Whether or not to castrate a gravid cat in an animal shelter

Analysis of the outcome

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Foreword

This paper was written with the help of many people, and I would like to thank them all. Without the involvement of my tutor Drs. Ruth van der Leij this research would not have been possible. Her encouragement and guidance have been vital in the process. Dr. Freek van Sluijs kindly agreed to oversee and grade the project. Some help with the ethical part of the paper was offered by Dr. Franck Meijboom. Talking to him helped me organise my thoughts and write them down. The animal shelter de Doornakker in Eindhoven kindly helped me by providing data about their cats. Special thanks are for manager Mindy Bax who organised for me to visit the shelter and gain access to the data. Data were also kindly provided by Riekske Dams from Redcat, the foster home organisation that works together with the animal shelter de Doornakker. A great help with some practical questions was Drs. Paul Morssinkhof, a vet from dierenkliniek De Kempen.

Abstract

A flow chart was used to estimate the number of rehomable cats per 100 queens that enter a shelter in two different situations. In the first situation a fictive shelter spayed all their female cats, in the second situation a fictive shelter never knowingly spayed a gravid cat. Information from literature about the number of survivors per step in the chart was used to calculate the final numbers. When assuming a 100 percent effectivity of gravidity diagnostics the number of rehomable cats per 100 queens was 100 and 140 respectively.

Samenvatting

Met behulp van een flow chart werd in twee verschillende situaties het aantal plaatsbare katten per 100 poezen die in een asiel terecht komen bepaald. In de eerste situatie gaat het om een asiel dat het beleid heeft alle poezen die binnenkomen te steriliseren, drachtig of niet. In de tweede situatie gaat het om een asiel dat het beleid heeft om drachtige katten hun kittens te laten krijgen voordat ze gesteriliseerd worden. Cijfers uit de literatuur werden gebruikt om het aantal katten per stapje te berekenen. Als aangenomen wordt dat 100 procent van de drachten gediagnosticeerd wordt kom je uit op 100 respectievelijk 140 plaatsbare katten per 100 poezen.

Introduction

Shelters are constantly confronted with different dilemmas. In the Netherlands it is standard for shelters to spay their cats before being rehomed. When a gravid cat comes in, a shelter will face a dilemma. Should they have her spayed immediately, thus performing an abortion, or should they allow her to give birth and then have her spayed? In this paper this dilemma will be discussed. By exploring the consequences of different choices that one can make, an attempt is made to summarise the important factors in a flow chart. A fictive shelter that always spays their non-sterile queens and a fictive shelter that never knowingly spays their gravid cats are discussed. The information summarised in the chart will lead to an answer to the main question; how many rehomable cats will shelter one and two have, per 100 queens that come in? With the answer to this question, a shelter can decide whether or not their resources are such that they can afford to allow gravid cats to give birth to their kittens. The decision about performing abortion on a gravid cat is one that a shelter board has to make. The vet plays an important role in this, not only because he or she is the one to perform the actual operation but also because his or her moral compass is important. A fitting decision can best be made when the knowledge and experience of both the vet and the shelter board are combined. The goal of this comparison of the two shelters is to provide a guideline for shelter vets in The Netherlands for advising a shelter board.

Materials and methods

Research question

How many extra rehomable cats per 100 queens will a shelter have in two different situations? Situation one is where a fictive shelter spays all non-sterile queens that come in whether they are gravid or not. Situation two is where a fictive shelter never knowingly spays a gravid queen.

Flow chart

A comparison will be made between two fictive shelters. In the first shelter all queens that enter the shelter are spayed. This means that abortion will be performed on the queens that are gravid. In the second shelter the policy is to not spay a gravid queen. Therefore this shelter needs to try and diagnose gravidity as soon as possible. Both shelters follow a branch of the flow chart. Information that is available in literature is used to determine the increase or decrease in the number of cats for each step. With this chart an estimate is made for the number of cats that end up in the rehoming cycle per 100 queens that come in. By using this chart a shelter can decide whether or not their resources are such that they can afford to allow gravid cats to give birth to their kittens. A shelter has a certain number of days (‘zorgdagen’) that they generally spend on one single cat. A shelter also has a certain number of days (‘zorgdagen’) they can provide per year. This number of days is influenced by different factors like the number of staff a shelter has. When combining these two numbers, a shelter can calculate how many cats a year they can handle. When this number is known, and with the estimates from the flow chart, a shelter can predict whether or not they can afford to let all the gravid cats give birth.

Data

The most important source of data is American literature. Some studies have been done in other countries, but most of the relevant studies for this paper have been done in the USA. No Dutch literature has been found on the subject. Some Dutch numbers were collected at the animal shelter de Doornakker in Eindhoven[1], and at the foster organisation Redcat in Eindhoven[2]. In 2010 438 adult cats were brought in as strays or abandoned cats. If a 50-50 rate of male-female is assumed there were 219 female cats brought in in 2010. A random sample of 60 cats was taken from these data. In 2010 29 gravid cats or cats with small kittens were brought in to the Redcat foster homes. Information about the number of kittens per queen and the survival rate was extracted from these data. Information was also collected from personal communication with one of the shelter vets of de Doornakker, drs. Paul Morssinkhof[3].

Shelter 1

The first fictive shelter spays all non-sterile queens that enter the shelter. Figure 1 shows the steps that have to be taken in this process.

					Cats available for rehoming
	Sterile	Rehome			100%
100 queens					
		Non-gravid	Neutering	Rehome	% survived
	Non-sterile				
		Gravid	Neutering = abortion	Rehome	%survived

Figure 1. *The branch of the flow chart for shelter one where every queen that comes in is spayed immediately*

The first step: sterile or not

In this chart the first step is to determine whether or not the queen is sterile, i.e. has been spayed already. There are no numbers known for the Dutch situation. In American studies the following numbers have been found. In Florida a percentage of 1.9% of all feral cats presented in a trap-neuter-release program (TNR-program) in 1998-2001 were already neutered[4]. In seven TNR-programs in different states of the USA a percentage of 2.3% of all feral cats was already neutered[5]. In another research in Florida 1.5% of all feral cats admitted in the research was previously neutered[6]. In this paper a mean percentage of 1.9% will be used. The three studies all focused on the same type of population and therefore a mean percentage is justified. The number is expected to be higher when only rehomable cats are considered. Feral cats that are entered in a TNR-program are released back into their colony or are euthanized, and therefore do not influence the number of cats that a shelter has to rehome. In the Netherlands a big part of the rehomable cats are stray, but not feral cats. Results from the sample of data from the shelter in Eindhoven support this assumption. 19 of 60 cats in the sample were sterile when entering the shelter, leading to a percentage of 31.7%[1, 2]. This is a much higher percentage than the one found in literature. As this percentage is only an indication from one shelter it will not be used in the calculations.

A consideration that should be made is the reliability of the method used to determine whether a cat has been neutered. For a tomcat it is easier to determine than for a queen. Some methods used in TNR-programs to mark a spayed queen are to tattoo her, or to amputate the tip of an ear. Stray cats that were originally pets will not have a tattoo or amputated ear tip even if they have been spayed. Spayed queens do have a scar from the operation, but this is not always a very visible or palpable scar. Another way to determine the neuter-status of a queen is to perform a laparotomy. This is not something that will be used as a standard method, because it is a very invasive method for the cat and a very expensive one. There is no data about how reliable the differentiation between spayed or not is, so it will not be considered further here. Queens that are sterile and otherwise healthy are ready for rehoming without undergoing an operation.

The second step: gravid or not

The non-sterile queens need to be spayed before they can be rehomed. In this shelter all cats are spayed, whether they are gravid or not. Therefore the differentiation between gravid or not does not need to be made before a decision about operating is made.

Something to consider when operating on gravid cats is the potential higher risk for the cat. When the risks of an operation are summarized, one can predict the number of rehomable queens a shelter will have over a period of time. The risks of an ovari(ohyster)ectomy will be discussed further down. In the USA different percentages are listed. A female cat is said to be

fertile from the age of four to twelve months, depending on body weight and on the season of the year[7]. This means that in a stray cat population kittens can get pregnant in the same year they are born. In a TNR- program in Florida 19% of the feral queens entered in the program were gravid during a period of time[4]. This was the overall percentage. Peaks were seen in March to April, and in July to August[4]. In other programs with feral cats in the USA a gravidity percentage of 15.9% was found[5]. In a neuter-clinic at universities in Florida and North-Carolina 17.9% of the feral queens was gravid at the time of entering the program[6]. A mean percentage of 17.6% will be used in this paper. To use the mean percentage is justified because all three studies are comparable. There is no Dutch data but the sample from the shelter in Eindhoven does support this percentage. In the sample of 60 cats 12 were found gravid. This leads to a percentage of 20%. What must be noted is that the queens that were spayed while gravid were not registered, so the actual percentage in this shelter might be higher.

The third step: neutering of the non-gravid queen

There are two different ways to neuter a queen. One can perform either an ovariohysterectomy or an ovariectomy. The execution of an ovari(ohyster)ectomy is not without risks. Complications can occur during or after the operation. During the operation the anaesthesia poses a risk, as does the development of hypothermia. After the operation different complications can occur, like infection of the wound, a wound that does not heal properly, evisceration when the wound opens, haemorrhage in the abdomen, fistulous draining tracts, or granulomas of the stumps[8-11]. A haemorrhage in the abdomen is the most common complication, and it is also one that can be fatal[9]. Some other complications can be fatal as well, like a stump granuloma or a fistula. Other complications are mostly costly because of the measures that need to be taken. An alternative method of performing an ovari(ohyster)ectomy is through a lateral flank incision. This reduces the risk of evisceration when the wound does not heal properly. However, the scar is less visible with this kind of incision, and a discolouration of the fur can be seen. This kind of incision is contra-indicated in a cat with a pyometra, a gravid cat, a cat in oestrus, an obese cat, or a cat younger than 12 weeks[9]. An ovariectomy has several advantages when compared to an ovariohysterectomy. It is a faster and less invasive method, as the uterus does not need to be extracted. The incision can be made smaller than with an ovariohysterectomy[11]. In a study with dogs, no difference in post-operative complications was found between an ovariectomy and an ovariohysterectomy[9].

<u>Anaesthesia; ASA-status and risks</u>

Before anaesthesia is performed a vet can assign an ASA status to an animal. The American Society of Anaesthesiologists physical status describes the health status of an animal according to a classification system[12]. This status attempts to give an indication of the risk of anaesthesia for the patient. Vets can adjust the anaesthesia protocol to fit the status of an animal. ASA physical status is not the only factor that influences anaesthetic risk. The age and weight of the patients play a role, but also the nature of the procedure performed, and the competence of the surgical team[12]. In humans, normal healthy patients are assigned an ASA I status, while pregnant women are assigned an ASA II status[12, 13]. There is no literature that states the status of gravid cats, but in this paper they will be assigned the ASA II status.

Anaesthesia always comes with risks, whether the patient is in very good or very bad condition. How big this risk exactly is has been assessed in many different studies. A few of the most relevant studies will be summarised here, including an attempt to differentiate between ASA physical status I and II. A retrospective study among 117 small animal practices in the United Kingdom between 2002-2004 revealed an overall anaesthetic-related death rate of 0.24% (190/79187) of cats undergoing anaesthesia[14, 15]. Of these 46% were assigned an ASA I or II status. About 60% of these deaths occurred within 48 hours post-operative[15]. The cats in this study were patients of the small animal clinics that participated in the study. Health status was defined, but not the reason for the operation or the sex of the cat. In this study statistics showed that several factors are related to an increased anaesthetic-related death rate, like an increasing ASA status, increasing age and weight, and others[14, 15]. A somewhat higher mortality rate was found in a study performed in 1993. This study was

performed in a veterinary teaching hospital in Colorado, where 683 cats were anaesthetised. Here 0.43% of all cats operated on died during or shortly after the operation[16]. However the type of operation is not specified, the ASA status is not mentioned, and this includes both male and female cats. A study in South Africa revealed a death ratio of 0.08% of all cats and dogs operated in different hospitals throughout the country during a specific period of time[17]. However this includes dogs as well as cats, and gives no information on the ASA physical status or the nature of the operation. In a study in Ontario an anaesthetic-related death rate of 0.1% of the cats anaesthetised was found[18]. This study does not take into account the different ASA physical status of a patient. In a trap-neuter-release program in Florida 11 out of 5323 cats that underwent a neutering procedure died due to surgical complications or anaesthetic-related complications[4]. This leads to a 0.21% death ratio. These 5323 cats were feral cats that were admitted to a neutering clinic between 1998 and 2001. There is no differentiation between male and female, and nothing was said about the ASA physical status. However all the operations were to neuter the cat. A comparable study in Florida and North Carolina gave a percentage of 0.23% of cats undergoing neutering that died during or short after anaesthesia with no visible underlying cause at necropsy [6]. This study includes males and females. In this study 7502 feral cats admitted to a neutering clinic between 1996 and 2000 were considered. Overall, when not taking into consideration sex of the cat, ASA physical status, and type of operation, an anaesthetic related death rate of 0.08-0.43% can be expected. In this paper a percentage of 0.2% will be used for non-gravid cats undergoing a spaying procedure. This is the mean of the results of Williams et. al 2002 and Scott et. al 2002. These two studies consider only operations performed to neuter cats, while the other studies mentioned above do not take the type of operation in consideration. The actual percentage for cats dying during a spaying procedure in the Netherlands might still be different. In a Dutch shelter not only feral cats but also stray cats will be operated on. Also this percentage does not take into consideration the sex or ASA status of the cats. In humans a study showed that there is a 5-7fold increase in mortality in a hospital between each ASA physical status[19]. Patients with an ASA II-IV status had a longer postoperative stay in the hospital than status I patients, and there was a higher risk of bronchopulmonary and circulatory problems per ASA status[19]. No studies with animals show the difference between the anaesthetic risks for ASA I and ASA II status patients. Therefore in this paper a 6-fold increase in mortality, and thus a death rate of 1.3%, will be assumed for gravid queens**.**

The fourth step: neutering of the gravid queen

When a cat is gravid when being spayed it could also be called abortion. Abortion can be performed in different ways[9, 20, 21]. One option is to perform a C-section. A second option is to use medication. However, both these methods do not spay the cat. In a shelter the main purpose of the operation is to spay the cat, not to perform an abortion. Therefore these two methods will not be discussed further.

Two options that do result in neutering are the ovariohysterectomy or the ovariectomy. A pregnancy is sustained by the production of progesterone in the ovaries. When an ovariectomy is performed this production of progesterone is stopped and thus the pregnancy will terminate[22, 23]. In the first stage of gravidity (the first 40 days), the foetuses will be resorbed[24]. After this period the fluid and tissue will be passed through the vulva[24].

According to shelter veterinarians in the USA the spaying of a gravid queen can be safely performed[25]. However when a cat is gravid at the moment of the operation some extra factors need to be considered. Bleeding might be more excessive because of the extra blood supply to the uterus and the placenta[10, 11, 24, 26-28]. Anaesthesia might be a slightly bigger risk[24]. This has not been very clearly researched, but as previously described the results of different (human) studies do suggest a bigger risk for ASA II status patients.

Some extra factors need to be considered cost-wise as well. In a pregnant cat more ligatures will be needed, as the vessels to the uterus are dilated[24]. This will also take more time[24]. This is confirmed by personal communication with the vet (drs. Paul Morssinkhof) of the animal shelter de Doornakker in Eindhoven. In their practice a thicker suture material is used in the cats that are in a late stadium of gravidity[3]. Extra attention should be paid to leaking vessels, as the chance that a dilated vessel will leak is bigger than the chance that a normal vessel will

leak. If the pregnancy is advanced, the vet might need to euthanize the kittens. This will also cost extra time and materials (i.e. the medicine and the needles used). Different papers contradict each other about the volume of anaesthesia needed for a gravid cat. According to research performed by Williams et al., gravid cats need more anaesthetics than non-gravid cats[6]. The shelter vet drs. Morssinkhof confirmed that they use a higher volume of anaesthetics for a gravid queen[3]. However, the BSAVA Manual of canine and feline anaesthesia and analgesia states that gravid cats need fewer anaesthetics than non-gravid cats[28]. In fact, they describe a general rule of a reduction in anaesthetics of 30-60%[28]. Less analgesia is needed due to the analgesic effect of progesterone which is produced during pregnancy[28]. This effect is called the oestrogen and progesterone-activated pain transmission prevention. Progesterone is also said to have an extra sedative effect, thereby also reducing the volume of anaesthetics needed. Furthermore, the absorption of inhalation anaesthetics is higher due to a decreased functional residual capacity and increased alveolar ventilation in a gravid cat[28].

During the operation extra attention needs to be paid to the anaesthetised gravid cat. The induction needs to be quick, and attention should be paid to the tube after intubation[28]. This is because the gravid cat will vomit quicker than a non-gravid cat[10, 11, 26, 28]. Furthermore, extra attention should be paid to the blood pressure of the gravid cat during the operation[10, 11, 26-28]. The blood pressure should be measured, and extra fluids should be administered[10, 11, 26-28]. The risk of hypotension is bigger in a gravid cat than in a non-gravid cat because of a larger cardiac output in the gravid cat[10, 11, 26-28]. This larger cardiac output is the result of the uterus and the placenta needing more blood. Anaemia is an extra complication that could occur in the gravid cat due to this bigger cardiac output[11]. Extra attention should also be paid to the oxygenation of the gravid cat[28]. Her requirement for oxygen is increased due to the uterus and placenta needing a lot of oxygen[28]. This increase in oxygen that is needed is hard to meet for the cat, as her ventilation rate will decrease due to the pressure of the uterus on the diaphragm[28]. Therefore the gravid cat needs extra oxygenation compared to the non-gravid cat. If this extra need for oxygen is not met the cat risks developing a respiratory alkalosis[27]. Extra attention should be paid to the temperature of the gravid cat, as she is more prone to developing hypothermia[11]. Most of these factors are interlinked, all the extra costs are summarised in table 1.

Extra ..	**Explanation**
Suture material	More ligatures needed due to dilated vessels
Time	More ligatures needed, more attention should be paid
Attention to leaking vessels	Dilated vessels will bleed more easily
Time to euthanize kittens	Kittens might need to be euthanized after the removal of the uterus
Medicine to euthanize kittens	The medicine needed to euthanize the kittens when in a later stage of gravidity
Anaesthetics? Contradicting sources	Some sources say more anaesthetics are needed for a gravid cat, others say less is needed.
Attention to intubation	Gravid cats might vomit quicker than non-gravid cats
Attention to blood pressure	Gravid cats can have a low blood pressure due to higher cardiac output
Admission of fluids	Extra fluids should be administered to compensate low blood pressure or anaemia
Oxygenation	Extra oxygenation is needed due to increased needs and decreased ventilation
Attention to temperature	A gravid cat can easily develop a hypothermia

Table 1. *The extra costs when neutering a gravid queen*

Shelter 2

The second fictive shelter has a non-abortion policy. All gravid cats get the chance to carry to full term and give birth to the kittens. This implicates that this shelter is able to detect pregnancy. In case a non-sterile cat is found to be non-gravid, she will be spayed. In the case of false-negative results an abortion will be performed. The detection of pregnancy and the successfulness of this will be discussed. The decisions that need to be made are summarised in the flow chart in figure 2.

							Cats available for rehoming
	Sterile		Rehome				100%
100 queens							
			Non-gravid	Neutering	Rehome		% of survivors
	Non-sterile	Pregnancy diagnostics					
			Gravid	Kittens are born	Queen neutering	Rehome	% of survivors (birth+operation)
					Kittens	Rehome	% of survivors (birth+postnatal period)

Figure 2. *The branch of the flow chart for shelter two where a gravid queen is never knowingly spayed.*

The first step: sterile or not

In this chart the first step is to determine whether or not the queen has been neutered, i.e. has been spayed already. The numbers that have been found abroad have been discussed above. Percentages of 1.5-2.3% sterile cats of all cats entering a trap-neuter-release program were found[4-6]. A mean percentage of 1.9% will be used in this paper. There are no numbers known for the Dutch situation, but the results from a sample from animal shelter de Doornakker in Eindhoven showed a proposed higher percentage for the situation in the Netherlands.

The second step: gravid or not

In this shelter the differentiation between gravid and non-gravid is very important, as this shelter has the policy not to spay a gravid queen. The percentages of pregnant cats in studies in the USA have been discussed. A percentage of 15.9-19% has been found. No Dutch numbers are known, but the sample showed a percentage of gravid cats of approximately 20%. A mean percentage of 17.6% will be used in this paper.

There are different ways to diagnose a pregnancy. These methods all have advantages and disadvantages. Without using any diagnostic methods one can get an indication of a pregnancy by seeing swollen and reddened nipples on the queen from day 24-28 post-coitum. In the last few days her abdomen will be swollen as well.

One way to detect a pregnancy is by using a transabdominal ultrasound. This method is a very safe method for the vet, the queen and the kittens as it does not use any radiation. It is not a very reliable method to determine the number of foetuses. However it is the only method that can determine whether the foetuses are still alive. According to Root and the BSAVA manual this method is reliable from day 16 post-coitum[29, 30]. Other sources like Nelson et. al state that a heartbeat can be seen from day 18-25 post-coitum, being reliable from day 20-24[31]. Johnston et. al states that a heartbeat is detectable from day 16-25 post-coitum[20]. The morphology of foetuses can be deciphered from day 26[20]. In this paper the most reliable period will be used, thus it will be assumed that an ultrasound can detect a pregnancy from day 24. The first day that gravidity can be diagnosed depends on different factors, like the experience of the vet performing the ultrasound, the individual cat, the speed with which examinations are done and others.

Another way to detect a pregnancy is by palpation of the abdomen. According to Root gravidity can be diagnosed only between days 21-35 post-coitum[29]. The BSAVA manual adds that it is detectable from day 17, but easiest between days 21-35[30]. After day 35 gravidity is hard to diagnose by palpation, but after day 55 foetuses should be palpable again[30]. Nelson et. al states that palpation of the foetuses is possible only between days 26-35[31]. According to Johnston et. al the palpation method is reliable from day 15, with the easiest period being between days 21-25[20]. After that they state that it is not possible to diagnose the gravidity until after day 58[20]. In this paper all sources will be considered. Three of four sources state that palpation is easiest from day 21[20, 29, 30]. Also three of four sources state that palpation is not possible after day 35[29-31]. Therefore palpation will be considered reliable between days 21-35 and after day 55 post-coitum. Different sources give different percentages of accuracy of this method. These accuracies will not be considered here.
A third method to detect pregnancy is by making an X-ray. On an X-ray dilatation of the uterus can be seen from day 17-21 post-coitum[30, 31]. A reliable detection of foetuses can be achieved after day 35-40, when the bones of the foetuses start calcificating[20, 29-31]. A few days after the start of calcification the separate foetuses can be counted. After calcification of the foetuses has begun this method is very reliable. Because the detection of a dilated uterus can be missed, an X-ray will not be considered reliable before day 40. In this paper radiography will be considered a reliable method from day 40. Radiography is a method that should be chosen with care, as the radiation is potentially harmful to the vet, the cat and the kittens[20].

The third step: the gravid queen
Gravid cats need special attention. It is advised to weigh them every week[20, 32]. The cats need a dry, warm and safe place to stay, where supervision is possible. To protect the cats from infections they should ideally be isolated from other cats. If they develop an infectious disease, this might affect the kittens in the uterus. For the birth process the queens need a quiet and safe space, with a special box suitable for giving birth in[20, 32]. This box is one that the mother cat can get in and out of, but the kittens cannot. A gravid queen will also need an altered diet. In the first few weeks the amount of food she needs will be similar to that of a non-gravid cat. After that the amount of food available for the gravid queen should slowly be increased, by giving 150% of the normal amount in the fourth to sixth week, up to 200% in the last weeks[20, 32]. The correct amount of food is very important for a gravid cat. If a gravid queen is obese she might suffer from dystocia, and the percentage of stillbirths can be higher[20, 32]. An underweight queen might have problems with the production of milk after giving birth[20, 32]. The advise is to give are 110 calories per kg body weight per day, up to 220 calories per kg body weight per day for a gravid queen in her last few weeks[20, 32]. These extra needs are summarised in table 2.

Extra...	**Explanation**
Weighing	It is advised to weigh a gravid cat every week
Dry, warm and safe place to stay	To protect the gravid cat she needs an extra dry, warm and safe place
Supervision	Gravid cats should be carefully monitored, so they should be kept in a space that is easy to supervise
Isolation	To protect the somewhat more vulnerable gravid cat she should be isolated from other cats
Birthing box	A gravid cat needs a special box to give birth in, in a quiet and safe place. Ideally this box is one that the mothercat can get in and out of, but the kittens cannot

Food	The gravid cat needs extra energy, this can be met by feeding her 150% of the normal amount in the fourth to sixth week, up to 200% in the last few weeks

Table 2. *The extra needs of a gravid queen*

When a cat is gravid, she has to carry for approximately nine weeks. Different sources give a possible gestation period of 52-74 days, with a mean period of 65-67 days[20, 33, 34]. No significant correlation was found between age or parity of the queen and the gestation period, nor was there a correlation between the number of kittens and the gestation period[20, 33]. For different reasons, not all gravid cats will carry to full term. Causes of abortion could be an infection, a deficiency, a chromosomal defect in the foetuses or an inadequate environment for the carrying queen. In the first term of the pregnancy foetuses will be resorbed. In the second term they will be aborted. No excessive research has been done about the number of gravid cats that do carry to full term. One study in the USA revealed a percentage of 88.2 % of all gravid cats in the study actually giving birth to their kittens[33]. This study was done in a feline research colony of 14 queens. As this is the only percentage that can be found in literature, this percentage will be used in this paper. The circumstances for the queens in the research colony could be somewhat compared to the circumstances in a shelter, so this percentage could be similar to one found in a Dutch shelter situation. The queens that do carry to full term will have to undergo the process of giving birth. Some queens might need help during the process. This can be medical help, or it can be necessary to perform a Caesarean section. There is not a lot of information about the number of cats that needs help during the process of giving birth. No Dutch numbers are known. A big questionnaire in the UK revealed a percentage of 8% of all gravid queens needing a C-section[34]. This was a questionnaire among cat breeders, so this might be a very different percentage for stray cats in a shelter. Different complications can occur post-partum. These might include retentio secundinarum, a prolaps of the uterus, a pyometra, mastitis or postpartum hypocalcaemia[35]. There are no percentages of complications known. Mother cats could also die during the birthing process. No data was found about this.

Kittens born

The number of kittens that a queen carries has a wide range. Different studies say that a queen can give birth to 1 to 13 kittens, with a mean of 3.3-5[4, 5, 20, 33, 34]. As these were all different kinds of studies with a very wide range in number of kittens born, a mean of 4 kittens per cat will be used. This mean is supported by data collected from Redcat, the foster home organisation of the shelter in Eindhoven. Here the gravid queens gave birth to 1-8 kittens with a mean of 4.3 per queen[2].

In the process of giving birth kittens have a risk of not surviving. Some kittens might die during the birthing process, others might have been dead in the uterus already (a stillbirth). Different percentages of survival of kittens have been found. In a study with a feline research colony in the USA 95.3% of the kittens a queen carried were born alive[33]. In a questionnaire in the UK cat breeders had a live kitten percentage of 92.8%[34]. In a cohort study in controlled feral cat groups a live kitten percentage of about 75% was found[36]. This means that of all kittens a queen carries an average of 75-95% survives the birthing process. In this paper a percentage of live kittens born of 94% will be used. This is the mean of the percentages found in Root et. al 1995 and Sparkes et. al 2006. The percentage for Dutch shelters is expected to be comparable to the situation at breeder's or in a controlled feline research colony. The percentage found in the feral cat populations in the USA will probably be lower than in a controlled shelter situation, as feral cats are subjected to dangers like infections, malnourishment, traffic and others.

The fourth step: neutering of the mother cat

Before a queen is rehomed she needs to be spayed. Mother cats can be spayed after weaning their kittens, which usually happens at an age of 4-7 weeks. It is advisable to spay a mother only after her kittens are off milk and after her mammae are less swollen[3]. When they are spayed, this will pose the same risks and complications as the spaying of a non-gravid queen. All this has been discussed above.

Although the risks of the operation are the same for the mother cat as for a cat that is spayed immediately after entering the shelter, other consequences for both the cat and the shelter do play a role. The cat has been in the shelter for a much longer time before she is ready for rehoming. The cat will have to stay until the kittens can be weaned. According to Dutch law ("besluit scheiden van dieren") kittens have to stay with their mother until the age of 7 weeks[37].

The fifth step: the kittens

To take care of a mother cat and her kittens is more intensive than to take care of one adult cat. Kittens need to be weighed daily. They need to be handled frequently to socialise them[32]. A close eye needs to be kept on the mother cat. A first time mother might need some help taking care of her kittens. Kittens might need encouragement to drink. Mother cats do not like to leave their kittens in the first period, therefore they should be encouraged to eat and drink enough[32]. To meet her energy demands during lactation the mother cat should eat 200-350% of the normal portion for an adult cat, with the peak of lactation at 3-4 weeks post-partum[32]. At the time of weaning the mother cat should be back to the normal amount of food.

If a mother cat dies during or short after giving birth, the shelter will find itself in charge of motherless kittens. The kittens will need powder milk every 2-4 hours up to an age of about 3-4 weeks. To take proper care of the kittens the shelter will need the powder milk, little bottles, an incubator or an infra-red lamp, and extra time[38]. All the extra things needed to take care of a mother and her kittens are summarised in table 3.

Extra…	**Explanation**
Weighing	Kittens need to be weighed daily to keep an eye on their progress
Handling	Kittens need to be handled frequently to make sure they are socialised and get used to humans
Encouragement	Kittens sometimes need encouragement to drink, especially in the first period post-partum
Attention for the mother	Especially first time mothers sometimes need some help taking care of the kittens, and they need to be encouraged to eat and drink themselves
Food	Also post-partum a mothercat needs extra food to meet her energy demands for lactation. She needs 200-350% of her normal amount of food with the peak at 3-4 weeks post-partum. At weaning she should be back to normal amounts.
Feeding	Motherless kittens or kittens of mothers that do not have enough milk need to be fed powder milk every few hours
Warmth	Especially motherless kittens need a safe, dry and warm environment

Table 3. *The extra needs of a mother cat and her kittens*

As discussed before, a queen can carry 1 to 13 kittens, with a mean of 3.3-5 kittens[4, 5, 20, 33, 34]. Of the kittens a queen carries, 75-95% will survive the birth process[33, 34, 36]. In this paper a survival rate of 94% will be used. Not all kittens that are born will survive until the time of rehoming. The age at which a shelter will rehome kittens might differ. This age depends on how long a shelter wants the kittens to have a mother and brothers and sisters, on the number of vaccinations the shelter wants to give the kittens before rehoming, etc. The Dutch law states that a kitten cannot be taken away from their mother before 7 weeks ("besluit scheiden van dieren")[37].

Different studies give survival rates for kittens. No Dutch numbers are known. The survival rate will depend on several factors as well. The way they are taken care of in the shelter will play a role, but also the genetics of the parents will play a role. For example, in a stray colony with a lot of inbreeding kittens might be weaker. The first three days of a kitten's life are the most crucial days, most deaths will be in this period[31]. In a study in the USA 75.6% of the kittens that were born alive survived until an age of eight weeks[33]. These were cats and kittens in a research colony. In a questionnaire among cat breeders in the UK a kitten survival rate of 90.9% at eight weeks was found[34]. The survival rates found in a study in the USA were based on watching a controlled feral cat group. Here a survival rate of minimally 52% at 14 weeks is given[36]. The other 48% was either found dead or just disappeared, thus the survival percentage might be higher[36]. At six months this survival rate was only 25%[36]. The kittens that were found dead had died because of a dog attack or car accidents (42.5%), because of a fall or other trauma, or because of an (infectious) disease[36]. In the safe environment of a shelter or foster home this survival rate is expected to be much higher, therefore these last percentages will not be considered in this paper. A survival rate of 75.6% will be used as the circumstances in the research colony appear to be most comparable to the circumstances in a Dutch shelter.

After surviving the first few weeks until they reach the rehomable age, the kittens have to actually be rehomed. The number of kittens that find a home depends on several factors. There are certain periods in a year when the rehoming of cats peaks, for example after summer holiday, around world animal day or around Christmas. The age, sex and coat colour of a cat play a role in de adoptability[39]. No Dutch numbers about the rehoming of kittens are known. In a study in Sacramento in 1994 only 20% of kittens offered for adoption were actually adopted[39]. The number of kittens actually rehomed will not be considered in this paper.

Results

When all the described percentages are integrated in the flow chart, the number of rehomable cats per 100 queens that enter the shelter can be calculated. In shelter one 100 of the queens will be rehomable. In shelter two 140 cats will be available for rehoming per 100 queens that enter the shelter. The different calculations are shown in figure 3.

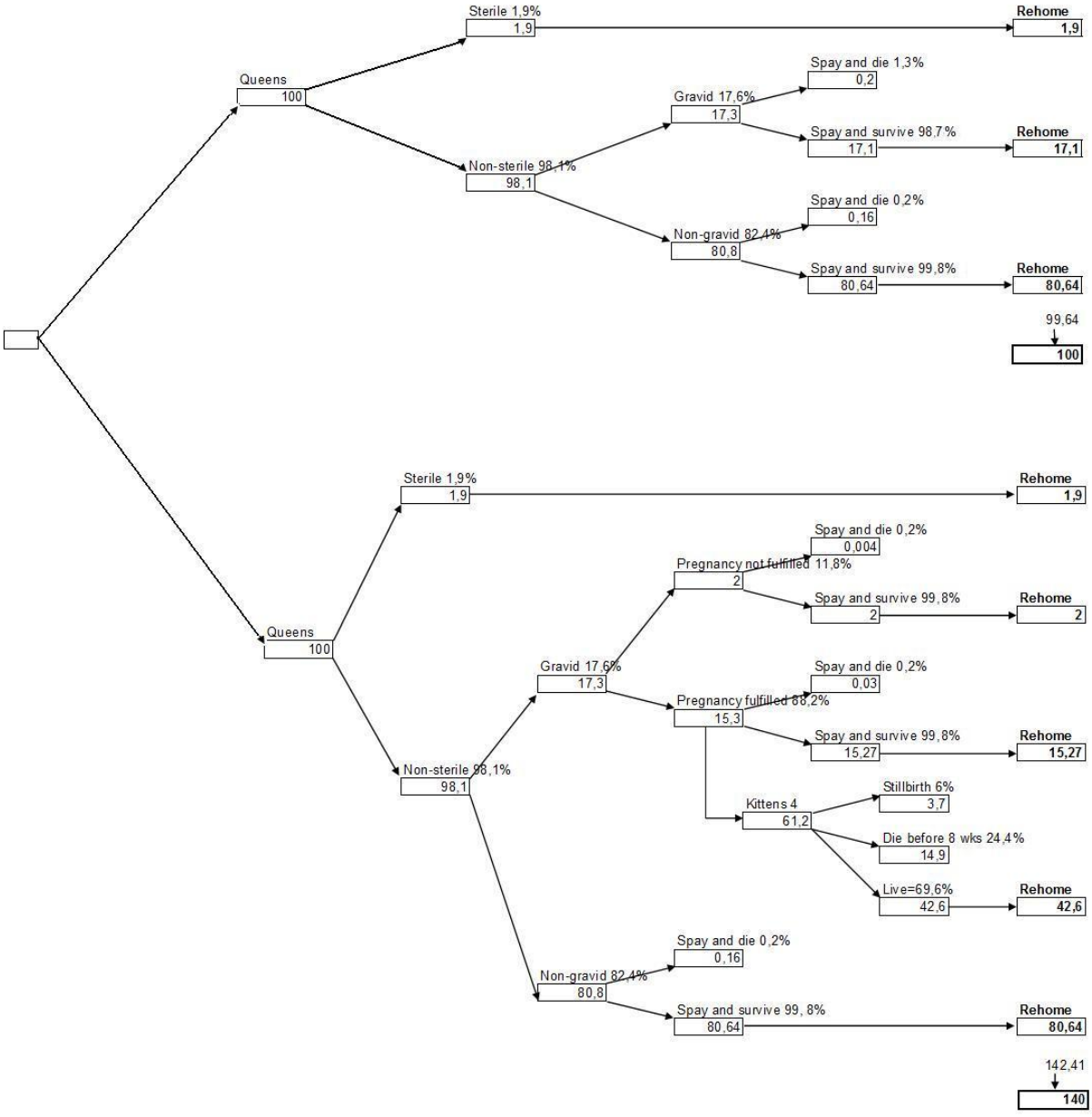

Figure 3. *The final flow chart with the data from the literature as described in materials and methods.*

Discussion

Results

In this paper a percentage of gravid queens per 100 queens of 17.6% was used. What must be taken into consideration is whether this is a true percentage or not. In these studies the gravidity was diagnosed during the spaying operation. Therefore a large amount of pregnancies will be diagnosed. However, the percentage that will be missed is not known. Queens that have just been fertilised might not show gravidity yet, even when performing a laparotomy. Therefore the actual percentage of gravid cats might be higher. In this paper the percentage found in the literature has been considered a true percentage.

For both shelters the number of cats that will be rehomable per 100 queens has been rounded. A number that is not rounded gives an impression of great accuracy. This accuracy is false in this study. All numbers that have been used were means of different studies, or were estimates in the study used. Therefore the final number of cats is only an approximation of the actual number of cats that will be available for rehoming. This accuracy can also not be achieved because every situation, every shelter, and every individual is different.

What must be considered is that the numbers and percentages used in this paper were all derived from foreign situations. Therefore the actual numbers might give a rough indication, but they will not be completely applicable to the Dutch situation. The outline of the charts and the questions that need to be asked to come to an answer to the main question can be used anywhere. So as soon as more Dutch data is available the charts can be corrected with Dutch numbers. What is needed is a study in which all these numbers are collected. An overview should be made of the number of sterile cats per sex, the number of gravid cats, the survival rates for gravid and non-gravid cats during a neutering-operation, the number of kittens a gravid cat carries, the survival rate for kittens and the number of cats that will be rehomed from a shelter on a yearly basis.

Pregnancy diagnostics taken into consideration

In the charts under results it has been assumed that shelter two can diagnose every gravid cat. However, different diagnostic measures have different accuracies. This will result in false negative outcomes, even if all the diagnostic methods would be used on one cat. Therefore even in shelter two abortions will be performed. If the diagnostic method is taken into consideration three different results will be found. The number of cats that will be rehomable has been calculated per diagnostic method, being ultrasound, abdominal palpation and radiography. Each method has a certain period of the gravidity in which it is reliable. For ultrasound reliability from day 24 post-coitum has been assumed. If gravidity is presumed to last 65 days, the gravidity can be diagnosed on 41 days of the total pregnancy. If there were 65 cats that were each one day further in their pregnancy, 41 cats would be diagnosed correctly as gravid. This would be 63%. So only 63% of the 17.6% gravid cats will be diagnosed as gravid, which leads to a gravidity percentage of 11.1%. This percentage is used in the chart, comparable to figure 4. This can be done for abdominal palpation as well. In this paper it was assumed that palpation is reliable between day 21 and 35, and after day 55. This leads to 24 reliable days, or 36.9% of all gravid cats. A percentage of 6.49% was used in the flow chart. For radiography reliability from day 40 was assumed, leading to a percentage of 38.5% of all gravid cats being diagnosed correctly. In the chart a percentage of 6.78% was used. For the ultrasound method it was calculated that a shelter will have to deal with 125 rehomable cats per 100 queens that come in. For the palpation method this number was 115. By using radiography as a diagnostic method a shelter would have to deal with 115 cats per 100 queens. These results have been summarised in table 4. When these results are considered, ultrasound seems the most reliable method as this method seems to miss the least pregnancies. Abdominal palpation is the least reliable method. Other things need to be considered as well, to determine the preferred method. The costs of the method, the safety of the method for the examiner and the animal, the ease of use, and others.

Method	Reliable on days..	Total reliable days during pregnancy	Gravidity percentage	Number of rehomable cats
Ultrasound	24-65	41	11.1%	125
Abdominal palpation	21-35, 55-65	24	6.49%	115
Radiography	40-65	15	6.78%	115

Table 4. *Different diagnostic methods and their reliability, the gravidity percentage per method and the resulting number of rehomable cats.*

The Dutch law

In the Netherlands an important law that a vet has to deal with is "De gezondheids- en welzijnswet voor dieren (GWWD)". This law has a few "besluiten" that specify certain regulations. What should be kept in mind is that there are concrete plans for a new law that will replace the "GWWD". This will be the "wet Dieren". This new law is planned to be implemented this year or the next. In the "GWWD" there is no specific rule about abortion in a cat while spaying her. However there are a few articles that can be useful for a vet that is put in the position where he/she is confronted with a gravid cat that needs to be neutered. Other articles are useful when advising a shelter about their policy concerning the age of weaning a kitten.

- "GWWD" article 39 states that it is forbidden to separate a young animal from its mother before a certain age[37]. In the "besluit scheiden van dieren" this is specified per species. For cats this period is 7 weeks[37].
- "GWWD" article 40 states that it is forbidden to remove or to impair a part of an animal, unless this operation is to neuter the animal, unless the operation is medically unavoidable, or unless any other part of the law specifically allows this operation[37].
- "GWWD" article 43 states that it is forbidden to kill an animal unless it is one of the exceptions defined by "Algemene maatregel van bestuur"[37]. This article is not yet valid at the time of writing. This indicates that by law a vet is allowed to perform an ovariohysterectomy on a gravid cat.

Apart from the law there is a special code for vets in The Netherlands, written by the veterinary association "De Koninklijke Nederlandse Maatschappij voor Diergeneeskunde (KNMvD)". This code is not enforced on vets by law, but it is strongly recommended to keep to this code. The disciplinary committee will sometimes refer to this code to judge a vet in a specific case. In this code no specific rules are written concerning the ovariohysterectomy of a gravid cat. However there are some points that can be useful to the vet that is in the position of making this decision.

- Article 2.1 states that vets should respect, guard over and improve the health and welfare of their patients[40] .
- Article 2.2 states that vets should respect the intrinsic value of their patients[40].
- Article 2.3 states that vets should perform first aid to patients in direct need of their care as good as they can, even if this includes euthanasia to prevent the animal from suffering. This also applies to wild or homeless animals[40].
- In articles 4.1 and 4.3 the vet is encouraged to always keep to the law, and handle according to veterinary protocols and codes[40]. The vet should keep animal welfare, animal health, the environment and public health in sight.
- In article 7.1 something similar is stated, the vet should always keep the law in mind when practicing, including the laws about animal welfare, animal health, and about public health and the environment[40].

Ethics

In a natural situation there is no question of performing an abortion on a cat. In a shelter the situation is not natural, therefore the dilemma of abortion might arise. This dilemma will arise only if there is overpopulation in the shelter. An option to decrease overpopulation is to perform abortion on all gravid cats. Another option is to euthanize all the neonatal kittens. An

abortion might feel very wrong, and the second option might feel worse. Why this feels so bad is hard to explain.
In ethics there are different streams of thinking. In utilitarianism (a form of consequentialism) the general outcome of an action in terms of overall happiness is important. The focus lies on maximising happiness for all parties involved. Maximising overall happiness for all is the ultimate goal, the actions needed to get there are less important. In the case of a gravid cat the following is important. Parties involved are the mother cat, the kittens, the vet performing the operation and the shelter that has to take care of the cat and her kittens. The shelter does not have the space, money or time to take care of all the kittens properly. For them it is a necessity that less kittens are born. The mother cat needs to be spayed anyway, so she will have to undergo an operation either way. For the kittens there seems to be little difference in being euthanized just before, or just after the birth process. The birth process always carries risks for the mother, therefore it is best for the mother cat not to have to undergo the birth process. An abortion is therefore a correct option according to utilitarians.
However, the utilitarian way of reasoning might not feel satisfactory. To find a satisfactory solution to the dilemma other ways of thinking can be explored. Another stream in ethics is deontology, which focuses more on the rightness of the action. Everything you do must be respectful for others. In this situation a question is whether it is respectful to euthanize a kitten, which is a healthy living animal that has a whole life to live. In humans, abortion is legal in the Netherlands up to 24 weeks. From 24 weeks on a human foetus is supposed to be able to survive outside the mother. What is difficult here is that there is no literature on the age of kittens from which they are viable. Instead of extrapolating this rule, one could compare humans and cats on the basis of the same principle. This would mean that an abortion in cats in the first period of gravidity is acceptable, but it is not acceptable in de second period.
Still something does not feel right. The length of life is not the only important factor, quality of life should be considered as well. The quality of life for a kitten depends on the capacity of the shelter. The capacity in terms of money, time and staff play a big role in this. One can question the quality of life of a kitten in an overfull shelter that cannot take care of the kittens the way they would like to. If the prospect of life in the shelter is not optimal, euthanasia (i.e. abortion) might be the best option. A possible medium is to abort only the early gravid cats. The line of acceptability is then drawn at the age at which kittens are viable. However, the exact age at which a foetus is viable is now known. This method would be comparable to the method used in humans.
The best moment to euthanize the kittens is a point of discussion. When taking into consideration the extra risks of the birth process for the mother cat an abortion seems like a better option. Furthermore, for the vet performing the procedure it is easier to euthanize a small foetus in the uterus than a neonatal kitten. Humans have an instant connection with a neonatal animal, as opposed to a foetus that is in a slimy uterus.
A sound answer to the dilemma can be found in the different streams of ethical thinking. With the help of utilitarian and deontological points of view the abortion dilemma can be summarised in two divisions. From a utilitarian point of view abortion can be justified because of greater happiness of the mother cat, the shelter, and the general cat population in the shelter. From a deontology point of view abortion can be justified by the proposed bad quality of life for kittens. However besides the many arguments that can be used many personal feelings play a role. Despite being able to reason why abortion is justified, for some people it may still feel wrong. In reality it turns out to be a decision based on morals and feelings. The shelter vets in Eindhoven do not spay a gravid queen after a certain period. The line is drawn at the stage where the foetuses are 2-3 cm long[3]. Gravidity is diagnosed with abdominal palpation, when there is doubt about whether the queen is indeed pregnant an x-ray or ultrasound is performed[3]. This policy was formed by the vets and the shelter together and was based on morals.
The above was written after talking to dr. Franck Meijboom[41].

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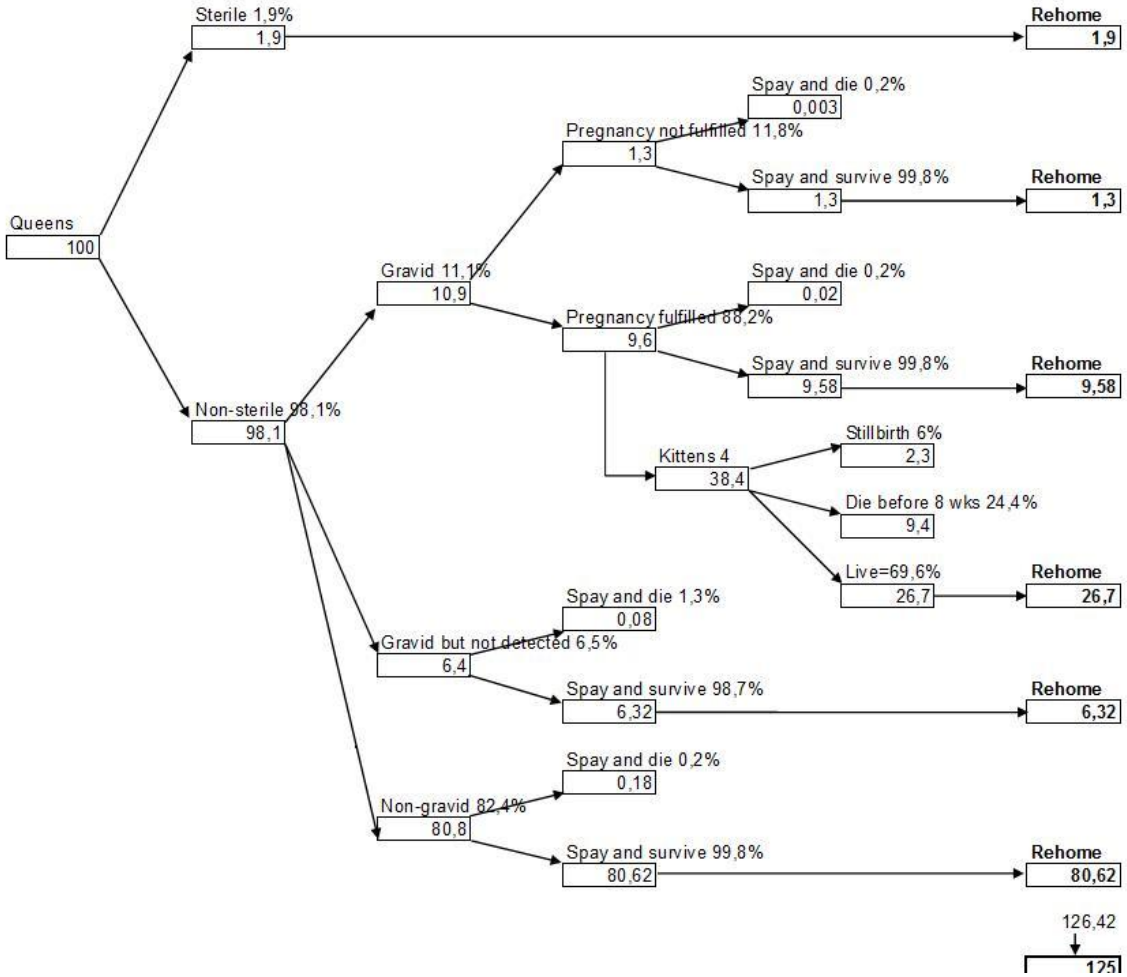
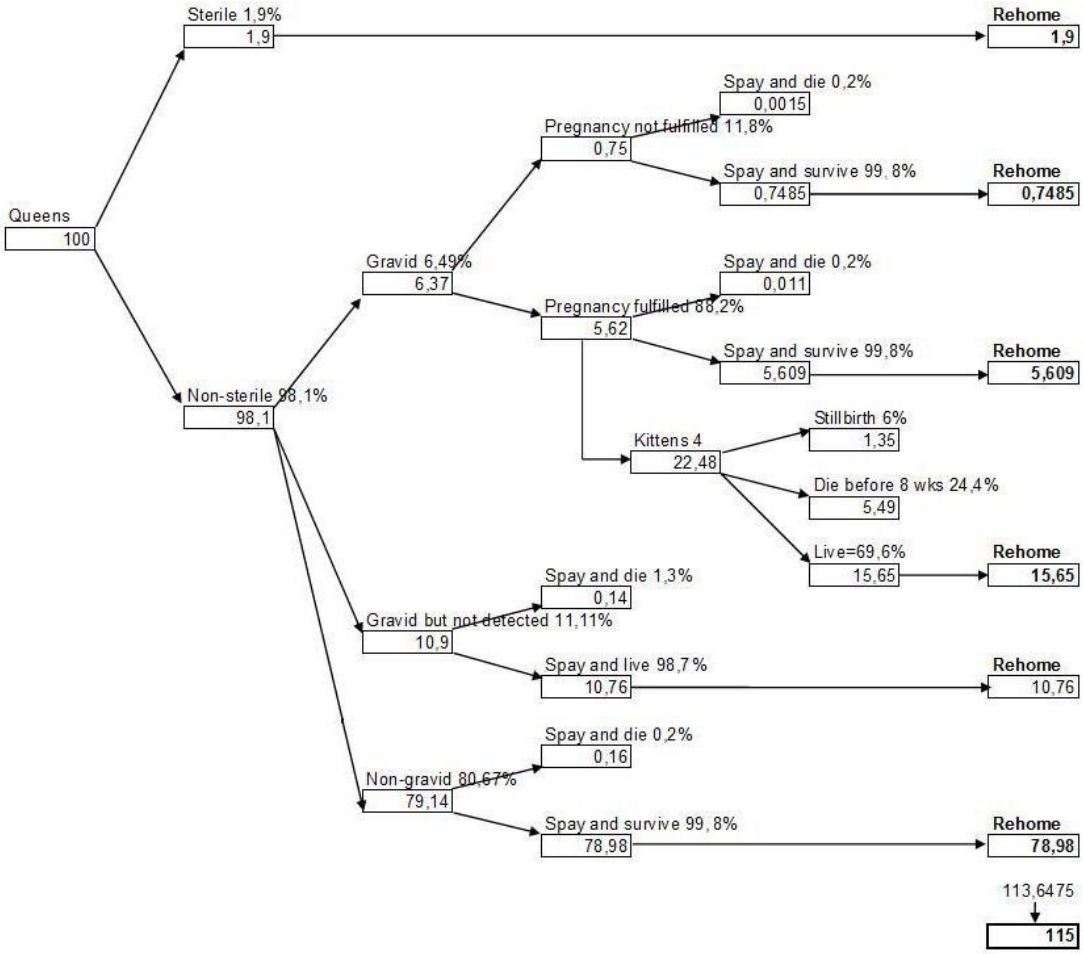
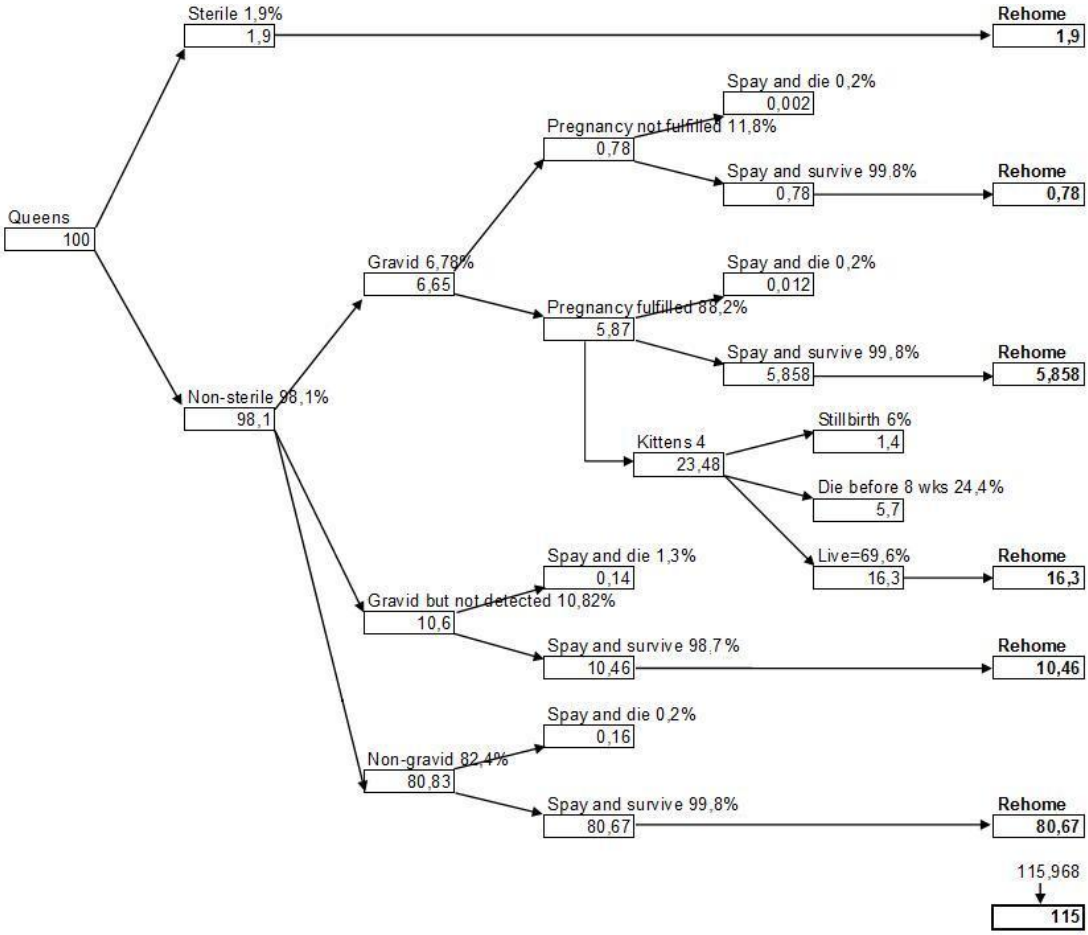
Appendix



Appendix 1. *The branch of the flow chart concerning shelter two, with a correction for the false negatives outcomes for ultrasound as the diagnostic method.*



Appendix 2. *The branch of the flow chart concerning shelter two, with a correction for the false negatives outcomes for abdominal palpation as the diagnostic method.*



Appendix 3. *The branch of the flow chart concerning shelter two, with a correction for the false negatives outcomes for radiography as the diagnostic method.*