shunting after surgery was investigated. Mehl et al.(2005) and Kummeling et al. (2012) found that low pre-operative plasma albumin is a predictive factor for postoperative persistent shunting and thus for an unsuccessful long-term outcome. In this study there was no significant association found for the 3 different groups.

The total WBC concentration was also measured in the majority of dogs before surgery and in a small group of dogs after surgery. For dogs with EH PC CPSS the median WBC concentration before surgery was 18×10^9/L, after surgery the median was 13×10^9/L. For dogs with EH PAZ CPSS the median before surgery was 14×10^9/L, after surgery the median was 9×10^9/L. For dogs with IH CPSS the median before surgery was 15×10^9/L, after surgery the median was 14×10^9/L. The reference interval for the total WBC concentration is $4.5 – 14.6 \times 10^9$/L. This means that only the median values before surgery for EH PC CPSS and for IH CPSS were above reference. For all three forms of CPSS the total WBC concentration has decreased after surgery, as already expected. The increased white blood cell count in dogs with CPSS is associated with impaired reticuloendothelial function in the liver and with intestinal bacteria that are translocated into the portal blood which directly reach the systemic circulation. After surgery the portal blood will flow through the liver which causes an increase in reticuloendothelial function. Also translocated bacteria will flow through the liver and will be removed from the portal blood by the reticuloendothelial system. Fewer bacteria will now reach the systemic circulation which causes the decrease in the total WBC concentration. During the study the predictive value of the pre-operative total WBC concentration for the presence of persistent shunting after surgery was investigated. No significant association was found for the 3 different groups.

Several pre-operative variables were found to be not significantly associated with persistent shunting after surgery and thus with long-term postoperative outcomes. Additional statistical analysis is needed to further investigate the predictive values of the pre-operative variables.

11% of the dogs of the study population died in the short-term postoperative period, within 1 month after surgery. Most common complications were hemorrhage and cerebral necrosis. Reported mortality rates in other studies are between 2% and 27%. These study populations are surgically treated by partial or complete ligation or with the ameroid ring constrictor.(Greenhalgh et al., 2010; Hottinger et al., 1995; Hunt & Hughes, 1999; Kummeling et al., 2004; Mehl et al., 2005; Winkler et al., 2003) The mortality rate in our study corresponds with the mortality rates in the previous studies. However, direct comparison between different studies is complicated because of variation in the definition of the short-term postoperative period. Some studies consider this to be limited to less than 1 week postoperative, other studies use less than 1 month postoperative.

For the long-term follow-up of the dogs of the study population, questionnaires were sent to the owners of these dogs. With the outcome of these questionnaires, a scoring system was developed to translate a variety of clinical signs into one, individual score that can be used as a clinical tool. This score is called the CPSS score. There is cooperation with the Royal Veterinary College (RVC) in London for the development of the scoring system. However, the RVC did not jet receive enough questionnaires back for evaluation and development of the system. That is why in this study only a basic variant of the scoring system is developed that needs to be optimized with the help of the RVC. With this basic scoring system a significant ($P < 0.001$) improvement was found in the CPSS score after surgery, compared to the CPSS score before surgery. The mean CPSS score before surgery was 43 and the mean CPSS

score after surgery was 11. This outcome suggests that the basic scoring system already can determine improvement after CPSS surgery.
The follow-up period had a large range, with dogs being operated in 2003 and dogs being operated a month before filling in the questionnaire. This makes interpretation of the outcome of the questionnaires more difficult because dogs that just have been operated need time to recover. It is possible that dogs that just had surgery still had some clinical signs during the time the questionnaire was taken, however later on these dogs may be completely recovered. This is something to keep into account.
The impact of the clinical signs on the quality of life of the dogs was calculated with the help of the questionnaires. In this calculation pre- and postoperative was taken together. Because the relatively small amount of questionnaires received back, because not all clinical signs are present in all dogs and because not all questions about the impact on the dog's life were answered correctly, the sample sizes were too small to take pre- and postoperative separately. This is also the reason why the impact of the clinical signs in the dog's life was not taken into account in this variant of the scoring system. The sample sizes were too small, even when the three different groups of shunting were taken together. To optimize the scoring system, it is an option to use the impact of the clinical signs. This is only possible with a bigger sample size. More questionnaires have to be filled out to get larger sample groups. When this basic scoring system is optimized it can be used in the detection or diagnosis of clinical CPSS.
One of the questions of the questionnaire was if the dog was treated with medical management before surgery and if yes, what was the clinical improvement of the dog. The mean clinical improvement was 5.3 on a scale from 0 – 10. Besides, medical management hardly showed any negative effect on the dog's quality of life, with a mean score of 0.9 on a scale from 0 – 10. The mean quality of life before CPSS was diagnosed and before treatment with medical management was 2.4, on a scale from 0 – 10. The mean quality of life before surgery and with medical management was 3.8, on a scale from 0 – 10. This shows, according to the owner, an improvement in the dog's quality of life when medical management is introduced. It can be concluded that medical management has a positive effect on the dog's health. The owners were also asked to give the quality of life of their dog at this moment, after surgery. The mean quality of life after surgery was 8.7, on a scale from 0 – 10. This is a large improvement compared to the situation before surgery with or without medical management. Owners are also very satisfied with the result of the surgery, with a mean score of 9.1, on a scale from 0 – 10. Only a few owners are still worried about the health of their dog, with a mean score of 2.9, on a scale from 0 – 10. These results show a large improvement in the dog's health, according to the owners and the owners are very satisfied with the results of the surgery.

The questionnaire also has its limitations. 112 questionnaires were sent to the owners and only 57% of the questionnaires were received back. The questionnaires were sent by mail, this makes it a bigger effort to return the questionnaires to the clinic. In the future it is better to send the questionnaires by email or as a fully digital questionnaire. The questionnaires also contained a lot of questions; this may demotivate people to fill out the questionnaire. Of the 64 questionnaires that were received back, only 36% was filled out correctly. A large amount of questions contained two parts, staging of the symptoms (never, less than once a month, monthly, weekly, daily), and qualifying the impact of this specific sign on their dog's life. This makes it easier to forget part of the question. Also a couple of questions could easily be misinterpreted because of the way the question was asked. The scoring system needs to be optimized, more questionnaires have to be filled out, and so these points have to be taken into account in the future.

21 patients came back to the clinic for an extra control visit. These dogs were randomly chosen with a follow-up time of at least 6 months. In this group, the percentage of hepatic encephalopathy, the outcome of

the ammonia metabolism and the fasting plasma bile acid concentration was relatively high for a group of dogs that already underwent surgery. Although the dogs were randomly chosen, the group of dogs did not represent the study population. A large group of owners rejected the offer for an extra control visit, mostly because they thought that drawing blood was too invasive for their dog. Also the owners of dogs that showed no clinical signs were less motivated to visit the clinic. Owners of dogs that recently had surgery, and owners of dogs that had disappointing results during the last routine control visit were more motivated to come to the clinic with their dog. These owners were more worried about their dog than the other owners. This probably results in a group of dogs with more clinical signs and higher plasma ammonia and plasma bile acid concentration than the mean of the study population after surgery. 42% of the dogs of this group had asymptomatic or symptomatic shunting.
With the help of the questionnaires filled out by the owners of the 21 dogs, a CPSS score was calculated for each dog. After calculating the mean CPSS score for dogs with symptomatic shunting, asymptomatic shunting and nog shunting, it came clear that the CPSS score was highest in dogs with symptomatic shunting and lowest in dogs with no shunting. This means that the CPSS score is associated with the postoperative shunting classification. However, this association is not significant, probably due to the small sample sizes.

The retrospective nature of this study is probably the biggest limitation of the study. However, the study was intended to describe the results of the last decade in order to evaluate our recent results and to compare them with earlier results. Time of surgery was upwards of 10 years before follow-up for some of the dogs in this study. 14 dogs did not came to the clinic for a control visit after surgery. Also the numbers of patients are low in the separate groups of EH PAZ CPSS and IH CPSS.
No standard diagnostic protocol was used for patients suspected for CPSS. This makes that not all data of interest were reported in the medical records. Every effort was made to contact referring veterinarians and owners, but because of the extended time since surgery some individuals were untraceable and some medical records were discarded. This could mask potentially important information or findings for this current study.

It is hard to draw conclusions about the dogs where follow-up was based on reports from owners, as these may be misleading and dependent on the duration of follow-up and whether animals are still being fed a low protein diet and symptomatic treatment such as lactulose. With standardization of the questionnaire it was tried to reduce these influences. From only 64 dogs of the 167 dogs of the study population long-term information through the questionnaires was available. The majority of the study population was lost to long-term follow up.

Conclusion

This retrospective study indicated that surgical ligation is a relatively safe, effective technique that in most cases results in resolution of biochemical abnormalities resulting from portosystemic shunting. Also clinical signs will reduce or disappear after surgery. Owners are very satisfied with the result of the surgery.
A basic scoring system was developed which can eventually help detecting clinical PSS. Bigger sample sizes are necessary for further development of the scoring system, which can be achieved with the help of the Royal Veterinary College in London. This study suggests that the basic scoring system can determine between symptomatic, asymptomatic and no shunting after surgery. This is promising information for the future.

References

Albrecht, J., & Jones, E. A. (1999). Hepatic encephalopathy: Molecular mechanisms underlying the clinical syndrome. *Journal of the Neurological Sciences, 170*(2), 138. doi:10.1016/S0022-510X(99)00169-0

Berent, A., & Tobias, K. (2009). Portosystemic vascular anomalies. *The Veterinary Clinics of North America.Small Animal Practice, 39*(3), 513-541. doi:10.1016/j.cvsm.2009.02.004

Butterworth, R. F. (2002). Pathophysiology of hepatic encephalopathy: A new look at ammonia. *Metabolic Brain Disease, 17*(4), 221-227.

Center, S. A. (1993). Serum bile acids in companion animal medicine. *The Veterinary Clinics of North America.Small Animal Practice, 23*(3), 625-657.

Center, S. A., & Magne, M. L. (1990). Historical, physical examination, and clinicopathologic features of portosystemic vascular anomalies in the dog and cat. *Clinical Techniques in Small Animal Practice, 5*(2), 83.

Center, S. A., ManWarren, T., Slater, M. R., & Wilentz, E. (1991). Evaluation of twelve-hour preprandial and two-hour postprandial serum bile acids concentrations for diagnosis of hepatobiliary disease in dogs. *Journal of the American Veterinary Medical Association, 199*(2), 217-226.

Ciecko-Michalska, I., Szczepanek, M., Slowik, A., & Mach, T. (2012). Pathogenesis of hepatic encephalopathy. *Gastroenterology Research and Practice, 2012*

Falls, E. L., Milovancev, M., Hunt, G. B., Daniel, L., Mehl, M. L., & Schmiedt, C. W. (2013). Long-term outcome after surgical ameroid ring constrictor placement for treatment of single extrahepatic portosystemic shunts in dogs. *Veterinary Surgery,* doi:10.1111/j.1532-950X.2013.12072.x

Felipo, V. (2013). Hepatic encephalopathy: Effects of liver failure on brain function. *Nature Reviews.Neuroscience, 14*(12), 851-858. doi:10.1038/nrn3587

Gerritzen Bruning, M. J., van den Ingh, T. S. G. A. M., & Rothuizen, J. (2006). Diagnostic value of fasting plasma ammonia and bile acid concentrations in the identification of portosystemic shunting in dogs. *Journal of Veterinary Internal Medicine, 20*(1), 13-19.

Greenhalgh, S. N., Dunning, M. D., McKinley, T. J., Goodfellow, M. R., Kelman, K. R., Freitag, T., . . . Jeffery, N. D. (2010). Comparison of survival after surgical or medical treatment in dogs with a congenital portosystemic shunt. *Journal of the American Veterinary Medical Association, 236*(11), 1215-1220. doi:10.2460/javma.236.11.1215

Harvey, J., & Erb, H. N. (1998). Complete ligation of extrahepatic congenital portosystemic shunts in nonencephalopathic dogs. *Veterinary Surgery, 27*(5), 413-416.

Hottinger, H. A., Walshaw, R., & Hauptman, J. G. (1995). Long-term results of complete and partial ligation of congenital portosystemic shunts in dogs. *Veterinary Surgery, 24*(4), 331-336.

Hunt, G. B. (2004). Effect of breed on anatomy of portosystemic shunts resulting from congenital diseases in dogs and cats: A review of 242 cases. *Australian Veterinary Journal, 82*(12), 746-749.

Hunt, G. B., & Hughes, J. (1999). Outcomes after extrahepatic portosystemic shunt ligation in 49 dogs. *Australian Veterinary Journal, 77*(5), 303-307.

Hunt, G. B., Kummeling, A., Tisdall, P. L. C., Marchevsky, A., Liptak, J., Youmans, K. R., . . . Beck, J. (2004). Outcomes of cellophane banding for congenital portosystemic shunts in 106 dogs and 5 cats. *Veterinary Surgery, 33*(1), 25-31.

Hurn, S. D., & Edwards, G. A. (2003). Perioperative outcomes after three different single extrahepatic portosystemic shunt attenuation techniques in dogs: Partial ligation, complete ligation and ameroid constrictor placement. *Australian Veterinary Journal, 81*(11), 666-670.

Kim, S. E., Giglio, R. F., Reese, D. J., Reese, S. L., Bacon, N. J., & Ellison, G. W. (2013). Comparison of computed tomographic angiography and ultrasonography for the detection and characterization of portosystemic shunts in dogs. *Veterinary Radiology & Ultrasound, 54*(6), 569-574. doi:10.1111/vru.12059

Koblik, P. D., & Hornof, W. J. (1995). Technetium 99m sulfur colloid scintigraphy to evaluate reticuloendothelial system function in dogs with portasystemic shunts. *Journal of Veterinary Internal Medicine, 9*(6), 374. doi:10.1111/j.1939-1676.1995.tb03296.x

Krotscheck, U., Adin, C. A., Hunt, G. B., Kyles, A. E., & Erb, H. N. (2007). Epidemiologic factors associated with the anatomic location of intrahepatic portosystemic shunts in dogs. *Veterinary Surgery, 36*(1), 31-36. doi:10.1111/j.1532-950X.2007.00240.x

Kummeling, A., Penning, L. C., Rothuizen, J., Brinkhof, B., Weber, M. F., & van Sluijs, F. J. (2012). Hepatic gene expression and plasma albumin concentration related to outcome after attenuation of a congenital portosystemic shunt in dogs. *The Veterinary Journal, 191*(3), 383. doi:10.1016/j.tvjl.2011.04.022

Kummeling, A., Teske, E., Rothuizen, J., & Van Sluijs, F. J. (2006). Coagulation profiles in dogs with congenital portosystemic shunts before and after surgical attenuation. *Journal of Veterinary Internal Medicine, 20*(6), 1319-1326.

Kummeling, A., van Sluijs, F. J., & Rothuizen, J. (2004). Prognostic implications of the degree of shunt narrowing and of the portal vein diameter in dogs with congenital portosystemic shunts. *Veterinary Surgery, 33*(1), 17. doi:10.1111/j.1532-950x.2004.04004.x

Lamb, C. R., & Burton, C. A. (2004). Doppler ultrasonographic assessment of closure of the ductus venosus in neonatal irish wolfhounds. *Veterinary Record, 155*(22), 699-701.

Mehl, M. L., Kyles, A. E., Hardie, E. M., Kass, P. H., Adin, C. A., Flynn, A. K., . . . Gregory, C. R. (2005). Evaluation of ameroid ring constrictors for treatment for single extrahepatic portosystemic shunts in dogs: 168 cases (1995-2001). *Journal of the American Veterinary Medical Association, 226*(12), 2020. doi:10.2460/javma.2005.226.2020

Mehl, M. L., Kyles, A. E., Hardie, E. M., Kass, P. H., Adin, C. A., Flynn, A. K., . . . Gregory, C. R. (2005). Evaluation of ameroid ring constrictors for treatment for single extrahepatic portosystemic shunts in dogs: 168 cases (1995-2001). *Journal of the American Veterinary Medical Association, 226*(12), 2020-2030.

Mertens, M., Fossum, T. W., Willard, M. D., Fosgate, G. T., de la Paz, A. G., Farmer, R., & Miller, M. W. (2010). Diagnosis of congenital portosystemic shunt in miniature schnauzers 7 years of age or older (1997-2006). *Journal of the American Animal Hospital Association, 46*(4), 235-240.

Montgomery, J. Y., & Bajaj, J. S. (2011). Advances in the evaluation and management of minimal hepatic

encephalopathy. *Current Gastroenterology Reports, 13*(1), 26. doi:10.1007/s11894-010-0150-z

O'Leary, C. A., Parslow, A., Malik, R., Hunt, G. B., Hurford, R. I., Tisdall, P. L. C., & Duffy, D. L. (2014). The inheritance of extra-hepatic portosystemic shunts and elevated bile acid concentrations in maltese dogs. *Journal of Small Animal Practice, 55*(1), 14-21. doi:10.1111/jsap.12156

Paepe, D., Haers, H., Vermote, K., Saunders, J., Risselada, M., & Daminet, S. (2007). Portosystemic shunts in dogs and cats: Laboratory diagnosis of congenital portosystemic shunts. *Vlaams Diergeneeskundig Tijdschrift, 76*(4), 241-248.

Papazoglou, L. G., Monnet, E., & Seim III, H. B. (2002). Survival and prognostic indicators for dogs with intrahepatic portosystemic shunts: 32 cases (1990–2000). *Veterinary Surgery, 31*(6), 561. doi:10.1053/jvet.2002.34666

Rothuizen, J. (1993). Portosystemic hepatic encephalopathy related with congenital and acquired hepatopathies in the dog. *Adv Vet Sci Comp Med, 37*, 403-416.

Ruland, K., Fischer, A., & Hartmann, K. (2010). Sensitivity and specificity of fasting ammonia and serum bile acids in the diagnosis of portosystemic shunts in dogs and cats. *Veterinary Clinical Pathology, 39*(1), 57-64. doi:10.1111/j.1939-165X.2009.00178.x

Skowronska, M., & Albrecht, J. (2012). Alterations of blood brain barrier function in hyperammonemia: An overview. *Neurotoxicity Research, 21*(2), 236. doi:10.1007/s12640-011-9269-4

Sura, P. A., Tobias, K. M., Morandi, F., Daniel, G. B., & Echandi, R. L. (2007). Comparison of 99mTcO4- trans-splenic portal scintigraphy with per-rectal portal scintigraphy for diagnosis of portosystemic shunts in dogs. *Veterinary Surgery, 36*(7), 654. doi:10.1111/j.1532-950X.2007.00317.x

Tisdall, P. L. C. (1994). Congenital portosystemic shunts in maltese and australian cattle dogs. *Australian Veterinary Journal, 71*(6), 174. doi:10.1111/j.1751-0813.1994.tb03382.x

Tobias, K. M. (2003). Determination of inheritance of single congenital portosystemic shunts in yorkshire terriers. *Journal of the American Animal Hospital Association, 39*(4), 385-389.

Tobias, K. M., & Rohrbach, B. W. (2003). Association of breed with the diagnosis of congenital portosystemic shunts in dogs: 2,400 cases (1980-2002). *Journal of the American Veterinary Medical Association, 223*(11), 1636-1639.

Van den Bossche, L., van Steenbeek, F. G., Favier, R. P., Kummeling, A., Leegwater, P. A. J., & Rothuizen, J. (2012). Distribution of extrahepatic congenital portosystemic shunt morphology in predisposed dog breeds. *BMC Veterinary Research, 8* doi:10.1186/1746-6148-8-112

van den Ingh, T. S. G. A. M., Rothuizen, J., & Meyer, H. P. (1995). Circulatory disorders of the liver in dogs and cats. *The Veterinary Quarterly, 17*(2), 70-76. doi:10.1080/01652176.1995.9694536

van Steenbeek, F. G., Leegwater, P. A. J., van Sluijs, F. J., Heuven, H. C. M., & Rothuizen, J. (2009). Evidence of inheritance of intrahepatic portosystemic shunts in irish wolfhounds. *Journal of Veterinary Internal Medicine, 23*(4), 950-952. doi:10.1111/j.1939-1676.2009.0319.x

van Steenbeek, F. G., Van den Bossche, L., Grinwis, G. C. M., Kummeling, A., van Gils, I. H. M., Koerkamp, M. J. A., . . . Spee,

B. (2013). Aberrant gene expression in dogs with portosystemic shunts. *PLoS ONE, 8*(2), e57662-e57662. doi:10.1371/journal.pone.0057662

van Steenbeek, F. G., van den Bossche, L., Leegwater, P. A. J., & Rothuizen, J. (2012). Inherited liver shunts in dogs elucidate pathways regulating embryonic development and clinical disorders of the portal vein. *Mammalian Genome, 23*(1-2), 76-84. doi:10.1007/s00335-011-9364-0

van Straten, G., Leegwater, P. A. J., de Vries, M., van den Brom, W. E., & Rothuizen, J. (2005). Inherited congenital extrahepatic portosystemic shunts in cairn terriers. *Journal of Veterinary Internal Medicine, 19*(3), 321-324.

White, R. N., Burton, C. A., & McEvoy, F. J. (1998). Surgical treatment of intrahepatic portosystemic shunts in 45 dogs. *Veterinary Record, 142*, 358.

Winkler, J. T., Bohling, M. W., Tillson, D. M., Wright, J. C., & Ballagas, A. J. (2003). Portosystemic shunts: Diagnosis, prognosis, and treatment of 64 cases (1993-2001). *Journal of the American Animal Hospital Association, 39*(2), 169-185.

Worley, D. R., & Holt, D. E. (2008). Clinical outcome of congenital extrahepatic portosystemic shunt attenuation in dogs aged five years and older: 17 cases (1992-2005). *Journal of the American Veterinary Medical Association, 232*(5), 722-727. doi:10.2460/javma.232.5.722

Attachments

Appendix:

1: Medical records of UKG database

2: Quality of Life Questionnaire as send to the owners (translated in Dutch)

3:

4:

EH PC CPSS

Patient	Breed	Gender	Age at surgery (months)	Medical management		Shunt attenuation	General impression		Retarded growth	Neurological signs		HE classification	
				before	*after*		*before*	*after*		*before*	*after*	*before*	*after*
1	Rottweiler	M	4		1	partial	3,12	5	yes	5,11,13,16	3,5,6,13,14,16,19,20,21,22,23	4	2
2	Cairn Terrier	F	4			complete						0	0
3	Crossbreed	F	21			partial	5,7	4	yes	3,4,8,9,14		3	0
4	Malteser	M	36			complete	1			4,7,8,13, 20, 22		3	
5	Cairn Terrier	F	4			complete	1	1				0	0
6	Malteser	M	14			complete	5,6,11	4		3,8,13,14,15		3	0
7	Yorkshire Terrier	M	5			complete	1,3,10	1		5,2		2	0
8	Maltheser	M	4			partial	5	1		1,4,5,6,9,10,14,20,21,22		2	0
9	Jack Russell Terrier	M	37			partial	3,11	4	yes	1,3,6,11,13,14,21,22,23		2	0
10	Crossbreed	M	4	1		complete	5			5,8,11,16		3	
11	Dachshund	F	5	1		partial	1	1	yes	20		1	0
12	Dachshund	M	15	1,2	1,2	partial	3,5,11	1,4	yes	1,3,4,6,7,11		2	0
13	Jack Russell Terrier	F	34			partial	1,11	1		1,5,6,15,20		2	0
14	Jack Russell Terrier	M	10	1		complete	3		yes			0	
15	Malteser	F	12	2	1	partial	3	4		13,15,21,22		2	0
16	Dachshund	M	6	1		partial	1,3,11			1,11,15		2	
17	Miniature Schnauzer	F	27		1	partial	5	1		1,5,14,24		2	0
18	Yorkshire Terrier	M	6			partial	6	1	yes	2,8		3	0
19	Malteser	F	5	1,2		partial	3,5	1	yes	4,5,11,14,16,20,21		2	0
20	West Highland White Terrier	F	5	1		partial	3,6	4		1,5,11,14,21		2	0
21	Jack Russell Terrier	M	14	1,2		partial	1,3,6	1,4		3,4,8,11,14		3	0
22	Malteser	M	50	1		partial				5,20,21		2	
23	Cairn Terrier	F	6			partial						0	0
24	Malteser	M	14	1		partial	3,5	1		1,8,11,14		3	0
25	Crossbreed	M	4,5		2	partial	3,5,7	1	yes	13,15		2	0
26	Dachshund	M	36			partial	3,5			4,9,11,13,20		2	
27	Malteser	F	67	1,2		partial	5,6	1,4	yes	1,6,15		2	0
28	Yorkshire Terrier	F	7	1,2		partial	1	1		6,13,14,21		2	0
29	Malteser	F	15	1,2		partial	3	1	yes	3,511,12,13,14		2	0
30	Pug	F	12		1	partial	3,5	1,4	yes	5,11		2	0
31	Dachshund	M	7			complete	3,5	1	yes	9,13,21		2	0

1a: Medical records of UKG database, details of patients with PC CPSS.

EH PC CPSS

	Gastro- intestinal signs		Micturition		Appetite		Activity level		Fasting Bile acids µmol/L		Fasting ammonia µmol/L		NH3 tolerance test		Albumine g/L		White blood cell count x 10^9 /L	
Patient	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*
1	1		4,6	4,6	3,6	3,6	2,4,5	2,5,6		7	>286	201		+				
2					6	1		1		16		19		-	28			
3	2,4	2	4,6,7		6	1	2	1	179	8	134	10		-	19	33		12,6
4		1	4,6		2,7		5		3	1	58	13	+	-	11			
5					1	1	1	1		4		19		-	26			
6					3	1	4	3	40		208	10		-	24		21,5	
7	1		1,4,5,6		6	1		1		1	170	16		-	30	30		
8						8	2	1	33		135	26		-	25		12,8	
9		1	6		6	1	4	1		6	187	16		-	30			
10	1				4		2,4			4		19				29		
11	1	1,3	2,3,4,5,6		4,6	1	1	1			162	62		-	20			14,1
12	1				4	8	2,5	1	23	73	33	17	+	-	26	26		
13	1	1			4	1	5,6	1	78		204	14		-	25		8,2	
14	1		2,5,6		4		2,5		37		100				25		18,6	
15	1	1	4,6,7		4	1	5,6	1				9		-	24			
16	1				4		2,4		58		159				31		12,9	
17	1		2,4		4,7	1	2	1	49	3	>286	12		-	23		12,9	
18	1		2		4	1	2,4	1	275	12	79	8		-	25		19,2	
19	1		4,6	6 <	4,6	1	2,4,6	1	54		153	45		-	19			
20	1		4,6	6 <	4,7	1	2,4	3			178	12		-	24		22,1	
21	1				4	8	2	1	66		149	16		+	20			
22			4		3,6		2,5		195		114				26		20,7	
23				6					13	6	32	7	+	-	31	33	11	9,4
24	1		2,3,4,7		2,6	1	2,4	1	168	10	224	7		-	18	5	16,5	9,3
25			3,4,6		2,7	6	2	1	230	19	194	23		-	20			
26	1,2,3		4		2,6		2,4,6		405		171				26		40,5	
27	1	1 <	2		1,6	1	2,5,6	1	135	22	123	18		-	16		42,6	15,2
28	1,2	1 <			6	1	2	1	125	26	286	9		-	21			
29	1,5				6	8	5	1	28	29	25	26	+	+	24			
30	1	1 <	4		4,6	8	5	5 <	615	26	94	13		-	28			
31	1		8		2,3	1	4	1		30	120	10		-	31		25,1	

EH PC CPSS

	Crystalluria		Bladder ultrasonography		Complications		Check-up		Ultrasonography post-operative	Mortality	Notes
Patient	*before*	*after*	*before*	*after*	*i.o.*	*p.o.*	*number*	*period, months p.o.*			
1				1,2			2	2	open	3 (4 months p.o.)	Hypoplasia v.portae
2				4			1	1	closed		
3			2			yes	1	1	open		
4			2				0				
5							1	1	closed		
6			4				1	1	unknown		
7			2				1	1	unknown		
8							1	1	open		
9			2,5	5			1	1	closed		
10							0				
11	yes		2				1	1	unknown		
12	yes		1			yes	1	1	open		
13			2	4		yes	1	1	closed	4 (8 years p.o.)	
14			1,2			yes				3 (2 days p.o.)	Cerebral necrosis
15							1	1	open	4 (8 years p.o.)	
16			2			yes				3 (0 days p.o.)	
17	yes		1	1 <		yes	1	1	open		
18	yes		1,2	4			1	2,5	open		
19					yes		1	1	open		
20			2	4			1	1	open		
21			2	4			2	3	open		
22			1			yes				3 (5 days p.o.)	Cerebral necrosis
23							3	6	unknown		
24	yes		4				2	6	unknown		
25			5				1	1	open		
26	yes		1			yes				3 (0 days p.o.)	Liver hemorrhage
27			1				2	3	unknown		
28	yes		1				1	1	unknown		
29		yes	2	1			2	3	open		
30			2	2	yes		1	1	closed		
31	yes		1	4			1	1	closed		

EH PC CPSS

	Breed	Gender	Age at surgery (months)	Medical management		Shunt attenuation	General impression		Retarded growth	Neurological signs		HE classification	
Patient				*before*	*after*		*before*	*after*		*before*	*after*	*before*	*after*
32	Jack Russell Terrier	F	10		1	partial	3,6,11	4	yes	4,5,6,11,13,20		2	0
33	Jack Russell Terrier	M	26	1		complete	5			7		1	0
34	Jack Russell Terrier	M	21			partial	1,3	4	yes			0	0
35	Chihuahua	M	6			complete				4,5,6,7,20		2	
36	West Highland White Terrier	F	15	1		partial	1,3	3	yes			0	0
37	Cairn Terrier	F	12			complete	1	1				1	0
38	Shih Tzu	F	7	2		partial	1,6	1		3,5,11,14,21,22,23		2	0
39	Miniature Schnauzer	F	16			partial	3,6	1,4	yes	1,14		1	0
40	Shih Tzu	F	21	1,2		complete	1					0	
41	Pug	F	36			complete	1,5			5,9,13,16,19,20,21		2	
42	Crossbreed	F	6			partial	3,6,11	1,4		5,6,13,14,15,16,19,20,21,22,23		2	0
43	Malteser	M	16	1		partial	5,11			1,5,6,11,14,20		2	0
44	Cavelier King Charles Spaniel	F	5			partial	1	1		9,11,13,14,16,22		2	0
45	Cairn Terrier	M	4			partial	1	1				0	0
46	Jack Russell Terrier	F	6	1		partial	1	1	yes	5,6,9		2	0
47	Yorkshire Terrier	M	6			partial	6,11			3,5,6,10,11,13,14,22		2	
48	Cairn Terrier	M	6			partial	1	1				1	0
49	Malteser	F	39	2	1	partial	1,2	1	yes	3,4,6,9,14,15		2	0
50	Yorkshire Terrier	M	11	2		partial	2	1,4		4,6,9,14,21		2	0
51	Bolognese	F	6	1,2		partial	6	1,4		2,3,4,6,9,11,16,21		2	0
52	Malteser	F	19	3	1	partial	3,5	1,4		4,8,9,13,14		3	0
53	Cairn Terrier	M	11	2		partial	1,3	1		5,21		2	0
54	Malteser	F	37	1,2	1	partial	3,5,11	1	yes	2,3,4,9,11,12,14,21		2	0
55	Yorkshire Terrier	F	28	1,2	1	partial	1	1		3,6,11,13,14,21,22		2	0
56	Jack Russell Terrier	M	17			partial	3,5	1	yes	5,8,11,14,21		3	0
57	Crossbreed	F	18			partial	1	1		9,13,17		2	0
58	Crossbreed	F	67	1		partial	1,3,5	1,3		2,3,5,6,13,14,17,20,22		2	0
59	Malteser	F	10			partial				7,8,15,20,21		3	
60	Jack Russell Terrier	M	67			partial	1,3,10	1				0	0
61	Pug	F	12			partial	1,3,5,6	1	yes	3,5,16,20		2	0
62	Yorkshire Terrier	F	4			partial	1,3			3,4,6,9,13		2	
63	Crossbreed	M	36			partial	1			21		1	

EH PC CPSS

	Gastro- intestinal signs		Micturition		Appetite		Activity level		Fasting Bile acids µmol/L		Fasting ammonia µmol/L		NH3 tolerance test		Albumine g/L		White blood cell count x 10^9 /L	
Patient	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*
32	1,2	1	4,6		4,6	1	4	1	260	0	>286	14		-	25		18,1	9,5
33	1,2		2,4,6		3	1	2,5	1	102	1	90	8		-	27			
34			2,3		2	1	2,4	1	100	1	93	12	+	-	25	32		9,7
35			4,6		2		2				133				24			
36						2,3		1		3	25	7	+	-	29			
37			4		1,6	1	1	1	275	1	187	16	+	-	25	28	18,2	13,8
38					3	1	1			5	>286	8		-	18			
39	1		2,4		1,6	1,8	4	1	29		178	32		-	28			
40			2,3		1		1		105		53				29		13,2	
41	1		4,6,7		4,6		4		114		>286				21		21,1	
42	1	1	4,6		2,3,6	1	2,5,6	1	24	27	116	45		+	21	17	21,8	
43	2						4,5,6		300	56	79	61		+	20		18,4	
44			4		1,6	1	2	1		13	124	69		+		26		
45					1	1	1	1			89	7	+	-	15			
46	1,2	1	4,6		1,6	1	5,6	1	22	4	57	10		-	24			
47	1		4		2,3,6				19		>286				22			
48			4,6		1,6	1	1	1			132	7	+	-	22		13,7	
49	2,3	2	4		3,6	3	4	5		13*	154	7		-	12		12,1	
50	1		4		2,3,6	1	2	1	106		169	8		-	17		18	
51			4,6		3,6	1	2,5,6	1			233	37		+	17		13,8	
52			1,4,6		3,6	1	2,5	1	69	8	67	13	+	+	21		9,7	
53			4,6		1,7	1	4,5,6	1		59	276	51		+	27		20,6	
54	1		4,6		3,6	1	2,4	1	136	1	32	15		-	21	26	29,1	
55			4,7		1,6	1	1	1	158	19	185	19		+	22	28		
56	1,2				2,3	1	4	1	11	4	43	7		-	16		21,2	
57			4,6		3,6	1,2,3	5	1,5		56	90	62		+			9	
58	1,2		4,6		3,6	1,2	6	2,6		440	161	160		+				
59	1,2		4		6		2		67		55				27			
60	1,2		2,3,6,7		1,7	1	2,5	1	72	3	149	28			27	28	9,3	
61	1				1	1	2,5	1		8		18		-	21	28		
62	1				1		4		103		90				24		11,7	
63	1		4,6		2,6		1		99		178				25		16,7	

EH PC CPSS

	Crystalluria		Bladder ultrasonography		Complications		Check-up		Ultrasonography post-operative	Mortality	Notes
Patient	*before*	*after*	*before*	*after*	*i.o.*	*p.o.*	*number*	*months p.o.*			
32							3	2	closed		
33	yes		1				1	1	closed	4 (5 years p.o.)	
34	yes		1,2,5				1	1	open		
35						yes				3 (2 days p.o.)	Shock
36			4				3	2	closed		
37							3	2	closed		
38			4				2	2	unknown		
39	yes		1,2	1,2			1	1,5	open	4 (5 years p.o.)	
40	yes		1			yes				3 (2 days p.o.)	Hemorrhage
41			4		yes	yes				3 (1 day p.o.)	
42							1	1	open	4 (4 years p.o.)	
43	yes	yes		3			1	1,5	open		
44			4				1	1	open and acquired shunting		
45							1	1	unknown		
46							1	1	closed		
47	yes		2			yes				3 (0 days p.o.)	Cardiorespiratory arrest
48			4	4			1	1	closed		
49							4	2	open		
50	yes		4				1	1	closed		
51			4				1	1	closed		
52			1				2	4	open		
53							3	2	open		
54			4				1	1,5	open		
55			2	1			1	1	open		
56							1	1,5	open		
57							1	1,5	open		
58			1	1			1	1	open		
59						yes				3 (0 days p.o.)	Abdominal hemorrhage
60			1,3			yes	1	1	unknown		
61			2				1	1	closed		
62			4			yes	0				
63			1				0				

EH PC CPSS

	Breed	Gender	Age at surgery (months)	Medical management		Shunt attenuation	General impression		Retarded growth	Neurological signs		HE classification	
Patient				*before*	*after*		*before*	*after*		*before*	*after*	*before*	*after*
64	Crossbreed	F	12		1	partial	3,5,11	4		1,5,14,15,20,21		2	0
65	Pug	F	5		1	partial	3,5	1,4	yes	1,5,21		2	0
66	Dachshund	M	6			partial	1	1		9,10,14,16		2	0
67	Malteser	F	7	1		complete	1,5	1	yes	1,3,4,5,11,13,14,21		2	0
68	Yorkshire Terrier	M	6			partial	1,5			5,9,13,14		2	
69	Border Collie	M	5		1	partial	1,5,6	4		5,14,15,21		2	0
70	Chihuahua	F	18		1	partial	1,3	1	yes	5,7,15,20,21	12	2	1
71	Jack Russell Terrier	F	12			complete	1,3,5	1,4	yes	4,6		2	0
72	Cairn Terrier	F	5			partial	1	1				1	0
73	Chihuahua	F	23			complete	1,3	1,4		3,7,8,13,14		3	0
74	Labrador Retriever	F	10	2		partial	3	4	yes	3		2	0
75	Border Collie	F	4,5		1	partial	1	4	yes	1,2,6,9,14,21		2	0
76	Miniature Schnauzer	F	7		1	partial	5	1	yes	5,6,7,13,14,20,21		2	0
77	Yorkshire Terrier	F	6,5	1		partial	1,5		yes	3,4,9,11,14		2	
78	Miniature Schnauzer	M	13	1,2	1	complete	3,5	1		5,9,20,21		2	0
79	West Highland White Terrier	F	7,5	1	1	partial		1,4	yes	3,4,6,7,11,13,21,22		2	0
80	Malteser	M	39	1		complete	1,3,5		yes	8,11		3	
81	Crossbreed	F	5		1,2	partial	6	1,4		1,4,6,9,11,14,21,22		2	0
82	Crossbreed	F	8	1,2	1	partial	3	4		21		1	0
83	Cairn Terrier	F	5		1	partial		1	yes	4,5		2	0
84	Malteser	M	9			complete	3	1	yes	3,12	12	2	1
85	Jack Russell Terrier	M	47	1		partial	3,6			2,3,14,16,23		2	
86	Beagle	F	11	1,2		complete	7		yes	1,5,9,14,20,21,22,23,24		2	0
87	Crossbreed	F	44			complete	5	1		11		2	0
88	English Cocker Spaniel	F	7			partial	3,6	1,4	yes	1,3,5,11,13,14,16,21		2	0
89	Jack Russell Terrier	M	21			partial	3,6	1		9,14		2	0
90	Cairn Terrier	M	7	2		partial	1,5,9	1		9,13,20,21		2	0
91	Pekingese	F	33			complete	5,6	1		5,9,11,13,14,20,21,22		2	0
92	Shetland Sheepdog	F	6			partial	1,3	1	yes	4,6,9,11,13,14		2	0

EH PC CPSS

	Gastro- intestinal signs		Micturition		Appetite		Activity level		Fasting Bile acids µmol/L		Fasting ammonia µmol/L		NH3 tolerance test		Albumine g/L		White blood cell count x 10^9 /L	
Patient	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*
64	1,2	1	3,4,6		4,6	2	4	1		18	>286	10		-	23		23	
65				6	3	1	2,4,5	1	110	28	285	36		+	19	25	24,3	
66					1	1	1	1	40	1	>286	18		-	19			
67			3,4,6		4	8	2,4	1		13	141	22			25		18,8	
68	2						2,4,5		161		285				23		21,2	
69	1,2		4,6		3,6	6,8	4,5	1	205	35	265	<7		+	23	27	17	
70	1		4		4	1	2,5	1	355	65	230	139			25	29	21,9	13,3
71	1		4		6	1	2,4,6	1	275	3	132	15		+	31	31	10,2	9,5
72			4,6		6	1	5	1		1	221	14		-	21	28	19	13,7
73	1		3		2	1	3,5	5		12	155	20		-			23,9	
74	1				3	8	2	1	15		103	25		+	18		21,9	
75	1		4,6		2,7	6	4	1	7	16	178	38		+	18		21	
76			3,4,5		4,6	3	2,4	1	265		>286	11		-	18		20,9	
77	1		4,6		2		2,4		72		116				18		19,8	
78	2		5		4	1	2,5,6	1		1	55	<7	+	-	24		14,6	
79			4		4,7	1	2,3,4,6	1		9	111	12		-	20	27	11,7	7,6
80			4,6		6		2,4				61				25		8,7	
81	2		4		6	1	2,4	1		8	219	<7		-	19	28	25,8	
82	1	1	4,7		6		2,5					7		-	24		7,5	
83		1				1	3	1		2	166	282		+	22		18,4	
84	1,2		4,6		4,6	8	2,5	3		3	123	19			24		13,8	
85			4,6		7		2,6		135		229				21		21,2	
86			4,6		2,4,6	8	2,5,6	1		1	83	<7			23	29	18,3	
87	1	1	2,4		3,6	1	2,5	1	117	4	22	<7				33		
88	1,2				2,3	1	4	1	161	24	>286	179			23	25		
89	1		4,6,7		3,6	1	2	1	126	5	157	<7		-	31	28	11	
90			4,6		3,6	1	4	1		14	218	17		+		26	20,9	15,7
91	1		4		3,6	8	2,5,6	1	154	10	126	<7			28	30	15,4	
92	4		4		2,6	1	2,5	1	178	1	190	30		-	21	26	21,7	

EH PC CPSS

	Crystalluria		Bladder ultrasonography		Complications		Check-up		Ultrasonography post-operative	Mortality	Notes
Patient	*before*	*after*	*before*	*after*	*i.o.*	*p.o.*	*number*	*months p.o.*			
64	yes		1	1			2	2,5	open		
65			4				2	4	open		
66			2	2			1	1	open		
67			4				1	2	closed		
68			4			yes				3 (0 days p.o.)	
69			1	1			3	10	unknown		
70			4	4			2	3	open		
71			4	4			1	1	closed		
72			1				1	1	unknown		
73			2				1	1	closed		
74	yes		4				1	1	unknown		
75	yes		4				2	3	open		
76	yes		1	4	yes		1	1	closed		
77			1				0				
78	yes	yes	1,2	1		yes	2	3	closed		
79			1	4			3	5	open		
80			1			yes				3 (3 days p.o.)	Cerebral necrosis
81			1				2	3	open		
82							1	1	unknown		
83			4	4			1	1,5	open		
84							1	2,5	unknown		
85	yes		2				0				
86			1				1	1	open		
87			1	2			1	1,5	closed		
88	yes		2				2	3	deviating vessel patern		
89			4	4			1	1	closed		
90			2	4			1	1	closed		
91			4	4			1	1	unknown		
92			4				1	1	closed		

1b: Medical records of UKG database, details of patients with PAZ CPSS

EH PAZ CPSS

Patient	Breed	Gender	Age at surgery (months)	Medical management		Shunt attenuation	General Impression		Retarded growth	Neurological signs		HE classification	
				before	after		before	after		before	after	before	after
93	Norfolk Terrier	F	10	1		partial	2	4	yes	5, 20		2	0
94	Yorkshire Tierrier	F	33			complete	3,	4	yes			1	0
95	Maltheser	M	46	1,2,3	1	complete	1,3	4	yes	2,5,13,16, 22, 23		2	1
96	Norfolk Terrier	F	3	1		partial	3,5,6	4		1,5,14,15, 20, 21		2	0
97	Crossbreed	F	42	1,2	1	partial	1,5					1	0
98	Miniature Poodle	M	37			partial	3	1,4	yes			1	0
99	Maltheser	F	47			partial	7,8	8		5,6,12,17	9,17	2	2
100	Lhasa Apso	F	54	1		partial	1,5			2,9,11,14		2	
101	Cairn Terrier	M	5,5		1	complete	5	4				1	0
102	Dachshund	F	6			partial	1,3,8					0	0
103	Great Dane	M	5		1	complete	1		yes			0	0
104	Crossbreed	F	55			partial	5		yes	1,14, 19		1	0
105	Crossbreed	M	14		1	partial						1	0
106	Welsh Terrier	F	40			complete	5		yes			1	0
107	Yorkshire Terrier	F	6	1,2	1,2	partial		1	yes	4,8,9,11,13		3	0
108	Shih Tzu	F	47			partial	1,8		yes	21, 24		1	
109	Dachshund	F	66		1	partial	3,5,6,8	1,2	yes	11,14,16,18		2	0
110	Pug	F	5,5	2		partial	3		yes	3,4,9,14,16, 21		2	
111	Fox Terrier	M	42	1	1	partial	2	1		14		1	0
112	Pekingese	M	56			partial	5	1		1,6,14, 20	14	2	1
113	Jack Russell Terrier	M	20		1	partial	1	1				0	0
114	West Highland White Terrier	F	23	1,2		partial	1	1				0	0
115	Jack Russell Terrier	F	5			partial	2,3,5,10	4		15		1	0
116	Norfolk Terrier	F	4			complete	1	1				0	0
117	Dachshund	F	7,5			complete						1	0
118	Miniature Pinscher	F	10			complete	1		yes	6,7		2	
119	Jack Russell Terrier	F	19	1,3		complete	3,11			3,5,6,(8),11,14,15, 21, 22		3	
120	Yorkshire Terrier	F	20			partial	5	4		15		1	0
121	Dwergschnauzer	M	14			partial	1,2		yes	4,16		2	
122	Fox Terrier	F	18	1,2	1	partial	3,5	1	yes	14, (18)		1	0
123	Chihuahua	F	35			complete	1,3	1,4	yes	5,15, 20, 21		2	0
124	Poodle	F	18	1,2		partial	1,3,8		yes	11		2	
125	Yorkshire Terrier	F	56	1,2		complete	3	1	yes	3,5,6,8,12, 22		3	0
126	Chihuahua	F	50			partial	1,5	4		5,8,14, 20, 21		3	0
127	Chihuahua	F	4			complete	1	4				0	0
128	Miniature Schnauzer	M	44	1		complete		1		6,14,16,17, 21		2	0
129	Jack Russell Terrier	F	78			complete	4	3				1	0

EH PAZ CPSS

	Gastro- intestinal signs		Micturition		Appetite		Activity level		Fasting Bile acids µmol/L		Fasting ammonia µmol/L		NH3 tolerance test		Albumine g/L		White blood cell count /L	
Patient	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*
93	2		4		5,7	1	5		115	5	142	13		-	17			
94			4		7	1,6	2	1	123	51	148	15		+	29	30		8,6
95	1		4,6	4	6		2	1	87		>286	15		-	21		16,3	
96	1,2				2,4,6	8	4,5	1			118	17			15			
97	1	1	4		2,4,6	8	2	1	22	8	129	7			14			
98	1	2	4,5,6,7		4	1	2	1	53	13	49	7	+	-	29			
99	1		4,6	6	7	1	3	5	41	11	96	19		-	29			
100	1		4		2		2		109		154				16			
101	1,3		4		3,6	1	4	1	90	2	48	24	+	-	26	26	10	8
102	1	1			3,9	1	2,4,5	1		2	74	7		-	27			
103									2	1	54	8	+	-	18	29	12,8	11,5
104	1				1,6	1	2	1	300	12	95	7		-	26	26	13,7	8,5
105	1,2		1,2,4			1		1		6	81	7		+	27		19,1	
106	1	1	4,6		3,7	1	4	1	190	1	88			-	23		15,7	
107	1,2				1	1	5	1		3	146	18		+			22,9	
108			4,6		4				71		125				23		12,6	
109	1		6		1	1	2				37	23	+	+	19	12	19,3	
110	1		4		4,7		5		465		286				24			
111			4		6	8	5	1	17	1	27	7	+	-	25	28	21,1	
112	1,2		4,6		3,6	8	4	1	175	14	117	28		+	26	30		
113	1		1,2		1	1	1	1	138	7	41	17	+	-	29			
114			2			1		1	107	1	238	22		-	30	36	12	
115	1,2				2,3,9				130	9	136	33	+	+	21	24	16,1	
116						1	1	1	14	30	111	28		-	28	28	12,4	
117	1		2,4		3,6	1			15		27	13	+	+	26		14,3	
118	3		2,4,6		1,6		3		35		46		+		28		6,4	
119			2,4,6		2,6		2,4				84				29		14,4	
120	1,2				1		4,5,6	5	70		129	19		-	<9		26,5	
121			2,4,6		6,8		5		59		212							
122	1,2		4		3,7,9	3	2	6	41	18		19			15	23		13,8
123	1		4,6,7		4,6	3	1	1	127	2	28	9	+	-	30	31		
124	1				2		2,6		53		98				27			
125			3,6	3	6	1		1	190	8	211	<7			24		13,3	
126						8		1	157	1	217	18		+	22		15,1	
127						1		1		1	62	<7		+	26	27	15,1	
128					3	1	1	1	100	51	49	<7			26	29	13,3	
129			1,2,3,5,6	3	6		4	1	200	13	51	12			28	32		

EH PAZ CPSS

	Crystalluria		Bladder ultrasonography		Complications		Check-up		Ultrasonography post-operative	Mortality	Notes
Patient	*before*	*after*	*before*	*after*	*i.o.*	*p.o.*	*number*	*period, months p.o.*			
93			2				1	2	open		
94							1	1	closed		
95			1,3				1	1	closed		Complete ligation in two surgeries
96	yes		2				1	1	closed		
97	yes		1,2	3			1	1	closed	4 (8 years p.o.)	
98	yes		1,2				1	7	unknown		
99	yes						2	3	open	4 (6 months p.o.)	
100			2			yes			unknown	3 (0 days p.o.)	Abdominal hemorrhage
101							3	2	unknown		
102			4				1	1	closed		
103					yes		2	7	unknown		Ruptured spleen intra-operative
104			4		yes		1	1,5	closed		Portal hypertensia and abdominal hemorrhage p.o.
105	yes		1,2,3	2			3	2	closed		
106	yes				yes		3	2	closed		
107			2			yes	2	3	open		
108	yes		1,2,3			yes			unknown	3 (0 days p.o.)	
109							2	2,5	open		
110			1			yes			unknown	3 (1 days p.o.)	Bleeding tendency which led to hypoxia
111	yes	yes (<)	1,2,3	2			1	1	open		
112			1,2	1			1	1	open		
113	yes		1,3	4			1	2	closed		
114	yes		1,2	4	yes		1	1,5	closed		
115			4				1	1	open	4 (1 year p.o.)	
116						yes	1	1,5	unknown		
117	yes		1,2				1	1	closed		
118	yes		2						unknown		
119	yes	yes	2,3,5						unknown		
120							1	1,5	closed		
121			2,3,5						unknown		
122						yes	1	1	closed		
123	yes		1	1			1	1	open		
124			4						unknown		
125			1				1	1	closed		
126			1	4			3	5	unknown		
127			4				1	1	closed		
128			4	2			1	1	closed		
129	yes		1				1	1	closed		

1c: Medical records of UKG database, details of patients with intrahepatic CPSS.

IH CPSS

Patient	Breed	Gender	Age at surgery (months)	Shunt type	Medical management		Shunt attenuation	General impression		Retarded growth	Neurological signs		HE classification	
					before	after		before	after		before	after	before	after
130	Golden Retriever	F	8	Left		1,2	partial		1,2,3,4			1,14	1	2
131	Hovawart	M	14	Left			partial	2,3,5,10	1,4			5,21,24	2	0
132	Crossbreed	M	6	Left	1		partial	1,5		yes		5,13,14,15,20	2	
133	Grand Basset Griffon Vendéen	F	14	Left	1		partial	1	1	yes		6,13	2	1
134	Golden Retriever	F	7,5	Left	1,2	1,2	partial	1	1,4	yes	3,4,5,11,16,20,21		2	0
135	Dobermann Pinscher	F	5,5	Left			partial	1,2,3,11		yes			1	
136	Golden Retriever	M	4,5	Left	1,2	1	partial	1,5,3	1,8,9		3,4,13,14		2	0
137	Labrador Retriever	M	9	Left			partial	2,3	1		1,9,11,13,14,21,22		2	0
138	Deerhound	M	5	Left			partial	1	1,3	yes			0	0
139	Irish Wolfhound	F	5	Left		1	partial						2	0
140	Labrador Retriever	M	5,5	Left	1,2	1	partial	1		yes			1	0
141	Bernese Mountain Dog	F	13,5	Left			partial	1,3,5,6		yes	11,17		2	
142	Cane Corso	M	4,5	Left	1		partial	1,2	1,4				1	0
143	Bernese Mountain Dog	F	9	Left			partial	1,5	1	yes			1	0
144	Irish Wolfhound	F	3,5	Left			partial	3,11	1,4	yes	5,6		2	0
145	Bernese Mountain Dog	F	4	Left			partial	1	1				0	0
146	Golden Retriever	M	12	Left	1		partial	1,2,5	1				1	0
147	Golden Retriever	F	9	Left			complete	1	1,4		19		1	1
148	Cane Corso	F	54	Left	1,2,3		complete	1,3,11	1,4		3,5,10,11,12,14		2	0
149	Petit Basset Griffon Vendéen	M	6,5	Left		1	partial	1,3,5	1,5	yes	1,5,6,8,11,21		3	2
150	English Cocker Spaniel	M	10	Left	1,2		partial	1,2,11			6, 13,20		2	
151	Crossbreed	M	17	Left	1,2		partial	1,9		yes	12,20,22		1	
152	Vizsla	M	12	Right	1	1	partial	1,9,11	1,4			6	2	0
153	Bearded Collie	M	6	Right	1	1	partial	2,5	1,4	yes		1,11	2	0
154	Labrador Retriever	F	3,5	Right	1,2		partial	1	1,4	yes	1,2,3,5,13,22		2	0
155	Golden Retriever	F	46	Right	1,2		partial	3,6		yes		2,5	2	
156	Shih Tzu/M	M	11	Right	1		partial	1,5				8,2	3	
157	Nova Scotia Duck Tolling Retriever	M	4	Right			partial	2	2,9,11	yes	4,6,11,14,15	2,12,14	2	1
158	Weimaraner	F	6	Right			partial	2,3,5		yes		2,15	1	
159	Bernese Mountain Dog	F	15	Right	1,2	1,2	partial	3,5					1	0
160	Stabyhoun	F	10	Right	1,2		partial	3,6			5,6,9,11,13,14,20,21,22		2	
161	Bearded Collie	M	4	Right	1,2		partial	1,9	1,3	yes	1,3,5,11,13,20		2	0
162	Shih Tzu	M	10	Right	1	1	partial	5	6		2,3,11,15,21,22,24	6,13,15	2	2
163	Crossbreed	M	11	Right	1,2,3	1	partial	1,2	1	yes			1	1
164	Cane Coro	F	5	Right	1	1	partial	2,3,5	1	yes		1,6	1	0
165	Australian Shepherd	F	13	Central	1	1	partial	1,2,3,5,9	1	yes	2,6,11,13,14,15,16,22,23		2	0
166	Bernese Mountain Dog	M	6	Central			partial	1	1		2,3,5,6,11,13,14,16,21		2	0
167	Golden Retriever	M	9,5	Central	2	1	partial	5	1			4,22	2	0

IH CPSS

	Gastro-intestinal signs		Micturition		Appetite		Activity level		Fasting bile acids µmol/L		Fasting ammonia µmol/L		NH3 tolerance test		Albumine g/L		White blood cell count × 10^9/L	
Patient	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*	*before*	*after*
130					1	1	5	1	380	237	166	84		+	25		14,1	
131	1,2	1			4	3	4,5	1	28	51	113	37		+	19		10,7	
132	1				2,3		4		3		171				8		34,2	
133			4,6,7	4,6	1,6	1	1	1	35	6	114	37		-	22			
134	1,2,3	1	4		3,6	2,8	2	1	156	21	286	249		+	16		17,7	
135			4		2,6		2				183							
136			4		2,3,6	1	2	1				76		-	16			
137	1		4		3,6	2,8	2	1	37	14	171	18		+	30	27		
138					1	1,8	1	1			154	173			19			
139									6	5	139	63		+	13	26	10,9	14,4
140			3,4		5,6		5			14		44		+	12	28	17,5	13,8
141	1		2,4		3,6		2		125		120				22		15,4	
142			4,6		2,3,6	8	2,5	1		10		24		-	23	27	15	
143	1,2		4,5,6		3,7	1,8	1	1	63	5	120	14		-	16	30	15,5	
144			3,6		2,3	1,8	5	1	93	170	286	> 286			25	18	11	
145					1	1	1	1	18		156	49		-				
146					1	1,2	5,6	1		3	54	12	+	+		30		
147			4,6	4,6	1,7	1	1	1	140		>286	46		-	24		13,1	
148			4		1	1	2	1			104	20		-				
149	1		4		3,6	2	4,5	5		147	269	113						
150	1				1		2				159				18		11,1	
151			4,7		3,6		3				>286				21			
152			4		1,7	1	2	1	14		44	20		-	27			
153	1		4		1,6		4	1		58	56	80	+	+	22			
154			4,6		1,6	1	1	1				22		-	16			
155	1		4,6,7		1,6		2		36		214				17			
156			3,4		2,3,6		6				>286							
157		1	3	4,6	2,3	2,6,9	2	2,3	180	250	270	90		+	21		14,8	
158	1				2,3		2				>286							
159	1				6		4		30	185	117	179			12	22	35,4	19,1
160			4		3,6		4,5,6		17		140				20		13	
161	1	1	3,4,6		2,6	1	1,2	1	12	33	214	147		+	16	20	13,74	11,8
162		1	4		2,3,6	1	4,5,6	2,4,5,6		110	119	212			26	23	16,8	
163	1,2		4	4,6	2,6	1,6	2	1	200	340	76	60		+	24	25	25,9	
164	1		4		1,6	1	2	1		154	202	98			10		8,3	
165	1		4		2,3,6	1	2,5,6	1	16	93	190	82		+	18		20,3	
166	1		4		1,6	1	1	1	2	1	285	72		+	20	27	26,8	
167			4		1,6	1	2,6	1		94	67	21	+	+		24		

IH CPSS

	Crystalluria		Bladder ultrasonography		Complications		Check-up		Ultrasonography post-operative	Mortality	Notes
Patient	*before*	*after*	*before*	*after*	*i.o.*	*p.o.*	*number*	*months p.o.*	*shunt*		
130	yes			1	yes		3	3	open		
131			2		yes		2	4	unknown		
132						yes				3(1 day p.o.)	Portal hypertensia and hypoglycemia
133		yes	2	2,3			1	1,5	open		
134							2	2	unknown		
135									unknown		
136							3	4	closed		
137			1			yes	2	3	open		
138			4		yes		2	3	unknown		
139							unknown	6	unknown		
140		yes	1,2				unknown	6	unknown		
141	yes		1						unknown		
142			1	4			1	1	open		
143							1	1	closed		
144			4				2	1	open	4(7 months p.o.)	Sepsis followed by euthanasia
145							2	4	closed		
146			4				2	3	unknown		
147			2				1	1	closed		Complete ligation in two surgeries
148			4	4			1	1	closed		
149			1,2	1,2			3	4	open		
150			1,2			yes				3(2 days p.o.)	Cerebral necrosis
151						yes			unknown		
152			4	4	yes		1	2	unknown		
153			2				2	3	open		
154			4	4			2	2	closed		
155			2		yes	yes				3(11 days p.o.)	Euthanasia because of lethargy
156					yes					3(25 days p.o)	
157							3	6	open	4(unknown)	
158			2,3						unknown		
159	yes		1,2,5				unknown	6	open	4(unknown)	
160			1						unknown		
161			4			yes	1	1,5	open		
162			2				1	1	open	4(3 years p.o.)	Euthanasia because of heartfailure
163		yes	4				2	3	open		
164			1,2				2	3	open	4(3 years p.o.)	Euthanasia because of chronical hepatitis
165	yes			2			1	2	open	4(unknown)	
166			1,5	1			1	1	open		
167			1,2	2			2	5	open		

1d: Caption for 1a-c

	Medical management	General impression	Neurological signs	GI signs	Micturition	Appetite	Activity	Bladder ultrasono	Mortality
1	Low protein/ kidney/liver diet	Attentive	Depression	Vomiting	Stranguria	As usual	As usual	Uroliths	Pre-operative
2	Lactulose	Calm	Abnormal behaviour	Diarrhea	Hematuria	Changing	Decreased	Sediment	Intra-operative
3	Antibiotics	Losing weight	Head pressing	Melena	Pollakisuria	Decreased	Increased	Cystitis	Post-operative (# days)
4		Gain weight	Circling	Gagging	Polyuria	Anorexia	Indolent	Normal	Died of different cause
5		Lazy/ indolent	Ataxia	Coprophagia	Dysuria	Unknown	Sleeps a lot	Polyp	
6		Soporous	Wandering around		Incontinence	Polydipsia	Tired		
7		Bad breath	Muscle tremors		Nocturia	Severe polydipsia			
8		Nervous	Seizures			Increased			
9		Excitation	Blindness			Pica			
10		Pain	Deafness						
11		Restless	Ptyalism						
12		Coma	Aggression						
13			Desorientation						
14			Vacant						
15			Weakness						
16			Compulsive movements						
17			Fear						
18			Insomnia						
19			Slip						
20			Fall over						
21			Staggering						
22			Looking for support						
23			Wobbliness						
24			Not walking						

2a: General information

Universiteit Utrecht

Naam:
Patiëntnummer:

Vragenlijst voor de kwaliteit van leven bij een levershunt

Hartelijk dank dat u onze vragenlijsten wilt invullen.

Er zijn twee verschillende vragenlijsten:

Deel 1 gaat over hoe het met uw hond ging voor de operatie van de levershunt.
Deel 2 gaat over hoe het nu met uw hond gaat.

Wilt u onderstaande vragen alstublieft beantwoorden voordat u met deel 1 begint?

1: Hoe oud was uw hond toen u hem/haar hebt gekregen?

Jonger dan 6weken 6-12weken 12weken-6maanden Ouder dan 6maanden

2: Hoe bent u aan uw hond gekomen?

Fokker (bedrijfsmatig) Particulier Asiel Vrienden/familie

Internet anders:

3: Heeft uw hond een stamboom (uitgegeven door de Raad van Beheer)?

Nee Ja

Registratienummer of transpondernummer (chip):

Anders (bijvoorbeeld buitenlandse stamboom of registratie door een kennel club):

2b: Quality of Life questionnaire before surgery

Universiteit Utrecht

Naam:
Patiëntnummer:

Vragenlijst voor de kwaliteit van leven bij een levershunt:

Deel 1: voor de operatie

1: Hoe vaak vertoonde uw hond de volgende verschijnselen ?
(voor de operatie en voordat er een medische behandeling werd ingesteld door een dierenarts)
Zet alleen een streepje op de lijn onder uw antwoord over een verschijnsel indien uw hond dit ook vertoonde

a: Toevallen (*of epileptische aanvallen*)

A1A1 Nooit Minder dan1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1A2 Helemaal niet |——————————————————————| Kan niet erger

b: Dringen *(met het hoofd tegen muren of dingen aanduwen)*

A1B1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1B2 Helemaal niet |——————————————————————| Kan niet erger

c: Cirkelen *(rondjes lopen)*

A1C1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1C2 Helemaal niet |——————————————————————| Kan niet erger

d: Desoriëntatie *(de weg kwijt zijn, niet goed weten waar hij naar toe moet)*

A1D1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1D2 Helemaal niet |——————————————————————| Kan niet erger

e: Agressie *(bijten, happen, snappen of grommen zonder reden)*

AIE1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

AIE2 Helemaal niet | ——————————————————— | Kan niet erger

f: Flauw vallen *(het verliezen van het bewustzijn en in elkaar zakken)*

AIF1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

AIF2 Helemaal niet | ——————————————————— | Kan niet erger

g: Schommelende gang *(moeite met normaal lopen, lopen als een dronkenman of omvallen)*

AIG1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

AIG2 Helemaal niet | ——————————————————— | Kan niet erger

h: Afwezigheid *(niet of verminderd reageren op de omgeving, zitten suffen)*

AIH1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

AIH2 Helemaal niet | ——————————————————— | Kan niet erger

i: (Schijnbare) blindheid *(tegen muren of obstakels oplopen)*

AII1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

AII2 Helemaal niet | ——————————————————— | Kan niet erger

j: Moeheid of zwakte *(snel gaan liggen, geen puf hebben, veel slapen)*

A1J1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1J2 Helemaal niet |——————————————————————————| Kan niet erger

k: Braken *(spugen van voedsel, gal of maagsap)*

A1K1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1K2 Helemaal niet |——————————————————————————| Kan niet erger

l: Diarree *(dunnere ontlasting)*

A1L1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1L2 Helemaal niet |——————————————————————————| Kan niet erger

m: Niet willen eten *(geen of verminderde eetlust)*

A1M1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1M2 Helemaal niet |——————————————————————————| Kan niet erger

n: Moeite met plassen *(persen bij het plassen en/of vaak kleine beetjes plassen)*

A1N1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1N2 Helemaal niet |——————————————————————————| Kan niet erger

o: Bloed in de urine *(rode plasjes)*

A1O1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1O2 Helemaal niet |——————————————————————————| Kan niet erger

p: Opvallend veel kwijlen *(spontaan speeksel uit de bek laten lopen)*

A1P1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1P2 Helemaal niet |——————————————————————————| Kan niet erger

q: Duidelijk veel meer drinken *(in combinatie met vaker en meer moeten plassen)*

A1Q1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend was dit voor uw hond?

A1Q2 Helemaal niet |——————————————————————————| Kan niet erger

A2 **2: Heeft uw hond last gehad van blaasstenen of een obstructie in de urinewegen (plasbuis) waarvoor u hem of haar naar de dierenarts heeft gebracht voor diagnose en behandeling?** Zo ja, kunt u hieronder wat meer details geven

Ja Nee

A3 **3: Vond u uw hond voor de operatie te klein of te dun voor het ras en de leeftijd?**

Ja Nee Twijfel

A4 **4: Hoe actief was uw hond?**

Totaal niet actief |——————————————————————————| Maximaal actief

5: Hoe graag wilde uw hond:

A5a

a: spelen?

Totaal niet |——————————————————————————| Maximaal

A5b

b: interactie (contact) met u als eigenaar?

Totaal niet |——————————————————————————| Maximaal

A5c

c: zich lichamelijk inspannen?

Totaal niet |——————————————————————————| Maximaal

A5d

d: interactie (contact) met andere honden?

Totaal niet |——————————————————————————| Maximaal

A6

6: Heeft uw hond een medische behandeling (bijvoorbeeld lactulose) of een speciaal dieet gekregen voorafgaand aan de operatie?

Nee Dieet Medicatie Medicatie en dieet

Zo ja, kunt u dit specificeren:

A7

7: Zo ja, kunt u op onderstaande schaal aangeven hoeveel verbetering dit gaf voor uw hond?

Totaal geen |——————————————————————————| Maximaal

A8

8: Indien uw hond een speciaal dieet kreeg, hoe graag at uw hond deze voeding vergeleken met de normale voeding?

Totaal niet |——————————————————————————| Uitstekend

A9

9: Heeft u het gevoel dat het speciale dieet de kwaliteit van leven van uw hond heeft beïnvloedt vergeleken met normale voeding?

Totaal niet |——————————————————————————| Maximaal

A10

10: Indien uw hond dieet of medicijnen kreeg voor de leverproblemen voorafgaand aan de operatie, kunt u aangeven of dit een NEGATIEF effect heeft dit gehad op zijn of haar kwaliteit van leven?

Totaal niet |——————————————————————————————| Maximaal

Dank u wel voor het invullen van deze vragenlijst.

Als u vragen heeft na het invullen van deze lijst, kunt u altijd contact met ons opnemen via email: chirurgieUKG@uu.nl onder vermelding van Onderzoek Levershunt.

2c: Quality of Life questionnaire after surgery

Universiteit Utrecht

Naam:
Patiëntnummer:

Vragenlijst voor de kwaliteit van leven bij een levershunt:

Deel 2: na de operatie

1: Hoe vaak vertoont uw hond de volgende verschijnselen?
Zet alleen een streepje op de lijn onder uw antwoord over een verschijnsel indien uw hond dit ook vertoonde

a: Toevallen *(of epileptische aanvallen)*

B1A1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1A2 Helemaal niet |——————————————————————| Kan niet erger

b: Dringen *(met het hoofd tegen muren of dingen aanduwen)*

B1B1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1B2 Helemaal niet |——————————————————————| Kan niet erger

c: Cirkelen *(rondjes lopen)*

B1C1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1C2 Helemaal niet |——————————————————————| Kan niet erger

d: Desoriëntatie *(de weg kwijt zijn, niet goed weten waar hij naar toe moet)*

B1D1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1D2 Helemaal niet |——————————————————————| Kan niet erger

e: Agressie *(bijten, happen, snappen of grommen zonder reden)*

B1E1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1E2 Helemaal niet |——————————————————————| Kan niet erger

f: Flauw vallen *(het verliezen van het bewustzijn en in elkaar zakken)*

B1F1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1F2 Helemaal niet |——————————————————————| Kan niet erger

g: Schommelende gang *(moeite met normaal lopen, lopen als een dronkenman of omvallen)*

B1G1

Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1G2

Helemaal niet |——————————————————————| Kan niet erger

h: Afwezigheid *(niet of verminderd reageren op de omgeving, zitten suffen)*

B1H1

Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1H2

Helemaal niet |——————————————————————| Kan niet erger

B1I1 **i: (Schijnbare) blindheid** *(tegen muren of obstakels oplopen)*

Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

B1I2

Helemaal niet |——————————————————————| Kan niet erger

j: Moeheid of zwakte *(snel gaan liggen, geen puf hebben, veel slapen)*

BJ1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BJ2 Helemaal niet |——————————————————————————| Kan niet erger

k: Braken *(spugen van voedsel, gal of maagsap)*

BK1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BK2 Helemaal niet |——————————————————————————| Kan niet erger

l: Diarree *(dunnere ontlasting)*

BL1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BL2 Helemaal niet |——————————————————————————| Kan niet erger

m: Niet willen eten *(geen of verminderde eetlust)*

BM1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BM2 Helemaal niet |——————————————————————————| Kan niet erger

n: Moeite met plassen *(persen bij het plassen en/of vaak kleine beetjes plassen)*

BN1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BN2 Helemaal niet |——————————————————————————| Kan niet erger

o: Bloed in de urine *(rode plasjes)*

BIO1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BIO2 Helemaal niet |——————————————————————————| Kan niet erger

p: Opvallend veel kwijlen *(spontaan speeksel uit de bek laten lopen)*

BIP1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BIP2 Helemaal niet |——————————————————————————| Kan niet erger

q: Duidelijk veel meer drinken *(in combinatie met vaker en meer moeten plassen)*

BIQ1 Nooit Minder dan 1 keer per maand Maandelijks Wekelijks Dagelijks

Hoe vervelend is dit voor uw hond?

BIQ2 Helemaal niet |——————————————————————————| Kan niet erger

B2 **2: Heeft uw hond na de operatie last gehad van blaasstenen of een obstructie in de urinewegen (plasbuis) waarvoor u hem of haar naar de dierenarts heeft gebracht voor diagnose en behandeling?** Zo ja, kunt u hieronder wat meer details geven

Ja Nee

3: Vindt u uw hond te klein of te dun voor het ras en de leeftijd?

B3 Ja Nee Twijfel

4: Hoe actief is uw hond?

B4 Totaal niet actief |——————————————————————————| Maximaal actief

5: Hoe graag wil uw hond:

a: spelen

B5a

Totaal niet |——————————————————————————| Maximaal

b: interactie (contact) met u als eigenaar

B5b

Totaal niet |——————————————————————————| Maximaal

c: zich lichamelijk inspannen?

B5c

Totaal niet |——————————————————————————| Maximaal

d: interactie (contact) met andere honden

B5d

Totaal niet |——————————————————————————| Maximaal

B6

6: Indien uw hond na de operatie nog steeds verschijnselen had, hoelang heeft hij/zij hier last van gehad?

Tot 4 weken na de operatie ☐

Minder dan 6 maanden na operatie ☐

Meer dan 6 maanden na operatie ☐

Nog steeds aanwezig ☐

B7

7: Heeft uw hond na de operatie een terugval gehad, waarbij de verschijnselen waren zoals voor de operatie? Zo ja, kunt u hierover iets meer vertellen?

Ja Nee

B8

8: Krijgt uw hond op dit moment nog medicatie of een speciaal dieet? Zo ja, graag specificeren.

9: Vindt u dat de voedingstoestand van uw hond is verbeterd sinds de operatie?

B9a

Totaal niet |——————————————————————| Maximaal

Welke waarde had uw hond voor de operatie (zie bijlage):

B9b

Welke waarde heeft uw hond nu (zie bijlage):

10: Hoeveel is uw hond in het geheel vooruit gegaan sinds de operatie?

B10

Totaal niet |——————————————————————| Maximaal

11: Hoe tevreden bent u met het resultaat van de operatie?

B11

Totaal niet |——————————————————————| Maximaal

12: Geef op onderstaande lijn aan hoe de kwaliteit van leven van uw hond was, voor de levershunt diagnose

B12

Zeer slecht |——————————————————————| Uitstekend

13: Geef op onderstaande lijn aan hoe de kwaliteit van leven van uw hond was, voor de operatie met dieet en/of medicatie

B13

Zeer slecht |——————————————————————| Uitstekend

14: Geef op onderstaande lijn aan hoe de kwaliteit van leven van uw hond nu is

B14

Zeer slecht |——————————————————————| Uitstekend

15: Maakt u zich nog zorgen over de gezondheid van uw hond?

B15

Totaal niet |——————————————————————| Heel veel

Dank u wel voor het invullen van deze vragenlijst.

Als u vragen heeft over de gezondheid van uw hond na het invullen van deze lijst, kunt u altijd contact met ons opnemen.

Bijlage vraag 9.

Patient	Days between surgery and questionnaire	A1A1	B1A1	A1A2	B1A2	A1B1	B1B1	A1B2	B1B2	A1C1	B1C1	A1C2	B1C2	A1D1	B1D1	A1D2	B1D2	A1E1	B1E1	A1E2
3	3818	5	1	8,9	0	1	1	0	0	5	1	5,4	0	5	1	9,5	0	1	1	0
6	3681	1	1	0	0	5	1	10	0	5	1	10	0	5	5	10	3,2	1	4	0
8	3612	1	1	0	0	5	1	8,4	0	5	1	8,4	0	5	1	8,4	0	1	1	0
11	3481	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
15 (died)	3288 [1]	1	1	0	0	5	1	8,1	0	1	1	0	0	4	4	8,2		1	4	0
20	3060	4	1	8	0	4	1	9	0	1	1	0	0	4	1	8,7	0	1	1	0
21	3046	1	1	0	0	5	1	5,5	0	5	1	5,5	0	5	1	5,2	0	1	1	0
24	2977	5	1	7,5	0	1	1	0	0	1	3	0	2,3	5	1	6,8	0	1	2	0
27	2895	1	1	0	0	4	1	0,6	0	4	1	1	0	4	1	5,5	0	1	1	0
28	2847	1	1	0	0	4	1	5,4	0	5	1	9,8	0	5	1	9,4	0	1	1	0
29	2833	2	1	10	0	2	1	10	0	1	1	0	0	5	1	10	0	2	1	10
31	2799	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
37	2535	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
39 (died)	2449 [1]	1	2 (1x)	0	9,4	3	1	1,4	0	1	1	0	0	1	1	0	0		1	
42 (died)	2362 [1]	1	1	0	0	5	1	9,7	0	5	1	9,8	0	5	1	9,6	0	1	1	0
45	2115	1		0		1		0		1		0		1		0		1		0
49	2081	2	1	3,4	0	4	1	5,1	0	4	1	8,5	0	2	1	4,9	0	1	1	0
50	1949	1	1	0	0	1	1	0	0	4	1	8	0	4	1	7	0	1	5	0
51	1908	1	1	0	0	5	1	9	0	5	1	9,2	0	5	1	9	0	1	1	0
52	1881	5	2	7,6	4,2	5	3	8,1	5,2	4	2	7,2	3,4	5	2	8,3	3,2	5	4	9
55	1673	1	1	0	0	5	1	2,4	0	5	1	2,7	0	4	1	3,2	0	4	1	2,8
60	1631	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	3	13	5,1
65	1128	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	4	0
66	1094	1	1	0	0	3	1	8	0	1	1	0	0	4	1	0	0	1	3	0
69	941	1	1	0	0	1	1	0	0	1	1	0	0	4	1	7	0	1	3	0
70	934	4 of 5	1	10	0	1	1	0	0	1	1	0	0	1	1	0	0	1	5	0
71	927	1	1	0	0	1	1	0	0	5	1	10	0	5	1	10	0	1	1	0
73	797	2	1	9,5	0	1	1	0	0	3	3	1,8	0,2	1	1	0	0	1	1	0
74	824	5	1	9,5	0	1	1	0	0	1	1	0	0	5	1	7,7	0	1	1	0
75	811	1	1	0	0	4	1	8	0	4	1	8	0	4	1	8	0	1	1	0
76	735	1	1	0	0	5	1	10	0	5	1	10	1	5	0	10	0	1	1	0
77	714	5	1	9,6	0	5	1	9,7	0	5	1	9,7	0	5	1	9,7	0	1	1	0
78	673	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
81	458	1	1	0	0	1	1	0	0	5	1	10	0	5	1	10	0	1	1	0
83	390	1	1	0	0	1	1	0	0	1	4	0	4,7	4	5	1,8	1,9	1	5	0
84	383	5	1	6,6	0	5	2	7,2		5	5	5,1	6,8	5	4	5,1	7,4	5	5	5,3
86	282	1	1	0	0	5	1	8,6	0	5	1	8,6	0	5	1	9,3	0	1	1	0
87	275	1	1	0	0	3	3	0,3	0,3	1	1	0	0	1	1	0	0	1	1	0

[1] Days between surgery and passing away

no answer or no interpretation possible

\- not applicable

Patient	B1E2	A1F1	B1F1	A1F2	B1F2	A1G1	B1G1	A1G2	B1G2	A1H1	B1H1	A1H2	B1H2	A1I1	B1I1	A1I2	B1I2	A1J1	B1J1	A1J2	B1J2
3	0	1	1	0	0	5	1	4,8	0	5	1	5	0	1	1	0	0	5	2	5	0,6
6	0	5	1	10	0	5	1	10	0	5	5	10	0	5	4	10	0	5	5	10	0
8	0	1	1	0	0	5	1	8,1	0	5	1	8,2	0	5	1	8	0	1	1	0	0
11	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
15 (died)	9	1	1	0	0	4	4	8,2	8,9	5	1	8,8	0	3	4	7		5	5	9,4	8,9
20	0	1	1	0	0	1	1	0	0	5	1	9,4	0	1	1	0	0	5	1	9,2	0
21	0	1	1	0	0	4	1	3	0	5	1	4,3	0	5	1	4,7	0	5	1	1,7	0
24		1	1	0	0	5	1	9,3	0	4	1	5,5	0	1	1	0	0	5	1	8	0
27	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	4	1	5,7	0
28	0	1	1	0	0	5	1	9,7	0	5	1	9,7	0	1	1	0	0	5	1	9,6	0
29	0	2	1	10	0	5	1	10	0	4	1	10	0	2	1	10	0	5	1	10	0
31	0	1	1	0	0	5	1		0	1	1	0	0	1	1	0	0	1	1	0	0
37	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
39 (died)	0		1		0		1		0		1		0		1		0	1	1	0	0
42 (died)	0	1	1	0	0	5	1	9,8	0	5	1	9,4	0	1	1	0	0	5	1	9,1	0
45		1		0		1		0		1		0		1		0		1		0	
49	0	1	1	0	0	1	1	0	0	4 of 5	4 of 5	1		1	1	0	0	5	4 of 5	0,7	
50	0	1	1	0	0	4	1	6	0	1	1	0	0	1	1	0	0	4	1	0	0
51	0	1	1	0	0	5	1	9,3	0	5	1	7,8	0	5	1	9,6	0	5	1	6,4	0
52	9,1	1	1	0	0	2	2	5,7	4,8	1	1	0	0	1	1	0	0	2	2	3,4	3,6
55	0	1	1	0	0	4	1	5	0	4	1	3,9	0	1	1	0	0	4	1	5,8	0
60	5,3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	2	2	2,8	5,3
65	9,3	1	1	0	0	1	4	0	0,1	1	1	0	0	1	1	0	0	5	5	8,8	0
66		1	1	0	0	5	1	0	0	5	1	0	0	4	1	10	0	5	1	0	0
69	1	4	1	6,7	0	5	1	6,7	0	4	1	6,9	0	1	1	0	0	5	5	8,4	4
70	8,1	1	1	0	0	1	1	0	0	4	4 of 5	4,8	6,6	1	1	0	0	5	4 of 5	4,8	6,3
71	0	1	1	0	0	1	1	0	0	4	0	8,4	0	1	1	0	0	4	1	7,5	0
73	0	2	1	7,5	0	4	1	9,5	0	5	1	9,1	0	2	1	5,2	0	5	1	9,8	0
74	0	1	1	0	0	5	1	7,6	0	5	1	8	0	5	1	5,5	0	5	1	6,1	0
75	0	1	1	0	0	4	1	6	0	4	1	8	0	4	1	9	0	1	1	0	0
76	0	1	1	0	0	5	1	10	0	5	1	10	0	5	1	10	0	5	1	10	0
77	0	1	1	0	0	5	1	9,7	0	5	1	9,8	0	5	1	9,6	0	5	1	8,1	0
78	0	1	1	0	0	2	1	10	0	1	1	0	0	1	1	0	0	5	5	1,5	4,5
81	0	1	1	0	0	5	1	8,3	0	5	1	10	0	5	1	10	0	5	1	9,2	0
83	4,9	1	1	0	0	2	4	0,8		4	5	4,4	0,6	2	1	0,7	0	1	1	0	0
84	9,2	2	1	1,4	0	5	5	7,2	8,4	5	1	7	0	5	1	7,1	0	5	1	7,2	0
86	0	1	1	0	0	5	1	9,1	0	5	1	9,4	0	5	1	9,7	0	5	5	9,3	4
87	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	4	3	0,4	0,3

Patient	A1K1	B1K1	A1K2	B1K2	A1L1	B1L1	A1L2	B1L2	A1M1	B1M1	A1M2	B1M2	A1N1	B1N1	A1N2	B1N2	A1O1	B1O1	A1O2	B1O2
3	5	1	5,5	0	5	5	4,8	6,4	4	4	5,3	1,3	1	1	0	0	1	1	0	0
6	5	1	10	0	5	2	10	0	5	1	10	0	1	1	0	0	1	1	0	0
8	1	1	0	0	1	2	0	0,2	1	1	0	0	1	1	0	0	1	1	0	0
11	3	2	0,4		1	1	0	0	1	1	0	0	1	1	0	0	5	1	0,2	0
15 (died)	4	3	9,3	8,8	3	1	8,2	0	5	4	9,1	6,8	3	5	7,1	8		1		0
20	3	2	5,7	0,5	1	2	0	0,5	1	1	0	0	1	1	0	0	1	1	0	0
21	5	2	6,5	5,2	4	2	3,3	6,5	5	2	10	3,9	4	1	5,6	0	1	1	0	0
24	5	4	8,9	7,8	4	2	5,8		1	1	0	0	4	3	7	4,9	3	2	6,6	
27	2	1	4,2	0	4	1	5	0	5	1	5,4	0	4	1	5,3	0	1	1	0	0
28	5	1	9,7	0	4	1	6,4	0	1	1	0	0	1	1	0	0	1	1	0	0
29	4	1	10	0	1	1	0	0	4	1	0	0	1	1	0	0	1	1	0	0
31	2	2			1	1	0	0	1	3	0		2	1	10	0	1	1	0	0
37	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
39 (died)	3	1	6,5	0	1	1	0	0	1	1	0	0	1	1	0	0	3	1	7,4	0
42 (died)	1	1	0	0	1	1	0	0	5	1	6,2	0	1	1	0	0	1	1	0	0
45	1		0		1		0		1		0		1		0		1		0	
49	3	1	1,5	0	1	1	0	0	5	4 of 5	1		1	1	0	0	1	1	0	0
50	4	2	4	0	2	1		0	4	1	0	0	1	1	0	0	1	1	0	0
51	1	1	0	0	1	3	0		5	2	3,8		1	1	0	0	1	1	0	0
52	2	2	6	4,8	1	1	0	0	1	1	0	0	3	2	6	3,5	1	1	0	0
55	4	1	6,8	0	2	1		0	2	1		0	3	1	4,7	0	1	1	0	0
60	4	3	1,2	1,8	3	3	1,2	0,9	2	1	4,7	0	4	2	7,4	9,3	4	2	2,6	1,2
65	1	3	0		1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
66	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
69	4	2	3,7	2,8	5	2	8	0	4	3	8,2	8	5	5	9,6	7,8	1	1	0	0
70	3	3	5,3	5	2	2	5,4	5,4	4	1	5,1	0	1	1	0	0	1	1	0	0
71	4	1	9,6	0	1	1	0	0	1	1	0	0	5	1	9,8	0	1	1	0	0
73	5	2	9,6	5,2	5	2	9,3	5,7	5	3	9,5	5,5	5	1	9,5	0	4	1	4,4	0
74	1	1	0	0	5	1	9,8	0	5	1	7,5	0	1	1	0	0		1		0
75	3	1	7	0	1	1	0	0	4	1	6	0	1	1	0	0	1	1	0	0
76	1	1	0	0	1	1	0	0	5	1	10	0	1	1	0	0	2	1	0	0
77	1	1	0	0	1	1	0	0	5	1	9,6	0	1	1	0	0	1	1	0	0
78	2	1	1,2	0	5	1	0,2	0	1	3	0	0	1	1	0	0	1	1	0	0
81	4	1	10	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
83	2	2	0,9		2	2	0,7		2	1	0,7	0	1	1	0	0	1	1	0	0
84	4	4	5,7	8,1	4	4	6,1	7,8	5	1	6,4	0	2	1		0	1	1	0	0
86	5	4	9,3	3	1	1	0	0	5	1	9,4	0	5	1	9,8	0	1	1	0	0
87	2	1	4,9	0	2	1	5	0	4	4	4,8	0,3	5	1	8,1	0	5	1	0,3	0

Patient	A1P1	B1P1	A1P2	B1P2	A1Q1	B1Q1	A1Q2	B1Q2	A2	B2	A3	B3	A4	B4	A5a	B5a	A5b	B5b	A5c	B5c	A5d
3	5	1	4,5	0	4	1	2,8	0	1	1	3	3	1,8	3,3	0,3	5,6	1,1	1,1	1,2	7,4	1,1
6	1	1	0	0	5	5	0	0	1	1	1	1	10	8	10	8,1	10	10	4,5	7,9	10
8	1	1	0	0	1	1	0	0	1	1	1	1	1,1	9,3	1,6	9,2	0,6	9	1,4	8,9	1,2
11	1	1	0	0	1	1	0	0	1	1	1	1	9,8	9,8	10	10	10	10	10	10	10
15 (died)		1		0		5		6,1		1		1		7,6		6,9		9,4		6	
20	5	1	8,3	0	1	1	0	0	1	1	2	1	1,8	9,2	4,7	9,6	4,7	9,6	4,7	9,6	4,7
21	5	1	5,1	0	4	1	3,1	0	1	1	2	1	10	10	4,9	10	5,2	10	5	10	2,8
24	5	2	9,5		4	2			2	2	1	1	4,3	5,6	5	5,4	8,2	8,7	5,1	5,6	1,6
27	1	1	0	0	1	1	0	0	1	1	1	1	5,6	6,9	5,3	6,6	5,4	6,1	2,8	0	0,8
28	5	1	9,4	0	5	1	9,3	0	1	1	2	1	0,4	8,7	0,5	7,2	9,6	9,8	3,3	10	0,4
29	4	1	10	0	4	1	0	0	1	1	2	1	0	10	0	10	10	10	0	10	0
31	1	1	0	0	1	1	0	0	2	1	1	1	5	5	5	5	5	7,5	5	7,5	5
37	1	1	0	0	1	1	0	0	1	1	1	1	10	10	10	10	10	10	10	10	10
39 (died)	1	1	0	0	1	1	0	0	1	1	3	1	4	7,8	7,6	8,2	7,6	8,2	5,3	8,2	5,5
42 (died)	1	1	0	0	1	1	0	0	1	1	1	1	0,7	9,4	0,2	9,1	6,8	9,3	0,5	9,3	6
45	1		0		5		0		1		1		10		7		7		8		5
49	1	1	0	0	1	1	0	0	1	1	2	1	3,9	3,9	4	4	6,9	7,8	3,7	3,3	5
50	3	1	0	0	1	1	0	0	1	1	1	1	5	10	0	10	5	10	5	10	0
51	5	1	8,5	0	1	1	0	0	1	1	2	1	4,7	8,6	2	9,4	8,7	9,4	3,6	9,4	3,2
52	1	1	0	0	2	2	3,5	3,8	1	1	2	1	4	5,2	4	4,8	7,2	4,2	6,2	5,2	1,9
55	5	1	4,4	0	5	1	5,4	0	1	2	2	1	10	10	10	10	10	10	5,3	10	0
60	1	1	0	0	1	2	0	2,6	2	2	1	1	6,5	5,2	6,3	6,7	8,9	8,3	6,7	5	3
65	1	1	0	0	1	1	0	0	1	1	2	1	0	0,4	2,5	9,7	9,8	9,8	2,6	9,7	9,4
66	5	1		0	1	1	0	0	1	1	1	1	10	10	10	10	10	10	10	10	10
69	1	1	0	0	1	3	0	2,5	1	1	1	1	5,4	2,2	3,7	10	4,9	10	4,9	10	10
70	1	1	0	0	5	4 of 5	10	4,6	1	1	2	2	1,9	5,2	3,5	7,6	10	10	2,4	6,6	8,9
71	1	1	0	0	5	1	4,8	0	1	1	2	1	4,9	10	5,2	10	10	10	4,4	8,1	10
73	1	1	0	0	1	1	0	0	1	1	2	1	0,2	8	1,9	6,3	9,6	9,9	1,1	9,6	0,6
74	1	1	0	0		1		0	1	1	2	2	2	9,6	4,8	8,3	7,7	9,4	5,2	6,6	6,8
75	1	1	0	0	5	1	8	0	1	1	1	1	8	10	6	10	6	10	8	10	9
76	1	1	0	0	1	1	0	0	2	1	2	1	0	10	0	10	10	10	0	10	0
77	5	1	9,3	0	1	1	0	0	1	1	2	2	6,1	8,6	3,9	8,2	0,7	8,3	4,8	8,4	4,7
78	1	1	0	0	1	1	0	0	1	2	1	1	0	2,6	4,9	3,1	6,5	8,3	2,9	2,4	0,6
81	5	1	10	0	1	1	0	0	1	1	1	1	1,8	10	1	10	7,6	10	1,3	10	0,5
83	1	1	0	0	1	5	0		1	1	2	2	8,6	6,3	8,5	5,2	8,7	9,3	8,8	9,4	9,5
84	1	1	0	0	1	1	0	0	1	1	2	2	2,3	9,4	1,4	5,1	8,4	8,7	2,1	8,8	9,8
86	4	1	6,2	0	5	1	9,8	0	1	1	2	3	0	5	0,6	4,7	4,7	9,9	1,1	4,7	0,8
87	1	1	0	0	1	1	0	0	2	1	1	1	5,6	5,7	4,4	2,1	1	4,7	0,5	2,3	3,3

Patient	B5d		A6	A7	A8	A9	A10		B6	B7	B8	B9a	B9b	B10	B11	B12	B13	B14	B15
3	3		1	-	-	-	-		-	1	1	7,8		10	10	0	-	7,3	0
6	0		4	1,7	10	4	0		-	1	1	0	4	10	10	0	0	10	1,8
8	9		2	4,3	9,8	9,5	0,2		-	1	1	0,8	0	9,9	9,9	0,2	3,2	9,8	0,1
11	10		2	0,1	10	0,1	0			1	1	0	0	0	10	10	10	10	0
15 (died)	0,9		1	-	-	-	-		1	2	2	9	+4	9,7	9,2	0,5	0,7	0	9,3
20	9,6		2	9,6	9,6	9,6	5			1	1	6,8	+4	9,8	9,8	0,7	3	9,8	0,5
21	10		2	3,9	8,5	10	0		3	1	1	10	3	10	10	0	2,9	10	1,8
24	0,9		4	4,3	7,3	1,3	1,4		2	1	1	0,8	+4	8,7	8,9	0,5	2,3	9,4	6
27	2,8		1	-	-	-	-		-	1	1	5,9	+6	9,7	9,3	0	0	8	5,4
28	5,1		4	9,4	9,3	9,5	0,4		-	1	1	10	+8	10	10	0,2	7,4	9,8	0,2
29	10		3	5	-	-	0		3	1	1	10	+6	10	10	0	0	10	0
31	7,5		1	-	-	-	-		-	1	1		2	7,5	7,5	7,5	-	7,5	0
37	10		1	-	10	10	0		-	1	1	-	0	-	10	10	10	10	0
39 (died)	8,2		4	0,5	9,8	0,5	9,3		-	1	1		+1	8,2	9,1	3,8	1,1	8,8	2,3
42 (died)	9,6		2	8,8	9,2	9,2	0		-	1	1	9,7	2	9,8	9,8	0,2	6,9	9,9	0,1
45			1	-	-	-	-												
49	5,6		4		2,8	0,7	1,1		1	1	1		4	7,7	9,3	3,1	6,4	8,8	0,2
50	0		4	7	1	0	0,5		1	1	1	10	+4	10	10	0	0	10	2
51	9,4		4	8,1	4,9	9,5	1,5		1	1	1	9,3	+2	9,7	9,7	3,3	1,4	9,7	0,7
52	0,9		4	2,5	2,9	2,9	3,2		3	2	2	5,3	+2	5,6	6,3	0,8	0,8	6,4	8,4
55	0		1	-	-	-	-		-	1	1		4	10	10	0	0	10	0
60	1,9		1	0,7	5,1	0,5	0		3	1	1	7,1	+2	6,3	7,5	5	5	7,5	6,15
65	9,6		2		9,8	9,9	0		-	1	2	9,8	4	4,4	9,9	5	5,2	5,2	10
66	10		4	10	10	10	0		-	1	1	0		10	10	0	3	10	0
69	1,7			8,8	10	9,1	1		-	2	2	8,8	0	9	7,8	2,6	4,8	7,8	3
70	9,2		2	7,9	10	7,9	0		4	1	2		2	6,8	4,8	2	6,7	6,8	5,8
71	10		4	10	10	10	0		-	1	1	0	2	10	10	4,6	8,1	10	2,7
73	9,4		1	-	-	-	-		-	1	1	9,6	7	9,7	9,7	0,2	0,3	9,7	0,4
74	7		4	7,5	7,5	9,7	0,4		-	1	1	9,8	+4	9,6	9,7	0,3	2,9	9,7	0,5
75	10		2	7	9	10	0		2	1	2		0		10	2	10	9	2
76	10		4	10	10	10	0		1	1		10	+4	10	10	0	10	10	0
77	8,6		1	-	-	-	-		-	1	1	9,6	+2	9,8	9,7	0,4	-	9,6	0,2
78	2,4		4	9,6	9,3	8,8	0,5		-	1	2	7	+1	7	9,8	4	6,3	8,7	7
81	7,7		2	5,6	7,9	5,4	0		-	1	1	0,1	0	10	10	0	0,6	10	0
83	7,6		1	-	-	-	-		4	1	2		2	5,7	9,1	8,6	5,8	9,1	4
84	9,6		3	1,5	0,8	1,6	5,1		4	2	1	8,1		5,6	6,8	1,3	2	5,2	6,8
86	4,8		2	5,2	5	6	0		-	1	1	10		10	10	0	0	10	4
87	4,7		2	2,1	8,6	0,4	0,4		-	1	1	4,4	-2	7,4	9,8	9,4	8,6	8,8	0,3

Patient	Days between surgery and questionnaire	A1A1	B1A1	A1A2	B1A2	A1B1	B1B1	A1B2	B1B2	A1C1	B1C1	A1C2	B1C2	A1D1	B1D1	A1D2	B1D2	A1E1	B1E1	A1E2
88	264	1	1	0	0	5	1	9,4	0	5	1	9,7	0	5	1	9,6	0	1	1	0
89	250	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
90	195	2	1	8,7	0	1	1	0	0	1	1	0	0	4	1	6,6	0		1	
91	176	1	1	0	0	1	1	0	0	2	1	7	0	2	1	6,8	0	1	1	0
92	52	1	1	0	0	2	1	7	0	4	2	6,7	1,3	4	1	7,3	0	1	1	0
94	3550	1	1	0	0	2	1	0	0	1	1	0	0	1	1	0	0	1	1	0
95	3350	1	1	0	0	1	1	0	0	1	5	0	9,6	1	4	0	7,1	1	1	0
96	3240	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
97 (died)	3233 [1]	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
98	3192		1		0		1		0		1		0		1		0		1	
104	2149	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
109	1798	1	1	0	0	5	1	4,8	0	5	1	3,2	0	5	1	6	0	4	5	4,5
121	1060	1	1	0	0	5	1	0,4	0	5	4	0	0	2	1	0	0	4	5	0
122	948	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
123	880	2	1		0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
125	721	5				5				5				5				5		
127	451	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
129	66	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
130 (died)	3889 [1]	1	1	0	0	4	2	2,5		4	2	5,1		4	4	6,7	5,4	1	1	0
141	2776	2	1	3	0	1		0		1		0		3	1	2,9	0	1	1	0
146	1569	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
147	1245	1	1	0	0	1	1	0	0	5	1		0	5	1	5,5	0	1	1	0
148	975	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
160	2252	1	1	0	0	5	1	10	0	5	1	7,1	0	5	1	7,3	0	2	1	7,2
162 (died)	971 [1]	1	1	0	0	3	2	7,8	2,1	3	2	8,2	2,1	3	2	8,3	2,2	4	2	7,3
163	1716	1	1	0	0	2	1		0	1	1	0	0	1	2	0	4,5	1	3,4	0

[1] Days between surgery and passing away

no answer or no interpretation possible

\- not applicable

Patient	B1E2	A1F1	B1F1	A1F2	B1F2	A1G1	B1G1	A1G2	B1G2	A1H1	B1H1	A1H2	B1H2	A1I1	B1I1	A1I2	B1I2	A1J1	B1J1	A1J2	B1J2
88	0	4	1	5,8	0	5	1	9,5	0	5	3	8,1	1	4	1	8,8	0	5	2	9,6	2,2
89	0	1	1	0	0	1	1	0	0	4	1	5,2	0	1	1	0	0	5	1	6,2	0
90	0		1		0		1		0		1		0		1		0		1		0
91	0	1	1	0	0	2	1	7	0	2	1	7,5	0	2	1	7,4	0	2	1	7,8	0
92	0	1	1	0	0	4	2	5,8	1,1	4	1	6,7	0	3	1	7	0	4	1	6,1	0
94	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	5		3	2
95	0	1	1	0	0	1	5	0	8,5	5	5	0,4	4,9	5	1	0,4	0	5	5	9,5	9,1
96	0	1	1	0	0	5	1	8,7	0	5	1	2,6	0	1	1	0	0	5	1	7,7	0
97 (died)	0	1	1	0	0	1	1	0	0	-	1	-	0	1	1	0	0		1		0
98	0		1		0		1		0		1		0		1		0		5		0
104	0	1	1	0	0	1	1	0	0	5	1	8	0	1	1	0	0	5		5	
109	5,8	1	1	0	0	3	1	3,1	0	1	1	0	0	5	1	3,3	0	5	5	3,9	5
121	0	1	1	0	0	4	1	0	0	4	1	0	0	5	1	10	0	5	1	0	0
122	0	1	1	0	0	1	1	0	0	5	1		0	1	1	0	0	5	3	7,5	0
123	0	2	1	0	0	2	1		0	1	1	0	0	1	1	0	0	5	1		0
125		5				5				5				5				5			
127	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
129	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	5	4	9,1	7,4
130 (died)	0	1	1	0	0	5	4	6,5	3,3	5	4	6,3	2,3	1	1	0	0	2	2	0,7	1
141	0	3	1	4,9	0	4	1	5,4	0	4	1	5,7	0	1	1	0	0	5	2	6,8	1
146	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
147	0	1	1	0	0	5	1	5	0	5	1	4,8	0	1	1	0	0	5	5	4,2	
148	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	4	2	8,6	5,9
160	0	1	1	0	0	5	1	5,9	0	5	1	8,5	0	5	1	10	0	5	1	10	0
162 (died)	1,8	1	1	0	0	3	2	7,7	1,7	4	2	6,1	1,8	3	2	7,9	1,7	4	2	5,2	1,8
163		1	1	0	0	1	1	0	0	1	2	0	3,3	1	1	0	0	1	2	0	

Patient	A1K1	B1K1	A1K2	B1K2	A1L1	B1L1	A1L2	B1L2	A1M1	B1M1	A1M2	B1M2	A1N1	B1N1	A1N2	B1N2	A1O1	B1O1	A1O2	B1O2
88	4	1	8,5	0	5	3	4,5	3	4	1	5,7	0	2	1	3,8	0	1	1	0	0
89	4	2	6,5	0,5	2	1	2,9	0	5	2	5,1	1,1	1	1	0	0	1	1	0	0
90		3		7,2		3		3,7		4		1,3		1		0	3-4	1	3,7	0
91	4	1	9,5	0	1	1	0	0	4	1	8,2	0	1	1	0	0	1	1	0	0
92	3	4	0	2,5	2	2	0	0,7	4	1	0,5	0	1	1	0	0	1	1	0	0
94	1	1	0	0	1	1	0	0	4		2	2,1	1	1	0	0	1	1	0	0
95	5	3	9,6	5	2	2	0,6	0,6	5	5	9,6	9,5	1	1	0	0	1	1	0	0
96	5	1	9,8	0	1	1	0	0	5	1	5,3	0	1	1	0	0	1	1	0	0
97 (died)	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0		1		0
98		2		0		2		0		3				1		0		1		0
104		2			5	2			1	1	0	0	1	1	0	0	1	1	0	0
109	5	1	8,2	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
121	4	3	10	0	3	1	0	0	2	1	0	0	5	1	10	0	1	1	0	0
122	5	1	8,8	0	5	1	8,8	0	5	4	10	0	1	1	0	0	1	1	0	0
123	1	1	0	0	1	1	0	0	5	1		0	1	1	0	0	1	1	0	0
125	4				4				5				5				5			
127	1	2	0	3,4	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
129	2	4	1	1	2	2	1,1	1	1	1	0	0	5	5	9	5,4	4	1	7,6	0
130 (died)	1	1	0	0	2	1	0,6	0	2	2	0,8		4	1	1,7	0	4	1		0
141	1	1	0	0	3	3	6,3	2,1	5	1	4,1	0	1	1	0	0	1	1	0	0
146	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
147	1	1	0	0	2	2	0		1	1	0	0	1	1	0	0	1	1	0	0
148		3	5	6,7		2		1,5	5	1	5,4	0	1	1	0	0		1		0
160	2	1	5,2	0	1	1	0	0	5	1	10	0	1	1	0	0	1	1	0	0
162 (died)	2	1	2,5	0	5	5	7,9	6,9	4	4	3,7	3,1	4	4	5	4,8	1	1	0	0
163	4,5	2	5,5		4,5	2	5,5		4,5	2	5,9		1	1	0	0	1	1	0	0

Patient	A1P1	B1P1	A1P2	B1P2	A1Q1	B1Q1	A1Q2	B1Q2	A2	B2	A3	B3	A4	B4	A5a	B5a	A5b	B5b	A5c	B5c	A5d
88	5	1	9,6	0	5	1	7,2	0	1	1	2	2	2,4	6,7	3,6	7	6	9,7	2,6	9	0,3
89	1	1	0	0	5	1	10	0	1	1	2	1	0,1	10	1,6	9,4	1,9	10	1,9	10	1,8
90	1	1	0	0	5	1	6	0	1	1	2	1	3,4	8,1	3,4	8,4	3,2	8,8	3,7	8,9	6,7
91	2	1	3,5	0	4	1	0,9	0	1	1	2	1	4,4	9,6	5	9,7	9,5	9,6	4,7	9,4	9,4
92	1	1	0	0	1	1	0	0	1	1	2	3	9,6	9,3	8,5	9,7	8,7	9,6	8,8	9,7	4,7
94	1	1	0	0	5		8,9	2,3	1	1	2	2	1,3	6,3	2,1	4,6	8	6,8	1,6	5,2	1,7
95	1	1	0	0	5	1	6	0	1	1	3	2	0,7	1,3	2,2	1,9	8,7	8,9	0,6	1,8	5,3
96	1	1	0	0	1	1	0	0	1	1	3	2	2,2	10	0	10	10	10	0	4,9	2,1
97 (died)	1	1	0	0	5	1	10	0	1	2	3	1	4,9	4,3	4,6	4,1	4,7	4,1	4,5	4,1	4,5
98				0						1		1		5		5		5		2	
104	1	1	0	0	5	1	6	0	1	1	1	1	0	3	0	0	1	8	0	3	1
109	1	1	0	0	1	1	0	0	1	1	1	1	2,1	2	1,8	1	9	8,9	3	1,5	1,2
121	5	5	10	10	5	1	10	0	1	1	1	1	4	6,5	2	4	10	10	3	6	3
122	1	1	0	0	5	1	0	0	1	1	2	2	0	4	2	3,8	10	10	3,7	3,9	4,2
123	1	1	0	0	5	1		0	1	1	2		0		0	5,9	10	10	0	6	0
125	5				5				1		2		0		0		4,9		2,9		0,7
127	1	1	0	0	4	1	0,9	0	1	1	1	1	10	10	9,8	10	9,8	10	10	10	9,9
129	1	1	0	0	1	1	0	0	2	1	1	1	2,8	7,5	1,1	5,3	10	10	5,6	6,5	4,5
130 (died)	2	2			4	1		0	2	1	3	3	4,6	5,3	5,3	6,7	3,6	6,9	3,8	6	1
141	1	1	0	0	1	1	0	0	1	1	1	1	1,6	7,6	1,4	5,2	5,7	8,8	1,3	8,8	5,5
146	1	1	0	0	1	1	0	0	1	1	1	1		10	10	10	10	10		10	10
147	1	1	0	0					1	1	1	1	5	4	5,2	6,4	2,3	6,7	2,6	7,7	3,4
148		1		0	5		9,2		1	1	2	2	4,5	7	8,5	10	9,3	10	6	8	7,3
160	1	1	0	0	1	1	0	0	1	1	2	1	0,4	9,6	0	10	0	10	0,4	10	0
162 (died)	1	1	0	0	5	5	4,1	2,7	1	1	1	1	4,7	8	3,2	7,2	6	8,4	2,5	3,7	5,7
163	1	1	0	0	5	2.3	10	4,8	1	1	3	1	8,4	10	8,5	10	10	10	10	10	10

Patient	B5d		A6	A7	A8	A9	A10		B6	B7	B8	B9a	B9b	B10	B11	B12	B13	B14	B15
88	3,6		4	6,7	9	9,1	0,7			1	2	7,8	+2	9,4	8,7	1,8	4,4	8	2,4
89	10		4	6,5	7,6	7,8	1		1	1	1	10	+4	10	10	0	2,3	10	0,7
90	9,8		4	7,8	9,6	7,9	0,8			1	1	8,7	+2	9,3	10	0,8	4,9	9,3	2,8
91	9,4		4	0,4	0,6	0,6	4,7		1	1	1	9,6		9,6	9,6	2,4	2,4	9,4	0,4
92	7,7		4	9,7	3,7	9,4	0,2		1	1	1	9,3	+2	9,4	9,4	1,9	7,9	9,4	6,7
94	2,4		3	0	0	0	0		-	1	1	5,8	0	9,2	9,9	1,3	-	5,4	7,8
95	8,3		2	1,9	1,8	1,9	0,7			2	1	0	0*	5,3	9,2	9,1	0,4	2,2	9,1
96	1,1		1	-	-	-	-		-	1	2	10	3	10	10	0	0	10	6,6
97 (died)	4,1		1	-	-	-	-		-	1	1	10	+2	10	10	4,4	-	10	-
98	5								-	1	1	7	0	7	9	0		10	0
104	1		2	7	0	0	0		-	1	1			7	9	0	0	8	0
109	2		4	3,1	8,2	4	2,7		1	1	1	4	+4	5,4	6,7	3,2	4,2	4,1	3,1
121	8		2	0	10	0	0		4	1	1	5	+2	10	10	0	0	10	2
122	1,7		4	2,6	2,3	3,3	0		2	1	1	7,2		8	10	0	2,4	10	0
123	5,7		1	-	-	-	-		-	1	1		+4	10	10	1,1		10	0
125			4	7,4	5,9	9,6	0												
127	10		1	-	-	-	-		-	1		5	0	10	10	10	10	10	2,3
129	6,4		4	5,3	10	5	0		1	1	1	7	0	8	10	1,4	2,2	8,2	1,5
130 (died)	3,1		1	-	-	-	-		4	2	2		0	4,1	4	4,1	4,4		
141	8,8		1	-	-	-	-		1	1	1	9,4	+4	8,9	8,9	0,8	0,8	9,4	0,3
146	10		1	-	-	-	-		-	-	1	-	-	-	7	10	10	10	0
147	7,6		2						1	1	1	0		6,7	8,4	2	2,2	6,9	10
148	10		1	-	-	-	-		-	1	1	9,4	+2	10	10	2,7	2,8	10	8,3
160	10		2	1,6	2	0	0		1	1	1		+6	10	10	1,1	1,6	9,3	0
162 (died)	8,3		1	-	-	-	-		4†	2	2	0,4	0	0,8	0,7	0,2	6,7	6,3	9,7
163	10		4	0	0,3	0	0		4	1	2	9,7	+2	6	8,6	2,4	2,1	10	10

3b: Caption for 3a, Results Quality of Life Questionnaire *(letters referring to question also given in appendix 2b-c)*

A1.1/B1.1 (. = A-Q)	0: Never	1: Less than once a month	2: Monthly	3: Weekly	4: Daily
A1.2/B1.2 (. = A-Q)	The number in the table is where the owner put down an X, on a scale of 0-10				
A2/B2/B7/B8	1: No	2: Yes			
A3	1: No	2: Yes	3: Doubt		
A4-A5/B4-B5	The number in the table is where the owner put down an X, on a scale of 0-10				
A6	1: No	2: Diet	3: Medication	4: Medication and Diet	
A7-A10	The number in the table is where the owner put down an X, on a scale of 0-10				
B6	- : No signs after surgery	1: Until 4 weeks after surgery	2: Less than 6 months after surgery	3: More than 6 months after surgery	4: still remaining/ signs remained till death
B9a/B10-15	The number in the table is where the owner put down an X, on a scale of 0-10				
B9b	The body condition score given after surgery minus the body condition score before surgery				

Patient	Neurological signs	HE classification	Shunt anatomy	Days surgery-check-up	Fasting Bile acids µmol/L	Fasting ammonia µmol/L	Ammonia tolerance test	Urine sample	Last check-up after surgery	Shunting long-term	Recovery	Compare shunting
6	Vacant	1	PC	3689	8	29	-	Not deflecting	No shunting	No shunting	Partial recovery	No shunting
11	-	0	PC	3509	15	36	-	Not deflecting	No shunting	No shunting	Complete recovery	No shunting
20	-	0	PC	3079	3	28	-	Not deflecting	No shunting	No shunting	Complete recovery	No shunting
52	Agression	1	PC	1900	12	42	+	Not deflecting	Asymptomatic shunting	Symptomatic shunting	No recovery	Persistent shunting
65	Lazy	1	PC	1129	172	84	+		Asymptomatic shunting	Symptomatic shunting	No recovery	Persistent shunting
66	-	0	PC	1088	1	8	-	Not deflecting	No shunting	No shunting	Complete recovery	No shunting
69	Lazy / Indolent	1	PC	928	121	28	+	Erytrocytes	Symptomatic shunting	Symptomatic shunting	No recovery	Persistent shunting
70	Agression	1	PC	939	285	201			Symptomatic shunting	Symptomatic shunting	No recovery	Persistent shunting
71	-	0	PC	925	1	39	-	Struvite	Asymptomatic shunting	No shunting	Complete recovery	No shunting
75	-	0	PC	802	19	39	-	Not deflecting	Symptomatic shunting	No shunting	Complete recovery	No shunting
83	-	0	PC	398	269	179		Ammonia urate	Symptomatic shunting	Asymptomatic shunting	Partial recovery	Persistent shunting
87	-	0	PC	259	1	26	-	Erytrocytes		No shunting	Complete recovery	
88	-	0	PC	282	156	189		Not deflecting	Asymptomatic shunting	Asymptomatic shunting	Partial recovery	Persistent shunting
90	-	0	PC	214	68	29	-	Not deflecting	Asymptomatic shunting	No shunting	Complete recovery	No shunting
95	Compulsive movements	2	PAZ	3382	1	31	-	Not deflecting	No shunting	No shunting	Partial recovery	No shunting
96	-	0	PAZ	3255	1	31	-	Not deflecting		No shunting	Complete recovery	
106	-	0	PAZ	2075	3	30	-	Not deflecting	No shunting	No shunting	Complete recovery	No shunting
112	Lazy / Agression	2	PAZ	1677	27	34	+	Not deflecting	Symptomatic shunting	Symptomatic shunting	No recovery	Persistent shunting
127	-	0	PAZ	445	3	13	-	Struvite	Asymptomatic shunting	No shunting	Complete recovery	No shunting
148	Lazy / Indolent	1	IH	994	28	47	+		No shunting	Symptomatic shunting	No recovery	Recurrent shunting
163	-	0	IH	1762	146	32	-	Epithelium	Symptomatic shunting	No shunting	Complete recovery	No shunting

Patient number corresponds with the patient number in appendix 1a-c
HE classification is done by the classification system of Rothuizen (1993)
Shunt anatomy: portocaval (PC), portoazygos (PAZ), intrahepatic (IH)
The **number of days** between the day of surgery and the day they came back for this study
Ammonia tolerance test was called positive when there was more than a twofold increase in ammonia concentration, and this concentration is above 45 mmol/L. No tolerance test was performed in 3 patients, because the fasting ammonia concentration was very high
Shunting during last check-up after surgery and shunting long-term were determined by table 5 on page 16
Recovery was determined by table 6 on page 16
Shunting was compared between the last check-up after surgery and the long-term check-up