Guinea pig dystocia in the Nordic countries

– A survey study comprising Finland, Sweden, Norway, and Denmark

Marsvinsdystokier i Norden – en enkätstudie

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Degree project/Independent project • 30 credits
Swedish University of Agricultural Sciences, SLU
Faculty of Veterinary Medicine and Animal Science
Veterinary Medicine Programme
Uppsala 2022

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Credits:	30 credits
Level:	A2E
Course title:	Independent project in Veterinary Medicine
Course code:	EX0869
Programme/education:	Veterinary Medicine Programme
Course coordinating dept:	Department of Clinical Sciences
Place of publication:	Uppsala
Year of publication:	2022
Keywords:	guinea pig, cavy, dystocia, caesarean section, birthing problems, reproduction
Nyckelord:	marsvin, dystoki, kejsarsnitt, födselproblem, reproduktion

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Abstract

This study focuses on veterinarians' and breeders' experiences of guinea pig dystocia in the Nordic countries. The countries included in the survey are Finland, Norway, and Denmark. The data for Swedish veterinarians and breeders was acquired from a previous study by Sandra Stolzenberg.

The new data collected from Finland, Norway and Denmark largely resemble the results from the Swedish study.

Veterinarians feel that they need more training in treating guinea pig dystocia. Opportunities to gain experience are scarce and collegial support is not always available as these cases often present during on-call hours. This may lead to a further reluctance to attempt treatment, especially more complex treatments such as performing a caesarean section. Most veterinarians who had performed a caesarean section had done so only once, which is scarcely enough to feel confident in the procedure.

Many veterinarians also reported that guinea pigs were a very small part of their patient base. This makes it less motivating to seek further education in this species as compared to the other species one treats more often. Furthermore, guinea pig anaesthesia is notoriously difficult and there is a 30-fold risk of mortality during anaesthesia as compared to dogs and cats.

The breeders who participated in the survey seem overall very engaged and the majority have many years of experience. Three out of four have experienced dystocia in their guinea pigs, but only half of these have sought veterinary assistance. Even fewer breeders have had a caesarean section performed on their sow. Reasons centre around it being a stressful operation for the sow, poor prognosis, and the cost.

Around 60% of sows did not survive a caesarean section and its recovery. All pups died in 71% of cases. Most sows died 1-3 days after the operation while the pups mostly were dead before extraction.

This disheartening statistic may explain reluctance to seek treatment. Reluctance to seek treatment will lead to late presentation, worsening the prognosis or not seeking treatment at all. This allows fewer chances for veterinarians to gain experience under good circumstances.

It appears a joint effort is needed to improve these statistics.

Keywords: guinea pig, cavy, dystocia, caesarean section, birthing problems, reproduction

Preface

In the future I hope to see a positive development in guinea pig health and welfare and that their status as a species worth excellent veterinary care will continue to improve.

Figure 1. Photo by Dan Barrett on Unsplash (unsplash.com).

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1. Introduction

This study is focuses on guinea pig dystocia and its treatment including caesarean sections in the Nordic countries Finland, Sweden, Norway, and Denmark. A similar study has already been made in Sweden by Sandra Stolzenberg, but I have expanded the area being studied. I have kindly been given permission to use her data and questionnaires with a few added questions, to be able to include her findings in my statistics.

Guinea pig dystocia is an important area of study because guinea pigs are far more likely to experience periparturient complications as compared to other rodents and the sequela of dystocia tend to be severe for both sow and pups.

The purpose of this study is to expand the knowledge about the current situation in the Nordic countries as pertains to the prevalence and treatment of dystocia in guinea pigs in these countries, both from the perspectives of guinea pig breeders and veterinarians treating exotics including guinea pigs.

The method was to conduct an online survey study directed to veterinarians and breeders. Prevalence of dystocia, treatment of it and risk factors in the sow were included in the survey. Additionally specific questions relating to caesarean section were explored, to get an idea of how many veterinarians have performed one, what the outcome was and breeders' attitude to caesarean sections.

The first part is a literature review in which I focus on guinea pigs in general and questions pertaining to their health with a particular emphasis on issues connected to parturition. I also intend to delve deeper into some areas that I consider to be of interest to the veterinary practitioner finding themselves with a guinea pig patient, namely anaesthesia and the procedure caesarean section, in the hopes of making this study useful in practise.

The second part presents the findings from the surveys and the conclusions that can be drawn thereof.

2. First section: The Guinea Pig

Scientific name	*Cavia aperea f. porcellus*	
Taxonomy	PHYLUM:	Chordata
	CLASS:	Mammalia
	ORDER:	Rodentia
	FAMILY:	Caviidae

The guinea pig is a South American mammal, specifically a large rodent. The name of the family, cavy, comes from the Latin form of the natives' word *cuy* which is the root of the Latin name Cavia.

The name guinea pig however is illogical, since the animal is not native to Guinea nor any relative to the pig. It is believed that the first part of the name comes from a mangled form of Guiana (the name given to the first colonized areas in South America). The pig part remains more unclear. In Latin the domestic guinea pig is called *Cavia porcellus*, which also translates to "little pig". Possibly, at the time of its arrival to Europe, the contemporary pigs being hairier than their modern counterparts are, the epithet was justified as the two species bore a closer resemblance than in the modern day.

Furthermore, both animals are liable to grunt, spend much of the day eating and both are of a compact build with a triangular head, the short legs of a sprinter and no tail of consequence.

Another parallel to the pig can be observed in both the domestic and the wild guinea pigs' gregarious nature and a keen intelligence (Musser, 2020).

2.1. The wild guinea pig

As this chapter concerns several separate species of *Caviidae* apart from the domestic guinea pig, the author shall make the distinction by using the term wild cavy instead when referring to the family comprising multiple species of largely undomesticated relatives closely resembling the domestic guinea pig. The recent addition to the *Caviidae* family, the capybara, and the mara is excluded due to being different in size, habitat, and behaviour than the smaller wild species of cavy.

Four genera of *Caviidae* exist containing more than a dozen species of wild cavy predominantly living in the Andes region of South America. They have adapted to many different habitats and can be found in all South America, except Tierra del Fuego and the Amazon (Adrian, 2011; Woods & Kilpatrick, 2005).

2.1.1. Anatomy

The *Caviidae* family consists of large rodents of short stout build, with small ears and very little tail. Adults weigh between 700-1200 grams, where males are slightly larger than females.

The short legs have four toes on the front feet and three toes on the hind feet.

Figure 2. Wild cavy. Photo by Photoholgic on Unsplash (unsplash.com).

The wild cavies have a grey-brown stippled, short, and straight coat. The eyes are medium sized in comparison to the body and positioned to give the best accuracy of vision forward of the animal but also a wide peripheral vision behind and above the animal, many important predators being likely to attack from above.

Their incisor and molar teeth are hypsodont, meaning that they grow continuously throughout the animal's life. The rate of growth adjusts after the rate of wear as in other hypsodonts. The incisors are covered in hard enamel only on the front, while the backs of the teeth are made of a softer material that crumbles with gnawing, leaving the teeth as sharp as possible despite wear. They have small mouths and oral cavities with cheek pouches on either side.

Their digestive system is dependent on caecal fermentation, much like the rabbit family and more distantly the horse (Müller *et al.*, 2014; Musser, 2020; Donnelly, 2015).

2.1.2. Diet

Cavies are herbivores and feed on stems, leaves, seeds, and sometimes roots of many kinds of grasses. They naturally consume several small meals throughout the day. The caecal fermentation employed by the cavy enables it to extract energy from highly fibrous materials. The cavy also recycles caecal bacteria for protein supplementation as caecotrophs. All cavies produce two types of faecal pellets, one nitrogen rich intended to caecotrophy and one nitrogen poor which is just waste. In times when food is unavailable, they will ingest both types of pellets which aids in keeping the caecal microflora stable (Connell, 2015; Asher *et al.*, 2004; National Research Council, 1995).

2.1.3. Behaviour and social life

Most cavies live in social groups of 5-10 animals, adhering to a strict hierarchy with a dominant male and female. There are also systems of females inhabiting strict territorial ranges showing aggression to all other females encountered and only tolerating the male whose range overlaps those of his females. Regardless of whether territoriality exists, their reproduction is polygynous, meaning that one male mates several females. Adjacent groups are often related and form a network of family groups. Communication with neighbours occurs by scent markings and vocalizations. The vocal range of cavies is surprisingly large, consisting of 7-11 distinct sound patterns.

Cavies are predominantly crepuscular, meaning they are at their most active around dawn and dusk.

Most species of cavy occupy a similar ecological niche as cattle as they prefer an open landscape with grass and areas of dense shrub, where they graze in small groups or pairs. Different species of cavy however specialize in different habitats and cavies can be found from swamps to deserts. The main type of terrain where the small species of cavy cannot be found in is the rainforest, where they are replaced by the capybara. Cavies inhabit crevices or burrows made by other animals or areas where dense, old vegetation that has folded over forming a system of protected tunnels (Connell, 2015; Westberg, 2011; Bays, 2016; Adrian, 2011).

Cavies are, due to their stout build, not particularly agile and cannot jump or climb very well. They are good swimmers, but they do not like getting wet (Harkness & Wagner, 1995).

They display remarkable skill at remembering the location of a food source and the path to it, even when complex. They also remember this information for months, without needing reinforcement.

When startled, cavies tend to freeze or flee with rapid darting motions. If a larger group is startled, they will “stampede” which means that all cavies run in different directions in a haphazard manner to confuse the perceived predator (Terrill, 1998).

Some behaviours observed in domesticated guinea pigs that have not been confirmed in the wild cavies are “popcorning”, where happily excited guinea pigs randomly jump into the air like popcorn popping and the guinea pig “rumba”, which is a courtship behaviour where one guinea pig flanks another, swaying its hindquarters and emitting curious rumbling sounds (Bays, 2016).

2.1.4. Reproduction and lifespan

An average lifespan of the wild cavy is 3 years, although most do not make it past their first year (Eisenberg, 1989).

Females are sexually mature at 4 weeks of age; males reach puberty approximately 2 weeks later. The gestation period is long compared to other rodents, 62 days, but the pups are subsequently precocious, being born with fur and open eyes and beginning to eat solid food immediately. Litter size varies from 1-6, the average being 2-4. A birth of as many as 13 pups at a time has also been described (Westberg, 2011; Manning *et al.,* 1984). Breeding occurs all year round and a female can breed up to 4 times a year in the wild. Rübensam et al. however found in their 2015 study that reproductive investment differed according to season, in the inclement seasons a reduced ovulation and fertilization rate resulted in smaller litters and the birthweight of the pups was lower. Maternal weight loss during lactation was highest during winter as well, even though litter size was reduced.

All cavies exhibit postpartum oestrus, which means they can conceive as early as 2 hours after parturition so the reproductive rate when unhindered by lack of mates, food and absence of disease is alarming. A female which lives to the maximum age of 8 years in the wild could produce more than 60 offspring.

The cavy only possesses two nipples located in the inguinal area, but this does not hinder them from successfully rearing larger litters, due to the young not being dependent on milk from the mother as they can consume solid foods immediately (Adrian, 2011; Westberg, 2011).

2.2. The domesticated guinea pig

Most of the diseases appearing in domestic guinea pigs that are absent in the wild cavies have to do with inappropriate nutrition or housing.

Domestic guinea pigs suffer from some of the diseases shared by almost all small companion animals - such as obesity - but there are also diseases unique to the guinea pig, which emerge only in domestic conditions.

These include vitamin C deficiency or overdose, dental problems from overgrowth, malocclusion, or iatrogenic damage and pododermatitis from rough wire mesh floors. Dystocia can also be classified as a domestication problem since domestic guinea pigs are seldom allowed to breed at will, may be more prone to stress from diet changes and suffer from obesity much more often than the wild cavy (Bishop, 2002; Minarikova *et al.*, 2015).

2.2.1. Nutrition

Avoiding obesity is important for the general health of the guinea pig and impacts reproductive health. The staple food of the guinea pig should always be good quality roughage. Guinea pigs are finicky eaters and do not adapt well to sudden changes in diet. For this reason, it is always a good idea to avoid diet changes during stressful circumstances such as late pregnancy or a hospital stay.

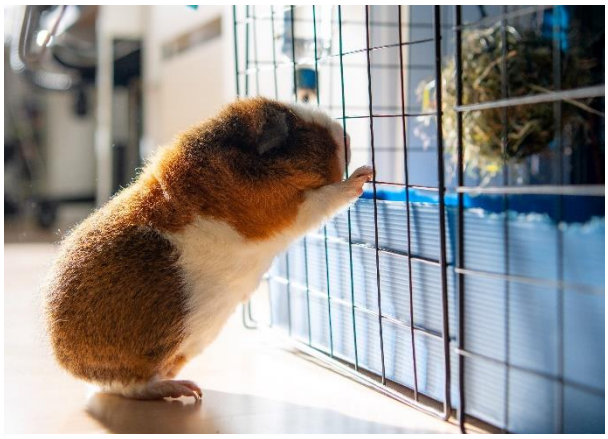

Figure 3. Photo by Jaroslaw Slodkiewicz on Unsplash (unsplash.com).

Hypovitaminosis C has been indicated as a contributing factor for dystocia due to it causing general weakness. This deficiency occurs because guinea pigs cannot synthesize vitamin C and supplementation has historically been heavily recommended to guinea pig keepers. Supplementation was warranted when nutritional information and commercial well formulated feed was not available but a study by Minarikova et al. in 2015 found the prevalence of hypovitaminosis C to be only 0.3%. Deficiency can still sometimes be seen in the pets of novice owners, but excessive vitamin C supplementation also occurs. It has been recommended that non-breeding guinea pigs should not be routinely supplemented with vitamin C, getting it instead from good quality hay and fresh greens. However, it is important to remember that vitamins deteriorate rapidly in feed stored at room temperature for months. Vitamin D naturally occurs in good quality hay, and a guinea pig's diet should contain 800-1000 IU/kg feed. For optimal metabolism of vitamin D, the guinea pig should be exposed to natural or artificial UVB light (Quesenberry, 1994; Planck & Rundgren, 2005; Terril & Clemons, 1998; Minarikova *et al.*, 2015; Müller *et al.*, 2014).

Excess vitamin C promotes the formation of uroliths through urinary ascorbate. Over supplementation of vitamin C and calcium may therefore increase the risk of developing uroliths. Potassium citrate attaches to urinary calcium and promotes its removal from the bladder. It can be given orally at 20 mg/kg twice daily (Rowland, 2020).

2.2.2. Behaviour

The domestic guinea pig shows some modifications to its behaviour that are attributable to domestication. As is expected, domestic guinea pigs show reduced aggression, stress and overall lower cortisol levels in their blood when interacting with humans (Kaiser *et al.,* 2014; Künzl & Sachser, 1998).

Interestingly, experiments have been made to differentiate whether domestication in the behavioural sense happens by exposure to humans or needs to be encouraged by selective breeding. A study found that the stress-responses of guinea pigs bred for 30 generations in captivity did not significantly differ from those of the wild cavy, while the guinea pigs bred for domestication showed reduced stress in the same situations. This is evidence that the process of domestication is dependent on the nature, rather than the nurture of the animal and has a high heritability (Künzl *et al.,* 2002).

An important observation for the guinea pig owner and the practising veterinarian is that guinea pig cortisol levels, and thus stress, are significantly reduced when entering a new environment if accompanied by another guinea pig with which they share a social bond (Hennessy, 2008).

2.2.3. Reproduction

Social patterns related to reproduction are like those of wild cavies. Polygynous groups where one male mate and defends several females form in both environments (Asher, 2004).

Since reproduction is not enjoyed at liberty in domesticated conditions, the first pregnancy of the sow may be much delayed compared to the wild cavy. This is likely to cause complications at parturition due to inability of the necessary stretching of the pelvic symphysis.

Obesity, which is often encountered in pet animals decreases fertility and poses a threat to the pregnant sow because it predisposes her to pregnancy ketosis. It also leads to fewer and thus larger pups, increasing the risk for obstructive dystocia (Michel & Bonnet, 2012; Bishop, 2002)

2.3. Reproductive diseases of the guinea pig

Diseases of the reproductive system are the third most common reason for presentation of the guinea pig for veterinary examination. This was found by Minarikova *et al.* (2015) in a study on disease prevalence in 1000 guinea pigs. Dystocia was only seen in 0.7% of the subjects in the study, but the study group consists of referrals and animals coming in for regular health checks so emergency conditions were not well represented.

The most common disorder in female guinea pigs was not associated with pregnancy but deserves mention due to high prevalence in the study group. Ovarian cystic disease was found to affect 66-75% of female guinea pigs between three months and five years of age. Increasing with age, an even higher prevalence is expected in the guinea pig older than five years. This is confirmed by Veiga-Parga et al in their 2016 study, where 95% of the guinea pigs examined for reproductive pathology had ovarian cysts. Affected guinea pigs are commonly asymptomatic, but symptoms such as anorexia, weight loss, flank alopecia and abdominal distension were described. Diagnosis can frequently be made by palpation. Ovariectomy is the treatment of choice if the symptoms trouble the guinea pig. This can be accomplished through small incisions of the dorsal-lateral body wall caudal to the last rib and thus completed without disturbing the GI-tract. Human chorionic gonadotropin has been tried as a treatment, at 1000 USP units i.m., injected twice 7-10 days apart. Cysts have decreased in size and the alopecia resolved by this method, but relief may only be temporary, and the cysts recur within several months. Puncture and aspiration are not recommended (Quesenberry, 1994; Burns *et al.*, 2001).

2.3.1. Pregnancy complications

Dystocia is the focus of interest in this study, but several other conditions can arise in association to pregnancy that deserve mention.

False pregnancy

This is rare but does happen in guinea pigs, as in many other species. The duration is around 17 days. If the sow starts lactating it is important to be attentive to the risk of her developing mastitis.

Resorption

This may seem like the sow has reduced fertility or is infertile when in fact the embryos are being lost early in pregnancy. Deficiencies in diet, stress for any reason and concurrent illness may all lead to this.

Spontaneous abortion

Later in gestation abortion may occur. If it happens before day 40 it is usually not noticeable, only a small amount of blood may be seen in the genital area or around the sow's mouth because she has cleaned herself. After day 40 there may be greater blood loss and the sow's health may be affected.

Abortion may be induced by respiratory or salmonella infection or toxoplasmosis. Non-infectious reasons are hormonal surge due to presence of another sow's new-borns being present or eating placentas, which contain oxytocin.

Treatment is symptomatic. Blood loss, post-partum depression may be alleviated by the company of another sow and her pups or another guinea pig (Rowland, 2020).

Pyometra

Develops a couple of weeks after oestrus or after parturition. Ovarian cysts or direct bacterial agent can be the cause. Symptoms are depression, hunched posture, and vaginal discharge. Recommended treatment is ovariohysterectomy. Aglepristone 10 mg/kg s.c. days 1, 2 and 7 combined with an antibiotic can be tried in especially valuable breeding animals.

Mastitis

Caused by large litters suckling, unsanitary floor in enclosure or secondary infection. Symptoms are swollen, painful and discoloured mammary glands. Antibiotic treatment is indicated, as is weaning the young and alleviating the sow's pain by applying hot compresses.

Vaginal/Uterine prolapse

Occurs after parturition. Symptoms are straining and prolapsed vaginal/uterine tissue. If the protruding tissue looks viable, reposition after lavage and lubrication can be attempted. Vaginal closure with 2-3 horizontal mattress sutures can help to prevent re-prolapse. NSAIDs may decrease swelling, as may hypertonic saline solution baths. Ovariohysterectomy should be performed to prevent toxaemia as a sequel. Prognosis is guarded to poor (Kondert & Mayer, 2017).

2.3.2. Parturition

Meticulous research has been conducted on the physiological mechanisms surrounding pregnancy, parturition, and foetal development in the guinea pig, but the purpose has been to better understand human reproduction. For this reason, despite a wealth of research, there are conditions solely affecting the guinea pig that have not received enough attention to attain sufficient understanding of disease mechanisms to avoid complications in parturition.

Recognizing abnormal parturition

A guinea pig pregnancy lasts 59-72 days. Average duration is 65 days. Before the date parturition is expected, the pelvic symphysis widening can be ascertained through palpation of a gap between the pubic bones. 5 days before parturition it should be 4-6 mm, 1-2 days prepartum it should be 11-14 mm. Normal parturition is characterized by abrupt onset, a duration of approximately 30 minutes and birth of pups 3-7 minutes apart.

A sow should not strain continually for more than 20 minutes without producing a pup, and neither should she strain intermittently for more than 2 hours. Depression of the sow at term, abdominal straining, and contractions or green or bloody discharge without expulsion of a pup are also signs of trouble (Ortega *et al.,* 2008; Quesenberry, 1994; Donnelly, 2015).

Dystocia is rare in all other rodents except the guinea pig (Girling, 2013). Guinea pigs have a high mortality in the periparturient period. Obesity, uterine inertia, and the sow being too old at first breeding are predisposing factors for dystocia. Many stillbirths are seen, especially in a sow's first litter. Prolonged parturition regardless of the cause is commonly associated to dystocia. Maternal exhaustion leading to prolonged parturition can be caused by dystocia from large foetuses or tight pelvic canal from failure of the symphysis pubis to widen, or subclinical ketosis (Riggs, 2009; Bishop, 2002; Donnelly, 2015).

2.3.3. Obstructive dystocia

A small litter will predispose a sow to obstructive dystocia because of the large size of the pups. Conversely, a large litter will produce individually smaller pups but result in higher incidence of stillbirths. Deformed foetuses may also cause obstructive dystocia, for example, roan to roan mating has a higher incidence of 'bull back' deformity. Malpresentation and too big pups will lead to fruitless labour and a rapidly weakening sow (Richardson, 2009).

In studies the most well documented risk factor for dystocia is advancing age of the sow at the first breeding. The older the sow is, the higher the risk for failure in widening of the pelvic symphysis before parturition. The pelvic symphysis is a non-synovial joint which joins the two pubic bones with fibrous cartilage, forming the pelvic girdle. A widening of the symphysis is necessary because at term the pups are much larger than the pelvic outlet. In late pregnancy, before parturition, the pubic joint cartilage is transformed into an elastic interpubic ligament through extensive collagen remodelling and leukocyte infiltration enabled by vascular-rization through bone resorption. Histologically the changes resemble an inflammatory process. This process is initiated by the hormone relaxin.

After parturition, the pubic symphysis does not return to its fibrocartilaginous state but remains a fibrous ligament. Consequently, the risk of obstructive dystocia is much reduced in the consequent parturitions of the sow (Emery & Lawton, 1947; Ortega *et al.,* 2003; Rodriguez *et al.,* 2003).

The cause and exact mechanism behind failure in pelvic symphysis widening is still subject to speculation. The mechanism has been described as stiffening of the pubic ligament or an onset of ossification of the cartilaginous symphysis when the sow starts to near one year of age. In the male guinea pig the interpubic joint is composed of a plate of hyaline cartilage with spreading ossification areas. Although interspecies comparisons prove inaccurate, it can be tentatively speculated that as

the pelvic symphysis in the virgin female resembles the male one at the onset of adulthood, the development of the virgin female pelvic symphysis follows the male model if she remains unbred, as happens in mice (Ortega *et al.*, 2003).

The consequence of failure of pelvic symphysis transformation in nulliparous females bred at an advanced age can be catastrophic. The pelvic canal widens with about 25-30 mm at parturition when the symphysis becomes elastic, but when it fails the sow does not stand a chance of delivering her offspring normally.

Treatment for obstructive dystocia is always caesarean section. The survival rate for the mother is reported to be poor. The pups may survive because of their advanced state of development at term, if they are alive at the point surgery is performed and they are extracted quickly (Quesenberry & Donnelly, 2019).

The exact age at which sows should be bred to ensure that the pelvic symphysis is not yet fused remains undefined. Richardson (2009) considers the ideal time to breed a sow to be when she is 4-5 months old or weighs 500 g. According to Riggs (2009), the risk for dystocia increases when breeding a primiparous sow after 6 months of age. Quesenberry (1994) considers the limit to be 7 months.

2.3.4. Uterine inertia

If the sow strains without presenting a pup and no obstacles for birth are found, the cause may be uterine inertia. The conditions that need to be verified before commencing treatment are that the pelvic symphysis has widened, the cervix is adequately open admitting an index finger and there are no pups stuck in the birth canal. It is also recommended to take a radiograph (suggested values in Table 1) to ascertain that the pups are anatomically normal and in the correct position.

When this has been verified, begin treatment by giving a solution of 10% **calcium gluconate**, 5-10 ml administered orally or 50mg/kg i.m. A bolus of 50% **glucose** 0.25-2ml is also given, i.v. or orally. If contractions do not start, **oxytocin** can be given, 0.2-3 IU/ kg subcutaneously in solution with fluids (or 1-2 IU given i.m., but this may result in violent contractions). If parturition does not begin within 15 minutes or a pup becomes stuck, caesarean section is necessary (Kondert & Mayer, 2017; Connell, 2015).

2.3.5. Pregnancy toxaemia

Pregnancy toxaemia has been included here, although not strictly related to the moment of parturition, as it can cause dystocia from weakening of the sow and the treatment involves induction of parturition or undertaking caesarean section.

There are two recognized forms of pregnancy toxaemia, one affecting mainly obese sows caused by metabolic changes and one caused by hemodynamic disturbance and uteroplacental ischemia.

Metabolic pregnancy toxaemia may develop at any point from the last two weeks of gestation and up to 7-11 days postpartum. The circulatory form occurs in late pregnancy up to parturition.

Metabolic form

In the **metabolic form,** the symptoms are anorexia, depression, acidosis, ketosis with accompanying ketonuria, proteinuria and a significantly lowered urinary pH from the normal 9 to 5-6. When hypoglycaemia progresses, there may be seizures and finally coma, escalating to death within 2-5 days (Kondert & Mayer, 2017; Connell, 2015). The mechanisms leading to hypoglycaemia are not completely clear, but the effects are devastating due to the late pregnant animal's 20% reduced blood glucose level compared to non-pregnant animals. In the animals developing pregnancy ketosis blood glucose drops to roughly 50% of the base amount, leading to ketosis. The gross pathological changes that can be found are an abnormally fatty liver and enlarged adrenal glands.

The most susceptible sows are in their 2-3 pregnancy, obese, and stressed. There is also a genetic component, but like other species experiencing a similar disorder, the most common causes are obesity and stress, leading to anorexia and hyper-lipidosis.

Preventative measures would then be to **keep sows that are to be bred at a healthy weight, encourage exercise, and avoid stress and changes in food**. Stress can be caused by a change of environment, company, or changes in diet. One study found that a guinea pigs would develop pregnancy ketosis because of a simple change in their diet consisting of denying them their daily ration of green cabbage, while all other food stayed the same. The control group that both changed their living environment and were denied their cabbage developed the same amount of ketosis cases. It appears that mere dietary changes can have radical consequences.

In practise this means avoiding breeding of sows that are obese (it is not recommended to try to reduce their weight once mated), encouraging exercise by scattering food and providing a large living area. Stress can be reduced by avoiding loud noises, diet changes, presence of predators and overcrowding. Guinea pigs are also prone to stress because of overheating due to their small surface area compared to their mass. Since the pregnant sow is already sensitive and the incidence of pregnancy toxaemia increases in hot weather, special care should be taken to keep her in a stable ambient temperature of about 20-22°C.

As another preventative measure to metabolic pregnancy toxaemia, one could provide sows in late pregnancy with water containing a small amount of glucose or propylene glycol (Richardson, 2009; Navia & Hunt, 1976).

If symptoms develop, prompt and aggressive treatment is indicated, including i.v. glucose solution, corticosteroids (0.2 mg/kg i.m.) and caesarean section or induction of abortion. Provide easily digestible high caloric rodent food every 2-3

hours in the critical stages and slowly return to a diet with more fibre as the sow improves. It must be remembered however that despite the best efforts of veterinarian and owner, the prognosis for the sow is still poor to grave once the condition has developed.

Circulatory form

The other form is the **circulatory or preeclampsia form**, which is caused by the gravid uterus compressing the aorta. Consequences are placental and uterine necrosis, hypertension, increased creatinine levels and death. Caesarean section and OHE can be tried, depending on the sow's condition. Because of the severe risks of surgery and anaesthesia, the prognosis is guarded to poor (Kondert & Mayer, 2017). There are no preventative measures, but heritability is suspected (Richardson, 2009; Donnell, 2015).

2.4. Caesarean section - Anaesthesia

The guinea pig is notorious for being difficult to anesthetize, being sensitive to medication, difficult to intubate and prone to complications after anaesthesia.

2.4.1. General considerations

There is always a risk involved in general anaesthesia regardless of the species in question. Studies have been made on mortality attributable to anaesthesia, and in dogs and cats, the death rates were 0.1 - 0.2%. There has been one study on the subject concerning guinea pigs, and the death rate was found to be 3.8%. This makes guinea pigs on average thirty times more likely to die from anaesthesia, regardless of procedure, than our more common small animal patients (Hawkins & Pascoe, 2012; Riggs, 2009).

Practical considerations

Preoperative fasting overnight is not indicated for the guinea pig because the species is unable to vomit, and hypoglycaemia develops rapidly. A short time (1-2 hours) of fasting is enough. This will facilitate cleaning the mouth before induction to reduce the risk of aspiration. Cleaning can be done with cotton-tipped applicators and gentle rinsing with a syringe.

Regardless of method of anaesthesia, the morbidity and mortality increase with the duration of anaesthesia. For this reason, all the preparations that that can be made before induction should be made. Equipment should be in place, monitoring equipment ready, heating system running, patient clipped and operation site sterile and drugs calculated and available, including emergency dosages for anaesthetic complications.

Special considerations for rodents are their propensity for developing hypothermia, which means washing and rinsing fluids should be warmed and disinfectants containing alcohol should be used sparingly (Quesenberry, 1994; Hawkins & Pascoe, 2012; Sorensen, 2012).

When local anaesthetic agents are used around the surgical site, the addition of an opiate can lengthen the median duration of analgesia. Addition of buprenorphine to lidocaine/bupivacaine prolonged analgesia for 9 h compared to analgesia without the opiate (Lichtenberger & Lennox, 2009).

During the procedure

After sedation but before induction it may be beneficial to empty the bladder with gentle palpation.

It is critical not to forget pre- and perioperative pain management because a swift recovery is key to preventing potentially mortal complications postoperatively.

Response to surgical stimuli, ocular and pinna reflexes can be used to assess depth of anaesthesia. Pedal retraction reflex, which is used on rabbits, cannot be used accurately on guinea pigs because they tend to have involuntary leg movements even when in adequate anaesthetic depth.

Blood volume is approximately 6-8 ml/100 g bodyweight. A blood loss less than 10% is considered relatively safe, but this means more than 5 ml in the average sized guinea pig is concerning (Lester, 2012; Lichtenberger & Lennox, 2009).

2.4.2. Sedation and premedication

Premedication is strongly advised before all anaesthesia in order to benefit from the reduced doses and thus reduced risks of multimodal anaesthesia. See table 1 for recommended dosages according to literature.

Table 1. Sedation and premedication

Drug	Dosage	Special considerations	Reference
Atropine	0,04 mg/kg SC or IM	Pre-anaesthetic, reduces bronchial and salivary responses	Lester *et al.,* 2012
Midazolam + Butorphanol	0.5-1 mg/kg 0.2-0.5 mg/kg i.m. or s.c.		Kondert & Mayer, 2017
Ketamine + Midazolam	5–10 mg/kg 0.5–1 mg/kg IM		Tamura,2010
Midazolam	0.25-0.5 mg/kg IM/IV		Lichtenberger & Lennox, 2009
Fentanyl	5-20 µg/kg i.v.	Respiratory & CNS depression	Kondert & Mayer, 2017
Medetomidine	0.5 mg/kg IM	No analgesia	Lester *et al.,* 2012
Diazepam	0.5 mg/kg IV		Lichtenberger & Lennox, 2009

2.4.3. Inhalation anaesthesia

Inhalation anaesthesia has the advantage of giving rapid induction and equally rapid recovery. However, the disadvantage is that it induces dose-dependent cardio-pulmonary depression. It is often used as the sole agent, but without premedication the dose of gas needs to be higher, and induction may become more stressful because rodents seem to resent the smell. Furthermore, inhalant doses do not block pain at normal level. Analgesic effect comes only when increased until the margin of safety to circulatory collapse is slim (Hawkins & Pascoe, 2012).

Intubation is very difficult because of the guinea pig's deep and narrow oral cavity. A face mask is usually selected for inhalation anaesthesia because of this, but it interferes with supervision of the patient and does not prevent aspiration. Upon intubation, visualization is hindered by the soft tissue in the cheeks but a small laryngoscope where the blade has been filed narrower can be employed to improve it. Further difficulties are caused by the palatal ostium, a small opening which allows entry to the glottis, and a small glottis relative to body size.

Endotracheal tubes for guinea pigs can be appropriated from a nr 8 French modified urinary catheter or a 2.0–2.5-mm Cole or Murphy ET tube or a 14-gauge i.v. catheter with a stylet to facilitate placement. Once in place, the endotracheal tube must be checked for accumulation of mucus periodically and suctioned as needed. Atropine sulphate (0.1-2.0 mg/kg SC) has sometimes been used to decrease mucus production (Quesenberry, 1994; Lester *et al.*, 2012; Clemons & Seeman, 2018).

For **induction on gas only**, an induction tank or face mask is used, whichever makes the animal less stressed. Use a closed system, non-rebreathing mask.

Isoflurane or sevoflurane may be used. After preoxygenation, isoflurane concentration is gradually increased to 2.5% or 3% until surgical anaesthesia is reached. The animal is then placed in face mask and isoflurane concentration is decreased to 1.5% to 2% for maintenance of anaesthesia (Clemons & Seeman, 2018; Kondert & Mayer, 2017; Quesenberry, 1994).

However, it is **strongly recommended to use premedication** to reduce the inhalation gas dose and thus also its side effects, which include respiratory depression. It can be a severe side effect if the patient is not intubated, and preparations have not been made for ventilation of the patient.

2.4.4. Anaesthesia using injectable agents

This is a must for dental- and mouth procedures in guinea pigs but can also be used for surgical procedures if inhalation anaesthesia is not available.

In contrast to what has been found in rabbits, medetomidine-ketamine (0.5/40 mg/kg) only provides immobilisation in guinea pigs, not surgical anaesthesia. Tiletamine-zolazepam in doses up to 50 mg/kg also produced immobilization but

did not reach surgical anaesthesia (Lester *et al.*, 2012). See table 2 for recommended dosages according to literature.

Table 2. Injectable anaesthetic agents

DRUG	DOSAGE	SPECIAL	REFERENCE
Ketamine+ diazepam	(20–30 mg/ kg) + (1-2 mg/kg) IM		Quesenberry, 1994
Ketamine+ xylazine	(30mg/kg) + (2.5 mg/kg) IM, SC, and IP	No respiratory depression, but instead reductions in blood pressure and heart rate	Lester *et al.,* 2012
Pentobarbital	37 mg/kg IP	Respiratory depression	Lester *et al.,* 2012

2.4.5. Epidurals

Epidural anaesthesia is performed regularly in ferrets and rabbits and can be used for surgery in guinea pigs as well. Epidurals achieve analgesia and muscle relaxation without the systemic effects of drugs with i.m. or i.v. administration. They have also been found to decrease recovery times because of the decreased amount of gas anaesthesia needed in conjunction with them (Lichtenberger & Lennox, 2009).

A study was made developing a method of spinal anaesthesia for abdominal and specifically reproductive organ surgery. The epidural is performed in a prepared clipped and sterile area between the first sacral and the last lumbar vertebrae. The guinea pigs remained completely anesthetized in the surgery area for 30-60 minutes. One complication resulted, a permanent paralysis of one hind limb in one of the 36 sows (Thomasson *et al.*, 1974). In this study, no mention is made of sedation of the patient to facilitate the placement of the epidural, but other authors recommend it (Lichtenberger & Lennox, 2009). See table 3 for recommended dosages for epidural analgesia according to Lichtenberger & Lennox, 2009.

Table 3. Epidural analgaesia

DRUG	DOSAGE - EPIDURAL	REFERENCES
Morphine	0.1 mg/kg with or without bupivacaine	Lichtenberger & Lennox, 2009
Bupivacaine 0,125%	0.1 mg/kg with or without morphine	
Lidocaine 1.5%	0.4 mg/kg	

2.4.6. Special considerations in anaesthesia of the pregnant animal

Care must be taken to reduce maternal stress as much as possible, because maternal stress leads to foetal stress. Dystocia is always stressful for the animal, but good analgesia, sufficient oxygenation and taking care to minimize body temperature loss are measures that nevertheless can be taken to improve maternal and thus foetal wellbeing. Short-acting, noncumulative anaesthetics that allow rapid recovery are the ideal. Rapid return to normality leads to better physiological homeostasis since the patient has had less time to deviate from normal parameters. Drugs that do not have cardio- or respiratory suppressant activity are preferred because as drugs diffuse through the placenta these will make resuscitation of the pups more difficult and may cause pups to be stillborn (Taylor, 1997).

Elective anaesthesia before parturition on a pregnant sow may cause brain damage to the foetuses, so the benefits should always be carefully weighed against the risks. Surprisingly, the duration of anaesthesia is not significant for the amount of damage it causes, but the stage of development of the foetuses is critical. If the development of the nervous system is at its peak when the sow is exposed to any of the common anaesthetic agents, the damage will be severe even with a short exposure, while a longer exposure later in development will not cause nearly as much damage (Rizzi *et al.,* 2007).

2.4.7. Fluid therapy

Intravenous or intraosseous route is preferred for rapid fluid replacement. The emergency rate is 5-10 ml/kg/hour of warmed isotonic fluid. Intravenous access can be challenging due to the small size of the animal, so an intraosseous catheter can also be placed in the proximal femur within the trochanteric fossa. A syringe pump is required for continuous infusion. Placement of catheter is done under regional analgesia or general anaesthesia.

Guinea pigs resent subcutaneous fluid administration, but it is still useful for slow fluid supplementation. Subcutaneous fluids can be given under the loose skin in the dorsal neck and back area. An estimated daily fluid requirement can be calculated as 10 ml/100g bodyweight/day. A volume of 30 ml/kg may be administered at a time using a 22 to 25-gauge butterfly catheter, and this is repeated 2-3 times in a day.

Intraperitoneal fluid administration carries the risk of organ puncture and is not generally recommended. If attempted, it should be done with warmed fluids due to the guinea pigs' sensitivity to hypothermia (Kondert & Mayer, 2017; Rowland, 2020; Quesenberry, 1994).

2.5. Caesarean section - procedure

The earlier the decision to perform a caesarean section is made, the better the chance of survival for the sow and the pups. If an ovariohysterectomy is performed at the same time, it must be remembered that the pups cannot survive the anoxia for more than a minute in the isolated uterus. The procedure itself is very much like that on other small animals. Because of the severe risks of surgery and anaesthesia, the prognosis is guarded to poor (Kondert & Mayer, 2017).

Place the patient in in dorsal recumbency but with an approximate tilt of 30°C to avoid the pregnant uterus pressing down on the aorta and compromising blood flow. It is also beneficial to elevate the head and chest to reduce the risk of aspiration and lessen the push of the abdominal contents on the diaphragm to ease the patients breathing. The surgical site being prepped and sterile, the patient anesthetized, and the incision line being infiltrated with local analgesic; proceed with a standard ventral midline incision starting caudal to the umbilicus and ending cranial to the pubis. Upon incision of the fascia of the linea alba, take care not to incise the fragile cecum and bladder that are usually located immediately beneath. In the pregnant animal the cecum may also have been pushed to the side by the uterus. The incision should be large enough to allow lifting out the pups and suturing the uterus or performing an ovariohysterectomy.

The uterus is wholly or partially exteriorized from the abdomen and packed off with sterile gauge or similar, to minimize contamination of peritoneum with uterine contents. An incision can then be made at the uterine body or the junction of a horn and the body. Care must be taken that the incision is not too deep to avoid damage to the pup inside. The first pup is withdrawn from the uterus and its amnion removed from the head and body. The umbilical cord is clamped about a centimetre from the abdominal wall and severed, avoiding any traction on it so as not to cause a hernia. The pup is handed to an assistant for rubbing dry and having its airways suctioned.

The other foetuses are gently pushed along to the uterine incision, where they are also removed. Occasionally a second incision in the other horn is needed to expel all foetuses after closure of the first incision.

Gentle traction should be used to remove each placenta, but if there is haemorrhage or excessive force seems to be needed, they should be left to be expelled later.

When the surgeon is positive that there are no more foetuses, the uterine incision is closed by use of inverting Lembert sutures of an absorbable suture material. Ensure that no small portions of placenta are left to compromise the wound edges. Remove all traces of blood from the surface of the uterus to prevent postoperative adhesion formation (Jackson, 2004).

Upon completion, closure of the abdominal wall is performed. It is generally made in two or three layers, linea alba and muscles, subcutaneous and subcuticular. The subcuticular closure method appears to cause the patient the least discomfort and they seem unaware of its presence. Never use visible skin sutures because rodents will inevitably shred them at first opportunity. Tissue adhesive is a better alternative, and pain control will also aid in making the patient leave the wound alone. Buprenorphine and meloxicam are recommended (Lichtenberger & Lennox, 2009).

Adverse reactions to suture material are common in guinea pigs after surgical procedures. They can vary in severity from mild local irritation to adhesions and abscessation. Suture materials that cause excessive local irritation and inflammation such as chromic gut should never be used in guinea pigs or other rodents.

Monofilament suture materials with hydrolytic degradation are preferred in rodent surgery, and suitable suture material sizes for guinea pigs are between 4-0, 5-0, 6-0, and 7-0. Cyanoacrylate tissue adhesive works reasonably well but is sometimes removed by the patient while grooming (Riggs, 2009).

2.5.1. Post-operative care and complications

The shorter the time under anaesthesia, the better the recovery. Monitoring does not stop in the operating room; monitor the patient in recovery until they are fully awake.

Multimodal analgesia is useful postoperatively, for example NSAIDs and opioids. Of the NSAIDs, COX-2-selective inhibitors seem to produce fewer side effects. These include carprofen, etodolac, meloxicam, and deracoxib (Lester *et al.*, 2012).

Guinea pigs are inconveniently agile considering post-surgical care and like all rodents, prone to pruning sutures. Elizabethan collars are impractical due to increasing stress and preventing caecotrophy. Careful intradermal suture technique should be used at wound closure with the possible addition of tissue cement.

Pain assessment post-operatively can be challenging due to prey animals such as guinea pigs hiding their pain and weakness. Behaviours that can be observed that indicate pain are aggressiveness, depression, hiding alone, rough coat due to less self-grooming and anorexia.

Some preparation can help to reduce complications, for example have the owner bring in a companion guinea pig with the patient that will be there pre- and post-operatively. To avoid anorexia, also have the owner bring food that they normally eat to get the patient eating as soon as possible after the operation. Upon release back home, advise the owner to weigh the guinea pig every day for at least a week. This way anorexia can be spotted and treated as early as possible.

Ileus is a common and severe post-operative complication. Firstly, reassess the plan for controlling post-operative pain to rule out pain as a contributing factor to ileus and anorexia. Daily crystalline subcutaneous or intravenous crystalline fluids are indicated, as well as palatable food to the anorexic guinea pig. If it still does not eat, force feeding finely ground high-fibre food with a syringe about every 3 hours may be necessary to keep the caecal motility up and flora balanced. Any anorexic guinea pig should be given parenteral vitamin C and as long as no blockage is present, metoclopramide can be beneficial to stimulate gastric motility (Hawkins & Pascoe, 2012; Lester *et al.*, 2012). Another motility enhancing drug combination that can be tried is cisapride (0.5 mg/kg PO q8h) and ranitidine (0.5 mg/kg IV q24h) (Liechtenberg & Lennox, 2009).

2.6. Drugs and dosages

Painkillers

A multimodal approach to pain control is advocated, and a combination of opiate and NSAID is often used. NSAID are administered directly before post-operative recovery for analgesia and to act as an anti-inflammatory to reduce adhesion formation.

Morphine, as the opiate with the most diverse receptor binding, should be used with caution in guinea pigs because it is the opiate most likely to produce GI-side effects, including ileus (Lester *et al.*, 2012; Clemons & Seeman, 2018). See table 4 for recommended dosages for NSAIDs and pain relievers according to Kondert & Mayer, 2017 and Lichtenberger & Lennox, 2009.

Table 4. Painkillers and anti-inflammatories

DRUG	DOSAGE & ROUTE	CAUTION	REFERENCE
Buprenorphine	0.01-0.05 mg/kg SC IM IV q6-12h	Do not combine with butorphanol, antagonistic	Kondert & Mayer, 2017
Meloxicam	0.2-1 mg/kg PO SC q24-48h	GI adverse effects	Kondert & Mayer, 2017
Carprofen	4 mg/kg PO q24h		Lichtenberger & Lennox, 2009
Tramadol	Post-op: 10 mg/kg PO q24h		Lichtenberger & Lennox, 2009

Antibiotics

Guinea pigs are, like other hind-gut fermenters, very sensitive to antibiotics. The caecal flora is composed of gram-positive bacteria and use of any antibiotic effective against gram positives will wipe it out. This results in clostridial overgrowth or enterotoxaemia from other gram negative or anaerobic bacterial

overgrowth. **Unsafe** to use are penicillins (e.g. amoxicillin, ampicillin), macrolides (e.g. lincomycin, clindamycin, vancomycin, erythromycin, tylosin), first generation cephalosporines (e.g. cephalexine) and tetracyclines. Even cutaneous use may be toxic in some cases (Quesenberry & Donnelly, 2019).

The **best choices** for antibiotics include trimethoprim-sulfamethoxazole, chloramphenicol, and enrofloxacin. See table 5 for antibiotics and dosages recommended for guinea pigs. Local recommendations on the use of antibiotics should be adhered to, for example, enrofloxacin is often not a first-choice substance.

Ototoxicity occurs with gentamicin, neomycin, and polymyxin B topicals. All guinea pigs receiving any antibiotic treatment should ideally be given live bacterial culture supplements. If diarrhoea or other signs of digestive upset appear, antibiotic treatment is discontinued. A mixture of water and faeces from a healthy guinea pig may be beneficial to administer with the intention of re-establishing a normal bacterial flora (Sorensen, 2012).

Table 5. Antibiotics recommended for guinea pigs

DRUG	DOSAGE & ROUTE	CAUTION	REFERENCE
Trimethoprim - sulfamethoxazole	15-30 mg/kg PO, SC q12h		Morrisey & Carpenter 2012
Chloramphenicol	30-50 mg/kg PO, SC, IM q8-12h		Morrisey & Carpenter 2012
Enrofloxacin	5-20 mg/kg PO, SC, IM q12h		Morrisey & Carpenter 2012
Metronidazole	25 mg/kg PO q12h		Sorensen 2012

3. Second section: Survey results in the Nordic countries

3.1. Materials and methods

A survey (appendix 1) about guinea pig dystocia was sent to veterinarians and breeders in Finland, Norway, and Denmark. It was sent by email to veterinarians and veterinary clinics that advertised specialization in exotics and to breeders that were part of the local guinea pig associations.

A link to the survey was also posted on Facebook in veterinary groups and groups for guinea pig enthusiasts to reach as broad a base of participants as possible.

The number of participants (see table 6) was reasonable, with the most eager participation in Finland. This can partly be explained by Finland being the only country receiving the survey in the native language. Veterinarians and breeders in Norway and Denmark were given the option to complete the survey in Swedish or English.

Table 6. Number of respondents

Respondents:	Finland	Sweden	Norway	Denmark	**Total**
Veterinarians	60	33	17	11	**121**
Breeders	32	44	17	43	**136**

3.1.1. Survey answers by veterinarians

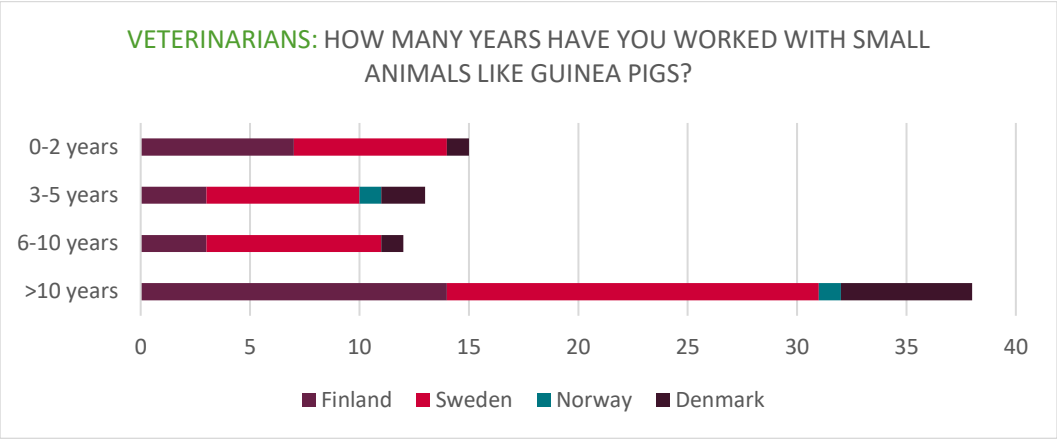

Figure 4. Veterinarians: Number of years veterinarians in the survey had worked with small pets like guinea pigs.

Most veterinarians that answered the survey have more than 10 years of experience of guinea pigs (Fig 4).

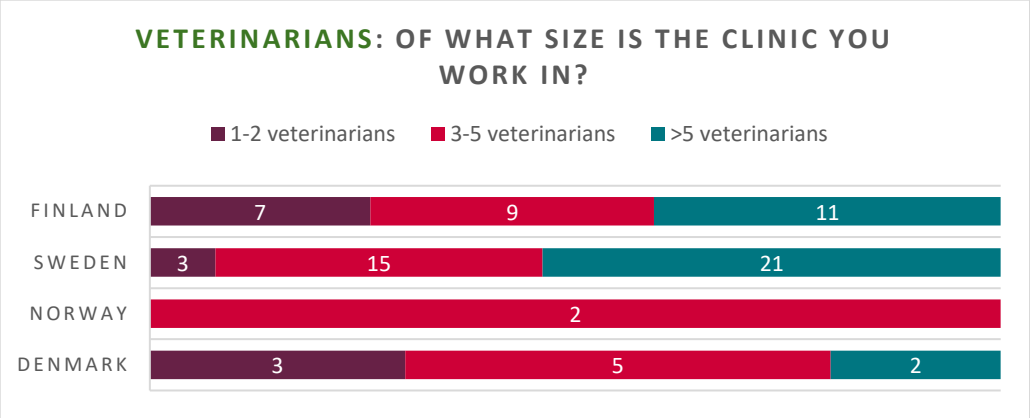

Figure 5. Veterinarians: The size of the clinic (number of employed veterinarians) where the respondents worked.

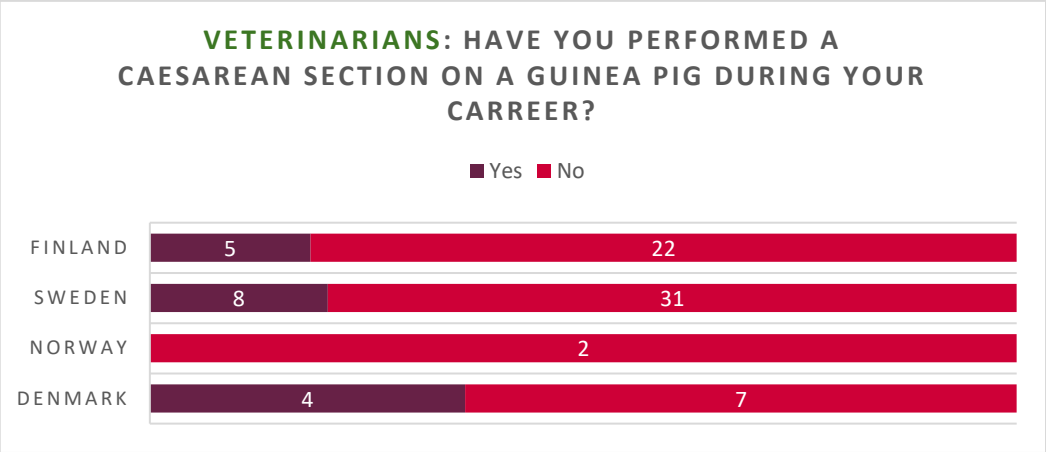

Figure 6. Veterinarians: Number of respondents who had performed a caesarean section on a guinea pig during their career.

A majority of the respondents work in a larger clinic, and 78% have never performed a caesarean section on a guinea pig (Figs 5 and 6).

Most of the 25 veterinarians who have performed a caesarean section had only done it once at 64% (n=16). Twenty-four percent had done it twice. One respondent in Finland has done it 5 times. One respondent in Sweden wrote that he or she had done it 10-20 times.

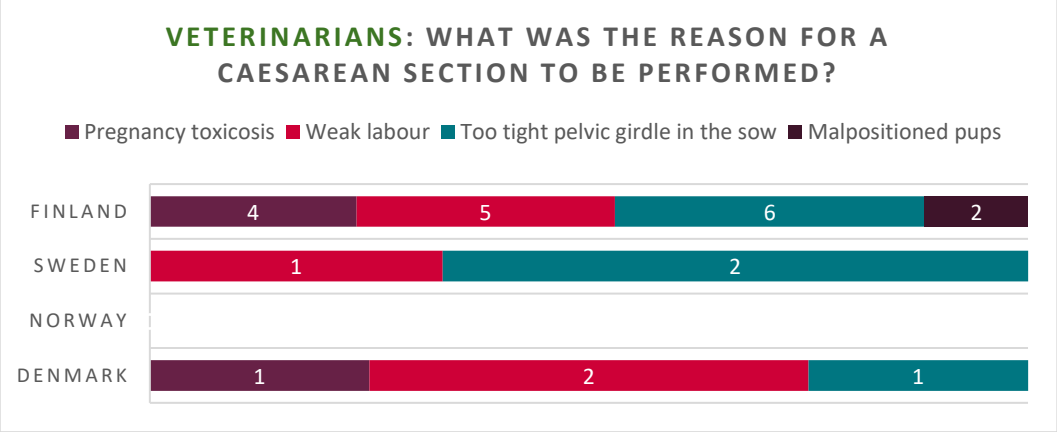

Figure 7. Veterinarians: The reasons why caesarean sections had been performed.

No answer was clearly more frequent than the others were when veterinarians were asked for the indication for performing a caesarean section (Fig 7). At 37.5%, too tight pelvic girdle was the most often chosen option. Weak labour was the indication in 33% of the cases and pregnancy toxicosis in 21% of cases. Pups with malpresentation were the indication in 8% of the sows needing the operation.

In the comments, one Finnish veterinarian gave the reason that the pregnancy had lasted over 76 days. Another wrote that the sow had been in labour for more than 24 hours. Swedish veterinarians who have also answered with a comment have

had two instances of too big pups and one instance of the sow becoming anorexic and the pups being dead.

Sow survival in cases where caesarean section was performed was surveyed among veterinarians. The most responses came from Finnish veterinarians, where the survival rate for the sow was 50% (n=5). None had died during the operation, but the first day post-surgery had been fatal for 60% (n=3) of the ones that did not make it and the remaining 40% had died at 2-5 days (n=1) respective more than 5 days (n=1) after the operation. Some Swedish veterinarians have had all sows survive; one respondent estimated survival frequency to 50%.

The results varied concerning **pup survival**. One Norwegian veterinarian responded that all pups had survived. Eight Finnish veterinarians answered that all or some of the pups had survived in 30% of the operations, in 70% none of them had survived. Of the Swedish veterinarians that answered the question, one replied that all pups had survived and two others that some pups had survived.

Anaesthesia protocol and type of supportive therapy was added as a new question for my survey, compared to the one previously conducted by Stolzenberg in Sweden. Because of this there are only answers from veterinarians in Finland, Norway, and Denmark, not from Sweden.

Many veterinarians did not answer what their anaesthesia protocol was because they did not have the data at hand or did not remember, but five did give answers. One veterinarian in Denmark anesthetised the sow with sevoflurane approximately ½ hour and the supportive therapy consisted of subcutaneous fluid and warmth. Other veterinarians have operated with xylazine and medetomidine coupled with local anaesthetic. Two veterinarians from Norway favoured a protocol consisting of dexdetomidine, butorphanol and ketamine, with meloxicam as a painkiller.

All supportive therapy protocols consisted of warmth, but some added oxygen and some gave subcutaneous fluids. Some veterinarians gave all three.

The veterinarians were also asked if they had **treated dystocia in guinea pigs in any other way than caesarean section**. Manipulation vaginally has been successful for a few veterinarians. Oxytocin, sometimes coupled with calcium has also been used to effect in a few cases. One veterinarian mentions that they favour sterilizing the sow instead of performing a caesarean section, but also opts for euthanasia if the condition of the sow is too bad.

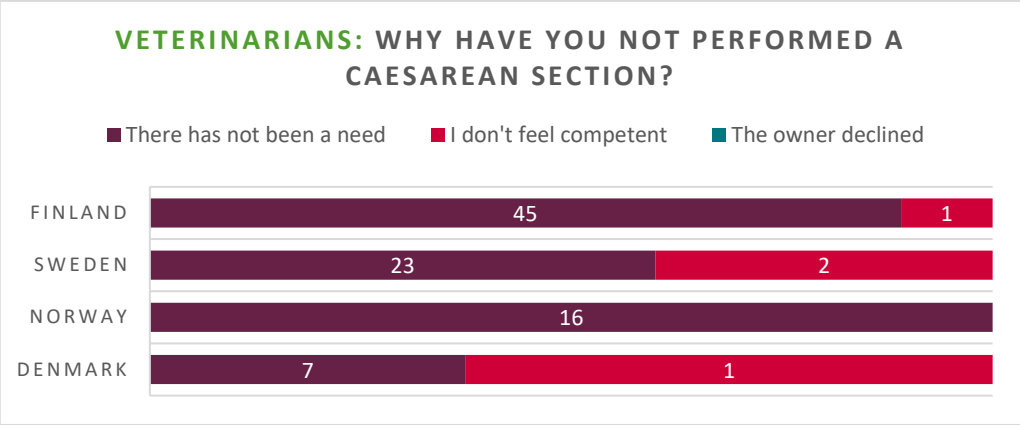

Figure 8. Veterinarians: The reason why veterinarians had not performed a caesarean section.

The reasons veterinarians gave for not performing a caesarean section were mostly that there has not been any need (Fig 8). When there has been a need, it has been during on-call time according to a Danish veterinarian. One Norwegian veterinarian wrote the owners were not willing to pay. A Finnish veterinarian responded that they rather choose to sterilize the sow to avoid the problem.

Additional comments concerning the general subject of guinea pig dystocia from many veterinarians were that they had never needed to treat dystocia in guinea pigs despite long careers as general practise veterinarians. Some of them wrote that they were pleased to treat guinea pigs and would do a caesarean section if the need ever would occur. Others stated that they seldom or never treated guinea pigs. Some veterinarians have successfully treated sows with dystocia using other means than surgery.

The price of a cesarean section during normal working hours and assuming no complications arise was estimated by a number of veterinarians in the various countries. Because the currencies are not the same, all prices are converted to Swedish kronas (SEK).

The breeders were also asked to give an estimate of how much they were willing to pay for a cesarean section. Those who responded have also been added to the graph.

In total 58 veterinarians and 84 breeders answered the question and the result can be seen in Figure 9.

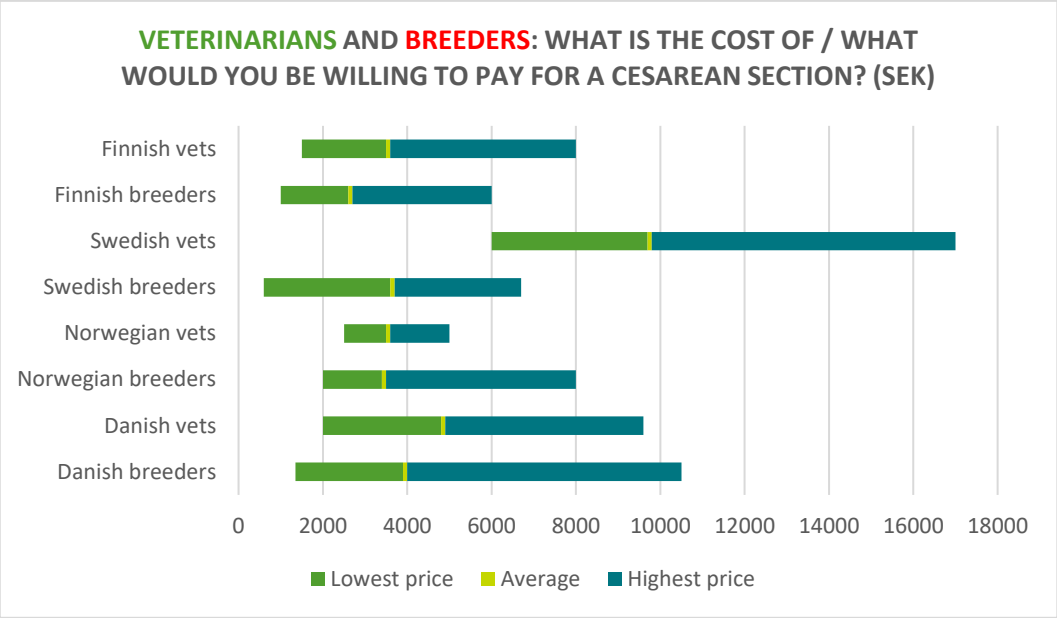

Figure 9. Veterinarians: The cost of a caesarean section according to veterinarians and the price breeders were willing to pay for a caesarean section.

In all of the countries surveyed, the average price breeders were willing to pay (2600-3900 SEK) for a cesarean section was lower than the average price given by the veterinarians (3500-9700 SEK). This aberrance was especially marked in Sweden, where the average price the breeders were willing to pay (3600 SEK) did not even match the lowest price given by the veterinarians (6000 SEK). The average price given by Swedish veterinarians (9700 SEK) was more than double the price most Swedish breeders were willing to pay. In the other countries the prices overlapped reasonably.

One Swedish and one Danish breeder are omitted from the graph because he or she answered 25000 SEK respective 100000 DKK, which shows admirable dedication to the health of their guinea pigs but was so far from the other values that it changed the mean value unreasonably.

Among the breeders of every country there were also several who answered with some variation of “Whatever it costs, because they are my responsibility”. Some also responded that cost did not matter because their guinea pigs were insured.

Note that the prices given were for normal working hours, not on-call hours. It can be presumed that the price quoted by veterinarians will significantly increase during on-call hours, while the price breeders are willing to pay will not increase proportionally.

3.1.2. Survey answers by breeders:

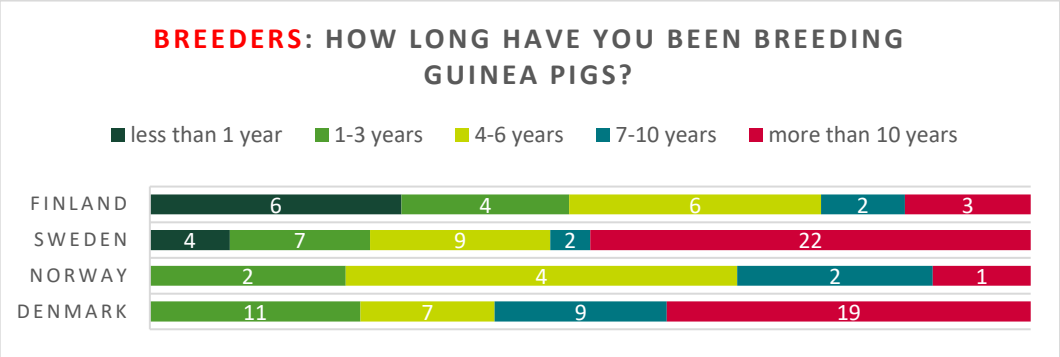

Figure 10. Breeders: How long (years) the breeder-respondents has been breeding guinea pigs.

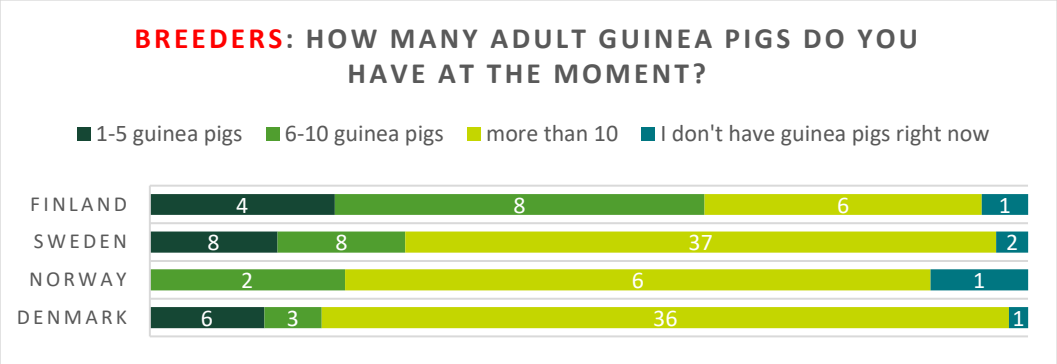

Figure 11. Breeders: Number of adult guinea pigs owned by the breeders at the time of the survey.

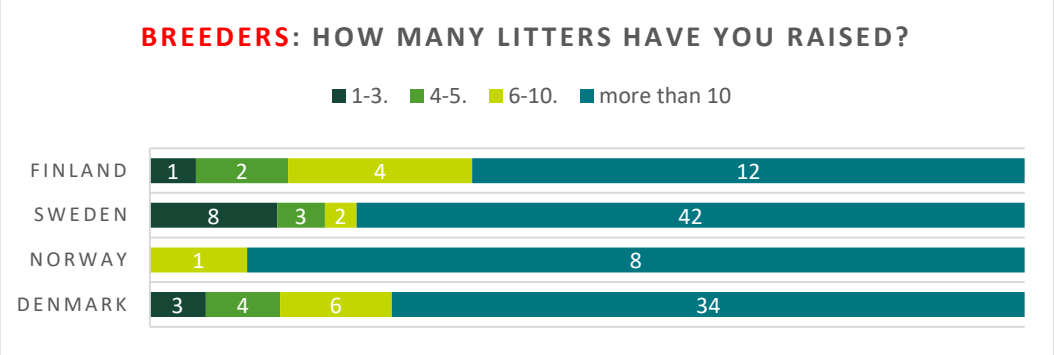

Figure 12. Breeders: Number of litters raised by the respondents.

The breeders who answered the survey seem to be very experienced and active. The majority (37.5% n=45) have bred guinea pigs more than 10 years, although Finland and Norway have many newer breeders as well (Fig 10). The overwhelming majority also own many guinea pigs, 66% (n=85) having more than 10 adult guinea pigs (Fig 11). Therefore, it comes as no surprise that when asked how many litters a breeder has raised more than 10 litters is the most common answer, given by 74% (n=96) (Fig 12).

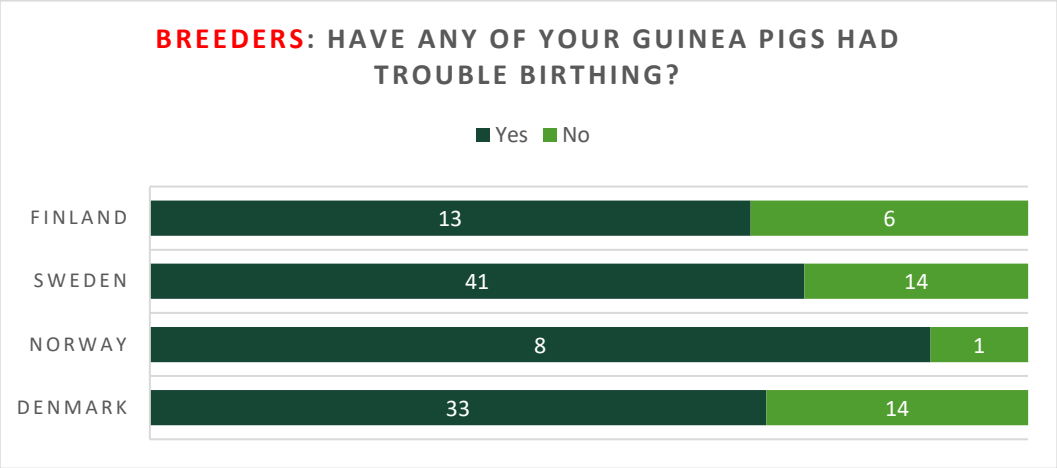

Figure 13. Breeders: Number of guinea pigs, which had trouble giving birth at each breeder.

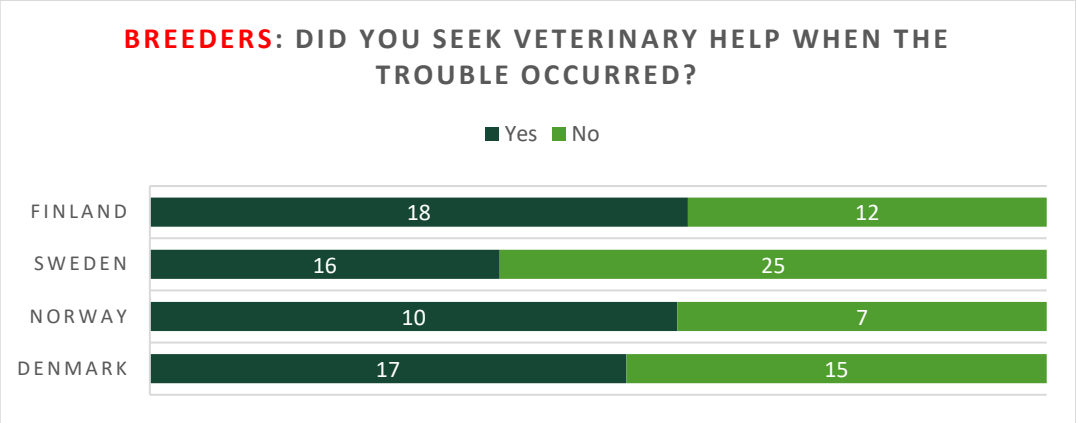

Figure 14. Breeders: Number of breeders who did not seek veterinary help when birthing trouble occurred.

Seventy-three percent (n=95) of breeders have had some kind of trouble with their guinea pigs birthing (Fig 13). Fifty-one percent (n=61) sought veterinary help when this happened (Fig 14). A slightly larger portion of breeders sought help in Sweden, 61% (n=25).

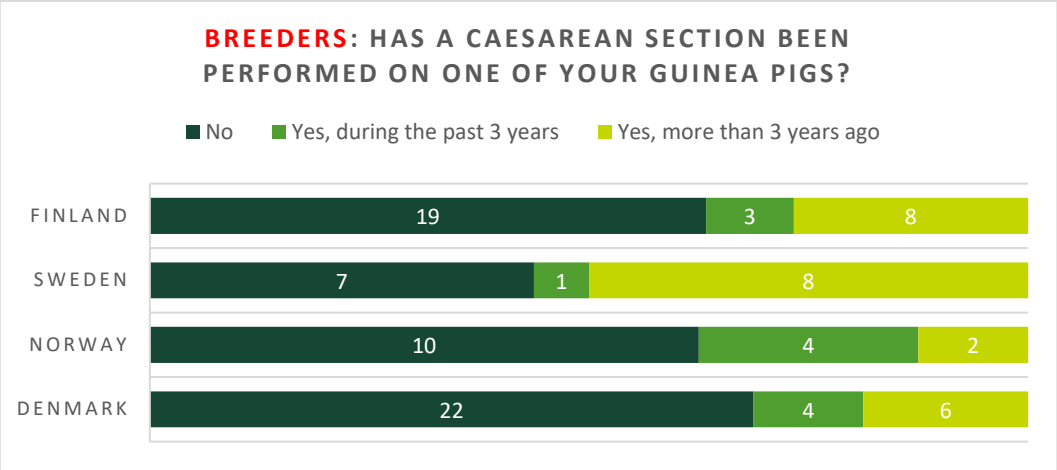

Figure 15. Breeders: Number of caesarean sections performed on each breeder's guinea pigs during the last 3 years, more than 3 years ago and if no caesarean sections had been performed at all.

Of the 94 breeders that answered the question, 61% (n=58) had never had a caesarean section performed on one of their sows. Thirteen percent (n=12) had had one performed during the last 3 years and the remaining 26% (n=24) longer ago than that (Fig 15).

The respondents whose sow had had a caesarean section were asked for the age of the sow in question. Thirty-one breeders in total responded. Over half (55%) of the sows were 7-12 months of age. Sixteen percent were 1.5 years and 29% were 2 years.

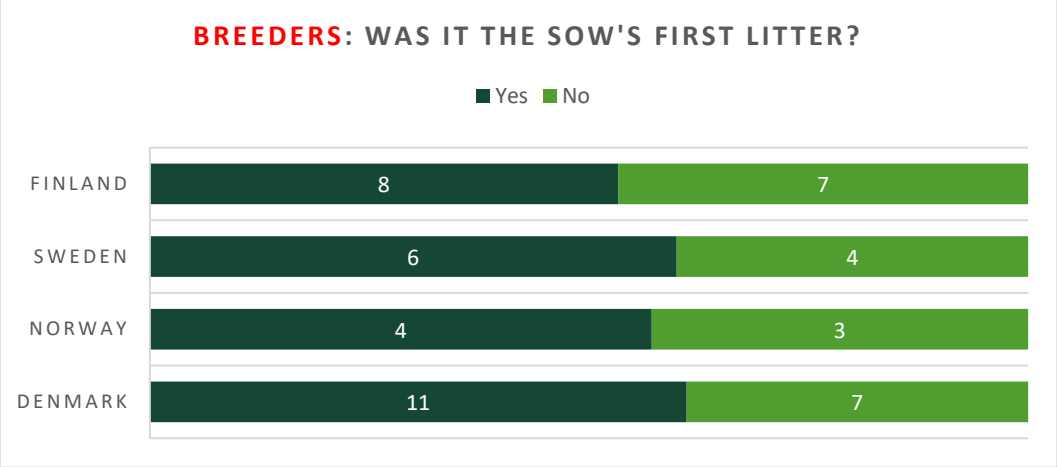

Figure 16. Breeders: If the breeders' sows in which caesarean section had been performed were primiparous or not.

Only 58% of the sows that needed a caesarean section were primiparous. The rest had previously had at least one litter (Fig 16). This implies that the risk for complications drops after the first litter but is still present. The causes for

complications may differ depending on litter number, because the causes are numerous as can be seen in the next diagram (Fig 17).

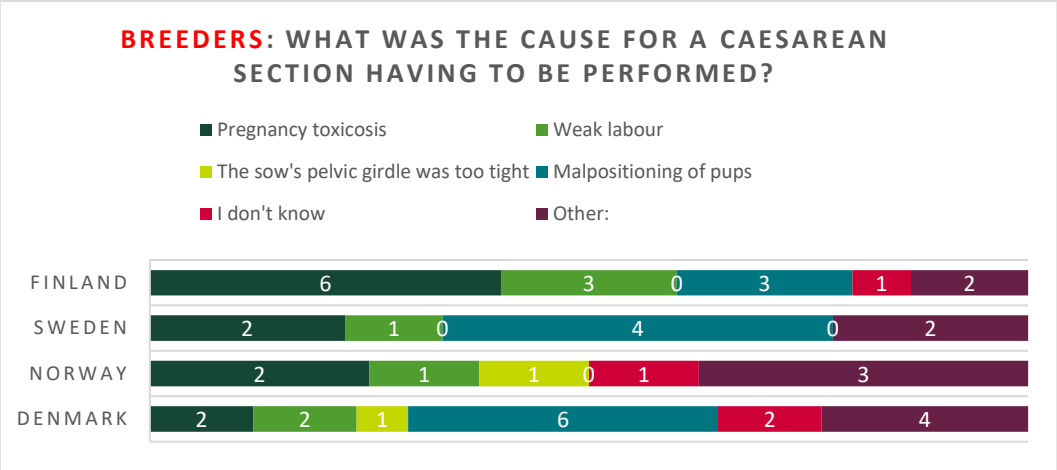

Figure 17. Breeders: The cause for a caesarean section having to be performed according to the breeders.

Reasons for performing a caesarean section according to the breeders are very varied as can be seen in Figure 17. The most common reason according to the survey was malpresentation of the pups at 26%. The second most common reason was pregnancy toxicosis at 24%. The third most common was weakness of labour at 14%, which is also indicated in one of the replies in the category “other” as “gave birth after oxytocin”.

A notable result was that very few of the respondents gave the reason tightness of the pelvic girdle, since that is the most widely studied reason for dystocia in guinea pigs. Some breeders however gave the reason that the pup was too large, which could apply as tight pelvic girdle.

Interestingly, two of the breeders also replied that the first pup was born normally but the rest were born by caesarean section. Here the pups born normally had survived but not those born by section in both cases.

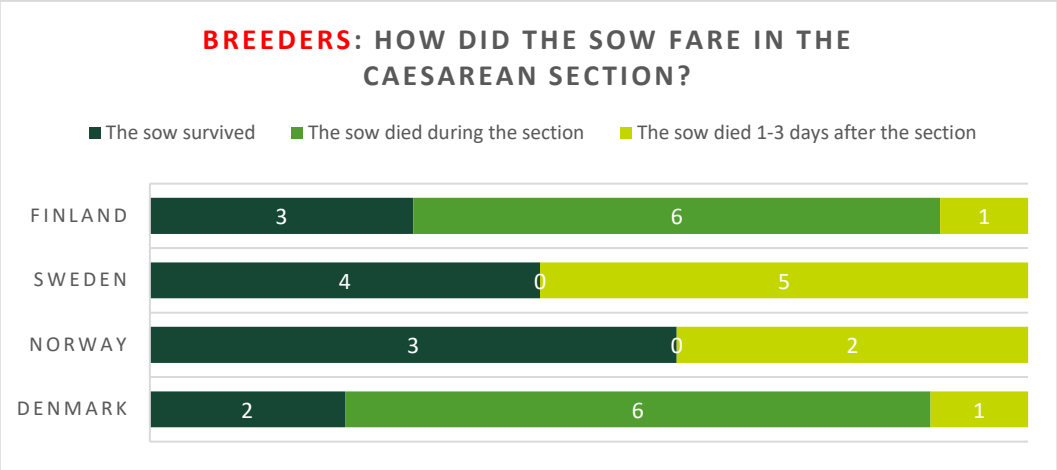

Figure 18. Breeders: Sow survival in connection to caesarean section; survived, died during the surgery or 1-3 days later.

Only 36% of the 33 sows that underwent a caesarean section survived (Figure 18). In Finland and Denmark, most casualties according to the breeders were during the operation, which contrasts with Sweden and Norway where the casualties were exclusively 1-3 days after the operation. This result is somewhat surprising when compared to the results from a similar question to the veterinarians, where no deaths during the operation was reported.

When combining the breeders' answers with the veterinarians the survival rate for the sow is 40%.

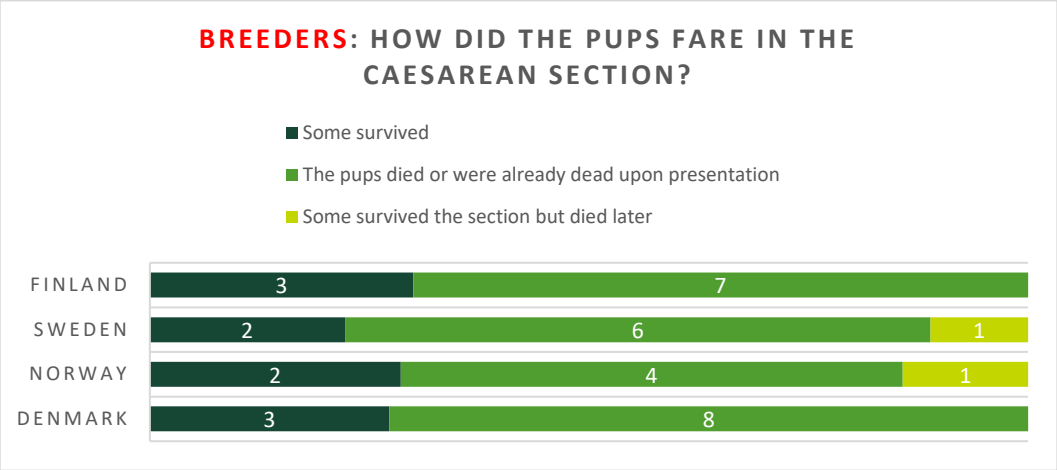

Figure 19. Breeders: Pups survival in connection to caesarean section; some survived, dead before or died at surgery or some survived the section but died later.

According to breeders, all or some pups survived in 23% of caesarean sections. In the remaining 77% of instances the pups were dead or died soon after (Figure 19).

Combined with the veterinarians' numbers, pup survival would be 29%.

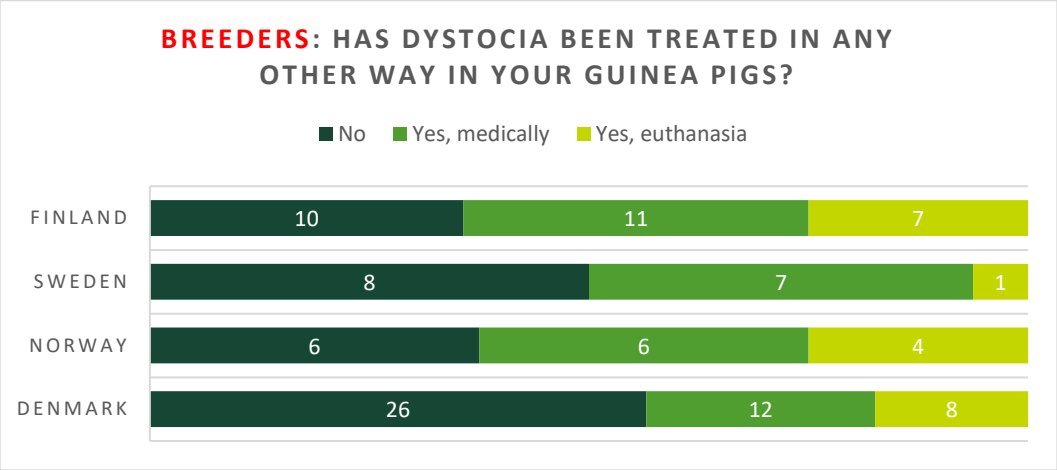

Figure 20. Breeders: Number of breeders whose guinea pigs' dystocia been treated in other way than by caesarean section: medically, euthanasia or not treated in other ways.

A fair portion of the sows have also been treated medically as Figure 20 shows. It was possible for the respondents to comment this question. The medical treatment has been in the form of oxytocin or injections of calcium, sometimes combined. One guinea pig has just received supportive fluids. Some also commented that manual help had been needed to deliver a pup.

Those who have answered euthanasia have either taken the sow to the veterinarian but euthanized in the face of a poor prognosis or done it at home in an emergency situation.

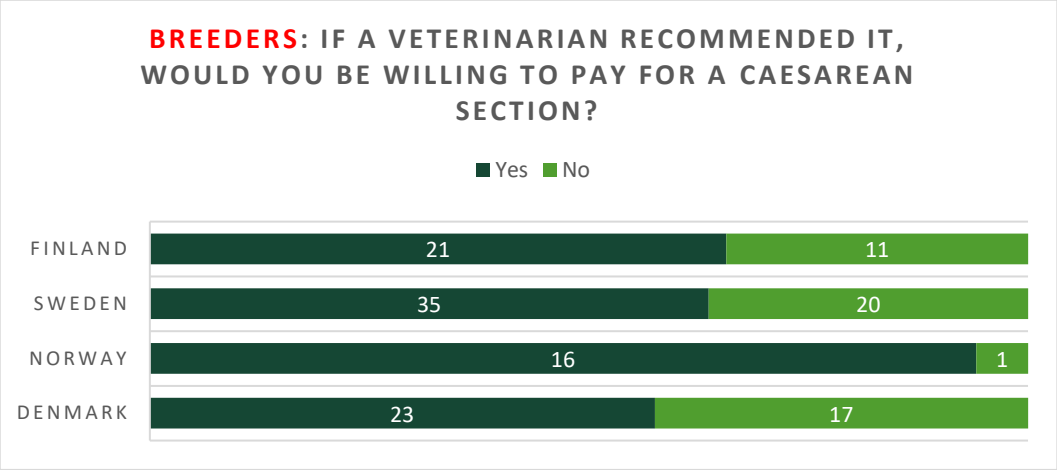

Figure 21. Breeders: Number of breeders who were or were not willing to pay for a caesarean section if it was recommended by a veterinarian.

At 66%, most respondents would be willing to pay for a caesarean section if recommended by their veterinarian (Fig 21).

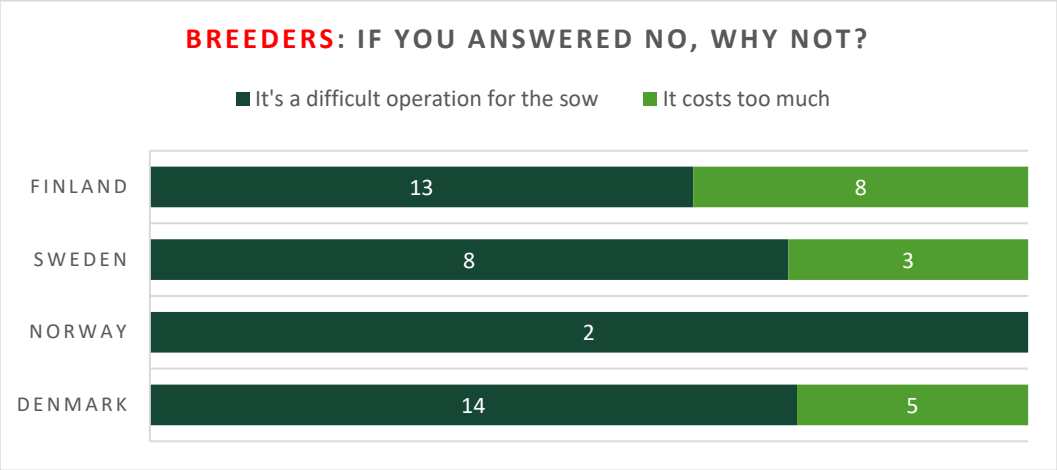

Figure 22. Breeders: Reasons stated by breeders for not being willing to pay for a caesarean section when recommended by a veterinarian; difficult operation for the sow or too expensive.

The breeders that were unwilling to have a caesarean section performed on their sow were asked for the reason (Fig 22). Approximately 70% of the breeders who answered no, declined because they thought the operation would be too tough for the sow. Comments also indicate this as breeders commented that the condition of the sow was the determinant factor. If she was in good condition, they might consider it, but otherwise they would opt for euthanasia. Some also mention that they have heard that the sow does not survive that often and that the pups are often dead.

One Danish breeder replied that they live so far from veterinarians knowledgeable in guinea pigs that transporting the sow to a veterinarian willing to do the operation would constitute unnecessary suffering for the sow and the delay would considerably reduce her chances of survival. A Finnish breeder is on the same track, saying that veterinarians who are familiar with the procedure are not usually available during evenings, nights, and weekends.

Breeders were also asked what measures they undertake to **avoid birthing problems** (Fig 23). Because of the wealth of responses, I have divided them into themes.

Swedish responses are omitted from the diagram because the survey made in Sweden did not allow for exact numbers, but the measures that the Swedish guinea pig breeders mentioned is included in the text part about each theme.

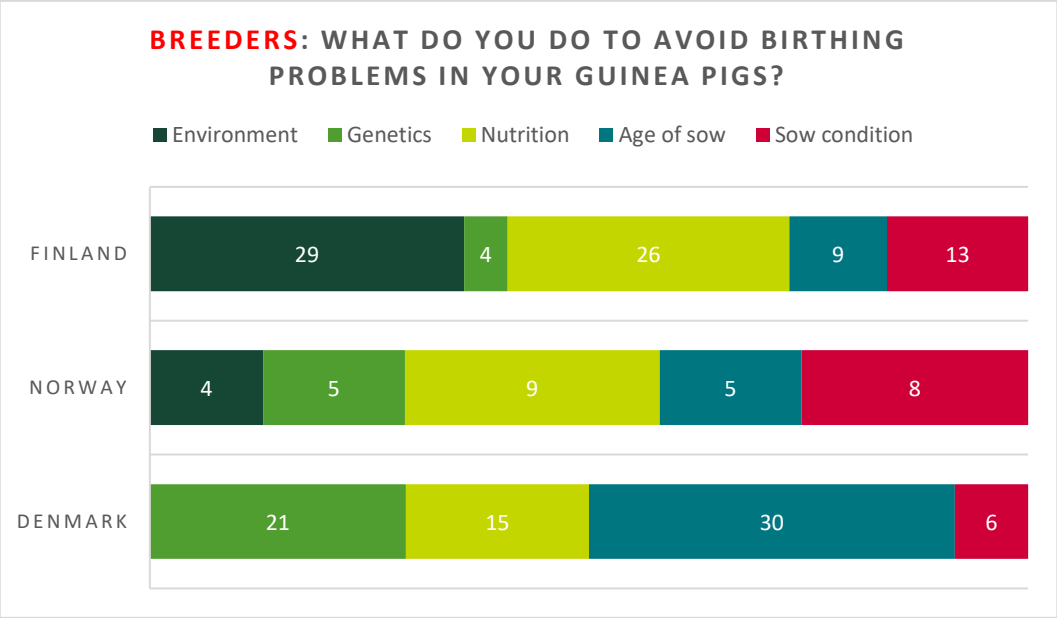

Figure 23. Breeders: Measures taken by breeders to avoid birthing problems in their guinea pigs; environment, genetics, nutrition, age, and condition.

Environment was an important factor for many of the breeders, especially in Finland. Danish breeders did not mention it but there may have been a technical problem with the survey. Most breeders that considered environment important wrote that they make sure to create as stress-free an environment as possible for the sow. Also, sows should not experience any changes in their routine during this time.

This meant that the environment should be quiet, and the sow should be housed with a companion or in a solitary enclosure, whichever seemed to suit the sow best. One breeder mentioned that they would not allow visitors in the piggery the last few weeks of the pregnancy.

Many breeders from all the surveyed countries also commented that they avoided all unnecessary handling of the pregnant sows

Ambient temperature was mentioned as a consideration by several breeders in Finland. They commented that the piggery should be kept cool, between 15-17 degrees Celsius.

Another consideration mentioned by many breeders was the importance of the enclosure being big enough to allow for movement, one favoured at least 5 m length of enclosure to encourage proper movement. On this theme, a Finnish breeder also commented that the sow should have activating elements in her enclosure to encourage movement and stave off boredom.

Genetics was also an important consideration. The most often mentioned requirement was that the sow did not come from lines that had had birthing difficulties. Several breeders stressed that only sows of even and calm temperament should be bred. One breeder responded that they avoid breeding guinea pigs with wider heads to other wide headed ones. One breeder stated that they were careful

not to breed sows that come from lines that tended to give few pups, as pregnancy carrying just one pup may result in too large size of the pup giving birthing problems. A couple of other breeders favoured guinea pigs which gave smaller litters, less than 5 pups because in their experience there was a decreased survival of sow and pups in pregnancies with a larger litter. One Finnish breeder would not breed sows that were easy keepers, gaining weight on very little feed.

The cornerstone of good **nutrition** is agreed to be good quality hay by most respondents. Many also stressed the importance of not overfeeding during pregnancy, the sow should not be fattened. Several breeders connected this, along with insufficient exercise, with increasing risk of pregnancy toxicosis.

Feeding extra vitamin C was mentioned by several breeders in each country. A few also recommended giving extra calcium during pregnancy.

More than one breeder commented that they would never give carrots to a pregnant sow as they are considered fattening.

One breeder made sure to give the sow her favourite foods during the last weeks of pregnancy to keep her eating enough as capacity for feed intake is reduced by the space-occupying uterus.

One Swedish breeder always gave banana before parturition to give the sow an energy-boost.

Age of the sow when bred for the first time was also an important consideration. The vast majority preferred to introduce the sow to the boar at 7-12 months of age. Several also commented that they do it before the sow is 1.5 years old. A few would consider breeding her up to two years of age. The opinions on this were very uniform throughout the surveyed countries. If the sow would not get pregnant, it was not bred again.

Sow condition is the last, but not least important point that came up. A vast majority of breeders were careful not to breed a fat sow. Upper weight limits were given, and most were around 1000 g. An ideal weight of 650-700 g was preferred by one breeder. The sow should also be in good general condition. Some also mentioned they would not breed a sow that was too small.

Also mentioned by several Swedish breeders was that there should not be too long or short a time period between litters in one sow. A few others also commented that they avoided breeding a sow more than three times.

Comments that were hard to classify were also given. Many of the breeders mentioned the importance of keeping track of the breeding date to better be able to anticipate the parturition and thus keep an extra eye on how the sow was doing. Monitoring both behaviour and appetite was mentioned by a Swedish breeder. One Finnish breeder recommended a surveillance camera to be able to observe without stressing the sow during birthing.

One breeder would, in case there was a change in behaviour, monitor the pH of the urine of a sow in late pregnancy with measuring strips, and if there was a drop in pH, they would suspect beginning pregnancy toxicosis.

One breeder mentioned giving oxytocin immediately when it looks like there may be problems (respondent possibly veterinarian as at least three Finnish veterinarians responded as breeders).

Some commented that they took no special measures to avoid birthing problems. One Swedish breeder thought it important that they could consult with a more experienced breeder in case trouble arose.

Another breeder commented that they did not have very good experiences with veterinary expertise about guinea pigs in on-call hours, and particularly called for more knowledge of guinea pig anaesthesia.

The breeders that live too far from a veterinarian consider home euthanasia preferable to long transportation to a veterinarian because of the worsening prognosis and animal welfare considerations by the time delay before getting treatment.

One breeder wants to stress that she has only had good experiences from caesarean sections, two of their sows had undergone it and both the sows and their pups survived and thrived.

One experienced Danish breeder of about 400 litters believed if they cannot get the pups out, neither can the veterinarian.

Two experienced breeders who had had 150 and 300 litters each answered in length. One sow with one of the breeders had undergone a caesarean section. Only a few cases of pregnancy toxicosis had occurred. One of the breeders believes these were caused by too high ambient temperature and keeping the sow in a small enclosure. The enclosure size has also been linked to pregnancy toxicosis by the other breeder. One has had a few litters where the pups were born dead, and they believe that this had been caused by too large pups delaying the birthing process too much for the pups to survive.

These two breeders also stress the importance of not breeding sows that are too fat and the importance of good nutrition, both in quality and quantity. The sows bred should be of even temperament and not prone to stress. They also should produce more than a single pup to keep birth weight reasonable. It is also recommended to record the breeding date to be able to prepare for the birth and monitor the sows closely when the time comes.

3.2. Discussion

The number of veterinarians and breeders participating in this study varied greatly from country to country, but I feel that overall response tendencies were similar in all countries included, making the responses representative. Some results can be skewed because persons who have experienced guinea pig dystocia may be more motivated to answer than those that have not, but this is difficult to prevent. This skewing may cause for example that the prevalence of dystocia found in this study may not reflect that of the entire population of domestic guinea pigs.

The prevalence of dystocia in guinea pigs in the Nordic countries seems to be as the literature review suggests. Most breeders had experienced it, but veterinary help had only been sought in half of those cases. Even fewer had had a caesarean section performed on their sows. Consequently, only 22% of the responding veterinarians had ever performed a caesarean section on a guinea pig, despite long careers.

The risks associated with anaesthesia of a guinea pig were high according to the literature review, with the mortality rate being 30-fold to that of dogs and cats. This was not evident in the survey results, where none of the veterinarian respondents reported having had a sow die during a caesarean section. This may be because of small sample size or judicious choice of surgical candidates by veterinarians. Breeders however reported 57% of sow mortalities in connection to caesarean section to have happened during the operation and the remaining 43% to have happened 1-3 days post-operation. Mortalities during a caesarean section may have many causes, detailing which were outside the scope of this study, but the discrepancy in answers by veterinarians and breeders is still notable.

There was a similar discrepancy in the total survival rates from caesarean section reported where only 36% sow survival and 23% pup survival respectively were reported by breeders. Veterinarians reported slightly better survival rates, 50% sow survival and 30% pup survival. As a practising veterinarian however, I would think that the breeders may present more accurate figures concerning long-term survival, as veterinarians are regrettably often too busy for extensive follow-up of all their patients and may be unaware of later developments.

Few veterinarians are very experienced in guinea pig anaesthesia and caesarean section and there are not always fellow veterinarians available to consult in on-call hours when these cases generally are presented. Very few of the veterinarians, although having treated guinea pig for other ailments, had performed more than one caesarean section. Low patient number presenting with dystocia makes difficult to become experienced.

This may lead to the second factor contributing high rates of mortality due to dystocia. The breeders may not bring their sows to a veterinarian until they have tried everything they can at home because of the poor prognosis and distrust in getting optimal treatment. Late presentation worsens the odds for successful outcome, as in any other medical emergency.

Thus, there was a much higher portion of breeders having experienced birthing difficulties in their sows compared with the willingness to treat them. The majority of breeders have had such experiences, but only about half of those were ready to take their sows to the veterinarian. Breeders were in general leery to seek veterinary help and particularly to have a caesarean section performed on their sows due to perceived veterinary inexperience, poor prognosis and sometimes cost.

Concerning the cost of performing a caesarean section on a guinea pig, there was mostly reasonable overlap in the price indicated by the veterinarians and the price breeders were willing to pay. Sweden was a notable exception, where the average price considered reasonable by breeders did not even approximate the lowest price given by veterinarians. The difference may be that the insurance rate of guinea pigs is much higher in Sweden than in the other countries and thus the owners may subjectively feel they pay less as insurance would cover most of the costs. In hindsight, I should have added a question about whether the guinea pigs were insured. This makes a notable difference in treatment costs for the owners and could also influence willingness to treat. Another factor influencing willingness to treat can be the low value of the individual animal. Even if guinea pigs are loved pets and individuals have high emotional value for their owners, the monetary value of an individual guinea pig may be less than the cost of treatment. This is inevitably a factor that professional breeders must take into consideration, though it is always a difficult decision.

Many of the strategies employed by breeders to prevent dystocia were found to be in accordance with research evidence in the literature review. Breeders recognize that age and weight of the sow are important factors, though the age span for breeding primiparous sows is broader than the recommendations in literature. Selective breeding for stress tolerant animals is also validated. The connection of nutrition and obesity to pregnancy ketosis also seems well understood by breeders.

Studies on the frequency of the different types of dystocia were not found and therefore not included in the literature review. Due to the multitude of studies focusing on failure of widening of the pubic symphysis, it was expected to cause most of the cases of dystocia but the indications for surgery reported by both veterinarians and breeders in this survey do not wholly support this. Possibly, this was due to multiple types of obstructive dystocia pubic symphysis-widening failure could have been the root cause of, but since for example large pups can cause obstructive dystocia despite correct pubic symphysis widening, it remains ambiguous. The varying ages that dystocia has occurred at and 40% of the sows not being primiparous also points to other causes being prevalent. The reason for the multitude of studies concentrating on pubic symphysis widening may be, as often is the case with studies on guinea pigs that they were made for the benefit of human medicine.

3.3. Conclusion

Surveys were conducted among veterinarians and breeders in Finland, Norway and Denmark and the response rate was fair, between 20-60 responses from each group. The results of these surveys aligned reasonably well with the results previously obtained by Sandra Stolzenberg from Swedish veterinarians and breeders. Similar problems were evident.

The prognosis for survival after caesarean section was no better than that indicated in studies. Only 36% sow survival and 23% pup survival respectively was reported by breeders. Veterinarians reported slightly better survival rates, 50% sow survival and 30% pup survival.

The relatively poor anaesthesia survival rate found in literature was not corroborated in the results of the survey, but that may be due to small sample size.

Despite the survey being angled to veterinarians working with exotics like guinea pigs, only 22% of the veterinarians responded that they had performed a caesarean section on a guinea pig. The reason stated by the overwhelming majority of veterinarians was that there had not been a need to perform one.

Seventy-three percent of breeders had experienced at least one instance of dystocia with their guinea pigs. However, only 51% of the guinea pigs with dystocia had been taken to a veterinarian. Of these, about half had undergone a caesarean section and half were treated pharmacologically.

The attitude of breeders toward having a caesarean section performed was divided, where 66% of breeders would have a caesarean section performed if a veterinarian recommended it. Of the breeders that would not have one performed, 70% reasoned that the operation would be too difficult for the sow, while 30% of the breeders that would not opt for a caesarean section would decline because of the cost.

The attitude of veterinarians to performing a caesarean section was generally positive, many commented that they would try to perform one if there was a need. A few would decline because they did not feel competent.

In conclusion, more clinical experience for veterinarians would be beneficial to guinea pig survival from caesarean section. Likewise, more confidence in veterinary treatment by breeders would improve sow survival statistics around parturition. If more sows were presented by breeders for treatment while still in good condition during obstetric complications, veterinarians would have a better chance to gain experience and successfully treat these patients, and above all, guinea pigs would benefit.

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Popular science summary

Guinea pigs are prone to experience trouble birthing their young. This has several causes. Sometimes the contractions can be weak due to prolonged labour or pregnancy toxicosis. There may also be a mechanical obstruction in the form of too large pups not being able to pass through the pelvic girdle and failure of the loosening of the ligament keeping the pelvic girdle together, causing the birth canal to be too narrow. Malpresentation of the pups may also be the cause, as in any other species.

Veterinarians are only consulted in a portion of the occurrences of birthing difficulty and the causes for this are many. Veterinarians, although they would be experienced in treating other guinea pig ailments are seldom given the opportunity so acquire much experience in treating birthing problems. This is especially true of caesarean sections. Very few veterinarians have performed more than one caesarean section on a guinea pig. Peer assistance is hard to come by in evenings, nights and weekends, when these cases usually are presented.

The prognosis for the sow survival is poor and for the pups even worse. This may make breeders unwilling to seek veterinary assistance except when they have tried everything they can at home. The time delay before veterinary treatment is begun may be considerable for this reason, which weakens the sow and may cause the pups to die before birth. Also, it inevitably means that only the most difficult cases come in for treatment. Both factors lower the survival rate, making the breeders more unwilling to bring in their sows for treatment. Thus, this is a self-perpetuating vicious cycle.

To break this, more veterinarians should somehow find the time to acquire a broader knowledge and experience of treating birthing problems in guinea pigs. This is dependent on the breeders bringing in their sows sooner when birthing trouble occurs. Only by breeders and veterinarians, helping each other the guinea pigs will profit and thrive.

To this end I have described the procedure and included some drug dosages relevant to treatment in the hope that some veterinarians will find this useful. Breeders may also find advice for avoiding birthing problems in this study.

Appendix 1 Questionnaires for veterinarians and breeders

Survey for veterinarians:

For how long have you worked with small animals like guinea pigs?
- 0-3 years
- 3-5 years
- 6-10 years
- More than 10 years

Of what size is the clinic you work on?
- 1-2 veterinarians
- 3-5 veterinarians
- More than 5 veterinarians

Have you performed a caesarean section on a guinea pig during your career?
- Yes
- No

(If yes) Approximately how many times have you performed one?
- Comment:

(If yes) What was the indication for a caesarean section?
- Pregnancy toxicosis
- Weak labour
- Too tight pelvic girdle in the sow
- Malpresentation of the pups
- Other:

(If yes) What was the anaesthesia and analgesia protocol for the caesarean section? If possible, indicate the dosages and duration of the treatment.
- Comment:

(If yes) During anaesthesia, did the sow receive any supportive therapy such as fluids, warmth or oxygen supplementation?

- Comment:

(If no) Why have you not performed one?

- There has not been any need
- I don’t feel qualified
- The owner of the animal did not consent
- Other:

How did the sow fare in the caesarean section? (How many sows survived / How many died?)

- Comment:

If the sow did not survive, at what point did death occur?

- During the section
- During the first day after the section
- 2-5 days after the section
- More than 5 days after the section
- No deaths occurred
- Other:

How did the pups fare in the caesarean section?

- All the pups survived
- At least one pup survived
- All the pups died

How much does a caesarean section of a guinea pig cost (at normal working hours), assuming that no complications arise?

- Estimated approximate price:
- I don’t know
- I don’t perform caesarean sections on guinea pigs

Have you treated dystocia in guineapigs in any other way than with a caesarean section? What way was that?

- Comment:

Anything else you’d like to add concerning the subject?

- Comment:

Survey for breeders:

For how many years have you been raising guinea pigs?

- Less than a year
- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

How many adult guinea pigs do you currently have?

- 1-3
- 4-5
- 6-10
- More than 10
- I don’t have guinea pigs right now

How many litters have you raised?

- 1-3
- 4-5
- 6-10
- More than 10

Have your guinea pigs ever had problems birthing?

- Yes
- No

If you answered yes to the previous question, did you seek veterinary help when the problems occurred?

- Yes
- No

Have any of your guinea pigs had a caesarean section when the problems occurred?

- No

- Yes, at some point during the last three years
- Yes, but it was more than three years ago

How old was the guinea pig that had to have a caesarean section?
- Comment:

Was it the guinea pigs first litter?
- Yes
- No

Do you know why a caesarean section had to be done for your guinea pig?
- Pregnancy toxicosis
- Weak labour
- The dam's pelvic girdle was too tight
- The pups were not in correct presentation
- I don't know
- Other:

How did the pups fare in the caesarean section?
- Some pups survived
- The pups died or were birthed dead
- Some pups survived the section, but died later

How did the sow fare in the caesarean section?
- The sow survived
- The sow died in the caesarean section
- The sow died 1-3 days after the caesarean section
- The sow died more than 3 days later, but as a consequence of the caesarean section

Have your guinea pigs been treated in any other way for birthing problems?
- No
- Yes, with medication
- Yes, euthanasia of the sow

If a veterinarian would recommend caesarean section for one your guinea pigs, would you be willing to pay for the operation?
- Yes
- No

If you answered yes, how much would you approximately be willing to pay?

- Comment:

If you answered no, what is the reason?
- It’s a difficult operation for the sow
- It’s an expensive operation
- Other:

Is there something you do to avoid getting birthing problems in your guinea pigs?
- Special diet
- Genetics
- Breeding the females before the age of:
- Comment:

Are there any other thoughts you would like to add?
- Comment: