

Juvenile castration in cats:
The current situation in the Netherlands



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1. Abstract

Cat overpopulation remains a problem in the Netherlands. Juvenile castration (6-16 weeks of age) can help facilitate adopting out young kittens which are unable to reproduce. As a result, problems with owner compliance are avoided and a shorter holding period for kittens in shelters can be achieved. While widely applied in the United States of America (USA), Dutch veterinarians seem reluctant to perform this procedure in kittens. A survey was sent to Dutch veterinarians, specialised in the field of companion animals, which showed that 21% of Dutch veterinarians perform juvenile castration and that this procedure constitutes 9.0% of the total number of castrations. Similar to other western countries, the majority of veterinarians (89%) recommends their clients to castrate cats at the 'traditional age' of 6-9 months of age ^[1-8]. Little scientific data supports this advice ^[9]. In addition to ethical objections, main concerns among veterinarians regarding juvenile castration are related to anaesthesia and long-term complications. However, research shows that short-term complications are similar to those in adult cats when appropriate care is taken regarding anaesthetic and surgical procedures. Many possible long term complications are either rejected or remain unproven. In the Dutch veterinary practice improvements concerning the procedure of juvenile castration can be executed especially regarding monitoring (i.e. temperature), recovery (feeding) and post operative pain management. Many veterinarians do not see juvenile castration as the right intervention to solve and prevent further overpopulation. However, there is a platform for awareness and advancement in this area since the majority of veterinarians believe there is currently overpopulation of cats and veterinarians should play a role in solving this problem. Practically applicable strategies can be created for long-term solutions regarding the current cat overpopulation. This may be achieved by creating a discussion among veterinarians, shelter personnel, researchers and the professional society for veterinary medicine.

2. Introduction

2.1 Background information

Many animal shelters in the Netherlands are populated with cats all year round. In the autumn and winter those cats are mostly half-grown and mature. From the beginning of March till the late summer the shelter also accommodates kittens born in this period.

In 2011 34,000 cats were admitted to Dutch animal shelters of which 26,000 cats were adopted out. Stray cats, which are often domestic cats that have lost or left their domestic home, form part of the problem of the surplus of cats in the Netherlands. 24,000 of the previously mentioned 34,000 cats that entered an animal shelter in 2011 were stray cats. An intact (stray) cat can produce a litter with multiple kittens two to three times a year which causes a rapid increase in stray cats in a particular area ^[10].

The *Dierenbescherming*, the Dutch society for the protection of animals, addresses this particular problem by educating the public and using the TNR method. With this method stray cats are Trapped, Neutered and afterwards Released back into their habitat to prevent overpopulation. In 2011 5,000 adult stray cats have been castrated and 4,000 stray kittens have been sheltered, socialised and adopted out. The *Dierenbescherming* receives a statutory contribution from the local municipality for the shelter of an animal for two weeks. However, the average time a cat stays in the shelter is four to six weeks. The *Dierenbescherming* is not a government agency, it also relies on donations from the public to fund the rest of the expenses ^[10].

Stray cats and their litters contribute greatly to the surplus of cats in the Netherlands ^[10]. Nevertheless, there is another issue which also forms part of the problem. Kittens that reside in shelters are adopted out around 8 weeks of age. During the adoption procedure the new owners sign an agreement to return the kittens after a few months in order to have them castrated. Even though most owners return the kittens for castration in time, other owners forget the appointment or do not see the necessity of the surgery. There are no data of owner compliance in the Netherlands but this is estimated to be < 60% in the USA ^[6,18]. The consequence of no castration is that those half-grown cats are theoretically able to reproduce at least once. This leads to the owner having to place a whole litter of kittens. There are two options for these kittens: either they are brought to an animal shelter thus adding to the shelter population or they are rehomed by the owner thus filling up cat homes available for shelter cats. Research among British cat owners shows that 19% of domestic cats had at least one unplanned litter ^[11], because they were not castrated in time, or not at all.

Castrating kittens before they are adopted would solve the problems with owner compliance. When the cats would be castrated at the 'traditional' age of 6 months ^[3,4,5], this would mean cats would have to stay in the shelter until that age. In the current overpopulated shelters, this is practically impossible and will create an animal welfare issue. Research has shown that there is a positive correlation between the duration of stay in a shelter and the risk of developing infectious diseases ^[12]. Also, early adoption is preferable to allow effective

socialisation^[6]. Applying juvenile castration allows for the adoption of young kittens while contributing to the prevention of cat overpopulation.

In literature there is a wide terminology to describe the castration of kittens at a young age. Early age neutering, paediatric neutering, prepubertal neutering and juvenile castration are all terms to describe the neutering of male and female cats at an early age. However, there is no exact age range that is considered to be “at an early age”. Different organisations and authors use different age limits. For instance, the American Society for the Prevention of Cruelty to Animals (ASPCA) defines paediatric, or early age neutering as castration at an age of 6-8 weeks^[13], whereas The American Veterinary Medical Association (AVMA) uses a wider age range of 8-16 weeks^[8]. In her article on clinical considerations of early neutering, Kustritz states that in the United States of America early age neutering is considered to occur between 6-14 weeks of age^[6] whereas Spain in his article on the long-term risks and benefits of early-age gonadectomy in cats uses a fairly wide age range of castration before 5,5 months of age to define early age neutering^[14]. When considering castration before the onset of puberty, i.e. when a cat can sustain a pregnancy without deleterious effects^[15], one has to bear in mind that queens can be sexually reproductive as early as 3.5 months of age^[16]. Therefore, in this study the age limits of 6-16 weeks are used as the definition of juvenile castration. This range includes the youngest adopted kittens, as well as the somewhat older kittens before they reach puberty.

Currently, juvenile castration is widely applied in America. As early as 1993 The American Veterinary Medical Association (AVMA) approved of a resolution stating “...AVMA supports the concept of early (8 to 16 weeks of age) ovariohysterectomies/ gonadectomies in dogs and cats in an effort to stem the overpopulation problem in these species”^[17].

However, in the beginning veterinarians in America had reservations about applying juvenile castration due to concern about anaesthesia in such young animals, as well as possible long term effects. These possible long term effects would include stunted growth, vaginitis, perivulvar dermatitis, urethral obstruction in male cats, urinary incontinence, impaired immunocompetence, obesity, and dermatologic, endocrine, cardiac, and behavioural abnormalities^[18].

Castration in such young animals also leads to questions about the safety of anaesthesia. From a physiological point of view the paediatric period is unique. Definitions of the paediatric period vary considerably, starting at two weeks of age ranging to 5-12 weeks of age^[14,22]. In paediatric animals the physiological differences with mature animals results in differences in pharmacokinetics and pharmacodynamics^[5,14]. Therefore, it is very important to adjust anaesthesia protocols specifically to these paediatric patients considering all those factors. Several anaesthesia protocols for juvenile patients are mentioned in literature^[6,19,23-25].

Meanwhile, several studies on short and long term effects of juvenile castration have been performed. Howe's^[5] study on short term complications indicates that when appropriate attention is given to surgical and anaesthetic techniques, morbidity and mortality rates are similar to those in traditionally aged cats (≥ 6 months) during the first week postoperatively.

Long term studies fail to support many of the concerns veterinarians have regarding long term complications ^[6-8,14,18-21].

There have been studies on the opinion of veterinarians on juvenile castration in the USA ^[4], the United Kingdom (UK) ^[2,26], New Zealand and Australia ^[26]. In the Netherlands *In Praktijk*, a journal for the veterinary practitioner, performed a small online survey in 2012 among veterinarians to investigate the opinion of Dutch veterinarians on early age neutering ^[1]. An extensive survey however, considering not only the present opinion of veterinarians on early age neutering but also the extent to which juvenile castration is already performed in Dutch veterinary practice and which anaesthesia protocols are used has not yet been conducted in the Netherlands.

This present research of the opinion of veterinarians on early age neutering, the extent to which juvenile castration is already performed in Dutch veterinary practice and which anaesthesia protocols are used is the first one among Dutch veterinarians.

2.2 Research question

What is the position of Dutch companion animal veterinarians on juvenile castration in (shelter) cats and how is it applied and performed in the Dutch veterinary practice?

Sub question: what are safe and effective anaesthesia protocols for juvenile castration?

2.3 Aim of the study

The aim of this study is twofold:

1. To describe the opinion of Dutch companion animal veterinarians on juvenile castration.
2. To describe how and to what extent juvenile castration is performed in Dutch veterinary practice, including the use of anaesthesia protocols.

2.4 Limitations of the study

A limitation is that the survey used in this study was filled out voluntarily. This may have led to non-response bias (non-response in this study was 69%; 578/834).

3. Materials and methods

3.1 Study design

Questionnaire

An online questionnaire containing 59 questions was sent to 863 companion animal veterinarians working in the Netherlands.

The questionnaire was used to obtain data relating to the present opinion of Dutch veterinarians on juvenile castration in cats, how and to what extent veterinarians perform this surgery and what anaesthesia protocols are used for juvenile castration in Dutch veterinary practice. Contact information was obtained from the *Koninklijke Nederlandse Maatschappij voor Diergeneeskunde* (KNMvD; the Royal Dutch Society for Veterinary Medicine). An accompanying letter in the email requested that the questionnaire should be completed within 3 weeks. A reminder was sent 2 weeks after the initial invite, requesting those veterinarians that had not yet filled in the questionnaire to do so before the due date.

3.2 Data analysis

Results from the questionnaire were originally presented in Excel format. Multiple hypotheses have been formulated involving binary variables which have been tested ($p < 0.05$) by means of the Chi-square test using a *Texas Instruments TI-83 Plus Graphing Calculator*. Other hypotheses involving quantitative variables have been tested ($p < 0.05$) by means of a two sample T-test. Tests have been performed using statistical analysis functions in the computer program *Microsoft Excel*.

3.2.1 Data on the respondents

Respondents were divided into groups representing different curricula depending on their graduation year. Since the standard duration of the training for veterinary medicine is six years, six years were subtracted from the provided graduation year and respondents were subsequently divided into the different curricula. Outliers which might have graduated within six years or those who might have taken more years to graduate may have been placed in the wrong group. However, this will most likely not be the case for many of the respondents.

4. Results

256 veterinarians completed the questionnaire, resulting in a response rate of 31% (256/834).

4.1 Data on the respondents

Of the respondents 39% (101/256) is male and 61% (155/256) is female.

Information regarding the different curricula in which the respondents received their education is presented in table 1.

Curriculum	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
1969 and earlier	26% (66/256)	± 5.4% 21%-31%
1982	44% (112/256)	± 6.1% 38%-50%
1995	18% (47/256)	± 4.8% 13%-23%
2001	11% (27/256)	± 3.8% 7%-15%
2007	1.6% (4/256)	± 1.5% 0.1%-3.1%

Table 1: Respondents divided into groups based on their curriculum, with corresponding 95% confidence intervals.

4.2 Work-related data

Respondents were asked whether they are an employee of either a veterinary clinic or an animal shelter, whether they work there as a veterinarian and whether they are an owner of the practice. Data are presented in tables 2,3 and 4. N.B. “An owner” represents both partial and single owners.

One of the respondents has indicated to be an employee both of a veterinary clinic and an animal shelter.

Place of employment	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Paid employees of a veterinary clinic	99% (253/256)	± 1.3% 98%-100%
Paid employees of an animal shelter	1.6% (4/256)	± 1.5% 0.1%-3.1%

Table 2: Respondents divided into groups based on their sector of employment, with corresponding 95% confidence intervals.

Nature of employment	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Employed as a veterinarian	98% (252/256)	± 1.5% 97%-100%
Otherwise employed within clinic or animal shelter	1.6% (4/256)	± 1.5% 0.1%-3.1%

Table 3: Respondents divided into groups based on the nature of their employment, with corresponding 95% confidence intervals.

Ownership	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
An owner of the clinic	63% (160/256)	± 5.9% 57%-69%
Not an owner of the clinic	37% (95/256)	± 5.9% 31%-43%

Table 4: Respondents divided into groups based on ownership of the clinic they work in, with corresponding 95% confidence intervals.

4.3 Clientele

Data on the clientele of veterinarians is presented in table 5. Data on the number of pet breeders veterinarians have as their clientele is presented in table 6.

Clientele	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Clients with individual or small quantities of pet animals not kept for breeding purposes	99% (247/250)	±1.4% 98%-100%
Clients with pet animals kept for breeding purposes	82% (205/250)	±4.8% 77%-87%
Animal shelters/traders	24% (61/250)	±5.3% 19%-29%

Table 5: Data on the veterinarians' clientele, with corresponding 95% confidence intervals.

Number of breeders as clientele	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
0-10	67% (147/221)	± 6.2% 61%-73%
10-30	29% (64/221)	± 6.0% 23%-35%
30-60	3.6% (8/221)	± 2.5% 1.1%-6.1%
> 60	0.9% (2/221)	± 1.3% 0.0%-2.2%

Table 6: Data on the number of breeders respondents have as clientele, with corresponding 95% confidence intervals.

4.4 Advised age at castration

Veterinarians were asked at what age they advise their clients to neuter their cats, making a distinction between male and female cats. Data are presented in tables 7 and 8. In a comment box several veterinarians remarked that they might consider neutering male cats before their advised age in the case of urine spraying behaviour. Others dis advise neutering male cats at all unless they start developing spraying behaviour.

Advised age at castration of a male cat	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
6-12 weeks	0.9% (2/231)	± 1.2% 0%-2.1%
3-5 months	8.2% (19/231)	± 3.5% 4.7%-12%
6-9 months	89% (205/231)	± 4.1% 85%-93%
10-12 months	8.2% (19/231)	± 3.5% 4.7%-12%

Table 7: Advised age at castration: male cats. With corresponding 95% confidence intervals.

Advised age at castration of a female cat	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
6-12 Weeks	0.4% (1/231)	± 0.8% 0%-1.2%
3-5 months	6.9% (16/231)	± 3.3% 3.6%-10%
6-9 months	89% (206/231)	± 4.0% 85%-93%
10-12 months	8.7% (20/231)	± 3.6% 5.1%-12%

Table 8: Advised age at castration: female cats. With corresponding 95% confidence intervals.

4.5 Veterinary opinion on juvenile castration

Respondents were asked if they felt that there is a surplus of cats in the Netherlands and whether or not veterinarians should play a role in resolving the problem of the surplus of cats in the Netherlands. Data are presented in tables 9 and 10.

Statement: There is a surplus of cats in the Netherlands	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Agreed	88% (204/231)	± 4.1% 84%-92%
Disagreed	12% (27/231)	± 4.1% 7.9%-16%

Table 9: Data on the respondents' opinion on the statement that there is a surplus of cats in the Netherlands, with corresponding 95% confidence intervals.

Statement: Veterinarians should play a role in resolving the problem of the surplus of cats in the Netherlands	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Agreed	91% (210/231)	± 3.7% 87%-95%
Disagreed	9.1% (21/231)	± 3.7% 5.4%-13%

Table 10: Data on the respondents' opinion on the statement that as a veterinarian they should play a role in resolving the surplus of cats in the Netherlands, with corresponding 95% confidence intervals.

The question to castrate cats before 4 months of age by clients has been received by 45% (103/231). Respondents that received this question were asked to indicate by whom they were asked to castrate cats before 4 months of age. These results are presented in table 11. 10 of these respondents indicate that they have received this question from other organisations such as the *Dierenbescherming* (n=6) and local workgroups (n=4), in order to castrate trapped (semi-) feral cats.

Type of clients which request juvenile castration	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Clients with individual or small quantities of pet animals not kept for breeding purposes	45% (43/96)	± 10% 35%-55%
Clients with pet animals kept for breeding purposes	49% (47/96)	± 10% 39%-59%
Animal shelters/traders	25% (24/96)	± 8.7% 16%-34%
Other, such as the <i>Dierenbescherming</i>	10% (10/96)	±6.1% 3.9%-16%

Table 11: Data on the different type of clients which requested the respondents to perform juvenile castration, with corresponding 95% confidence intervals.

Respondents were successively asked in which types of cats and for what reasons they would consider juvenile castration. These questions seem very much alike but might have given some insight for example as to which type of cats are believed to contribute to “the surplus of cats” had the similarity of the questions not led to confusion, deduced from remarks in the comment box. Also, the skipping of the second question by 42 respondents, makes interpretation of these results unreliable. Results from both questions are displayed in the text below and tables 12 and 13. However, since 42 respondents skipped the second, almost similar question, results from the former question (represented in table 11) might be more representative.

Type of cats in which juvenile castration would be considered	Percentage and number of respondents, presented in brackets	95% confidence interval for the percentage of respondents
Shelter cats	56% (130/231)	± 6.4% 50%-62%
Common household cats	17% (38/231)	± 4.8% 12%-22%
Purebred cats with or without pedigree	13% (31/231)	± 4.4% 8.6%-17%
None of these types of cats	43% (99/231)	± 6.4% 37%-49%

Table 12: Data on the different type of cats in which respondents would consider juvenile castration, with corresponding 95% confidence intervals. N.B. “common household cats” are those cats which are not kept specifically for breeding and without a clear breed.

The question concerning the reasons for which veterinarians would consider juvenile castration did not contain the possible answer “None of the above”. Therefore, respondents

who might not want to perform juvenile castration for any of these reasons were not able to answer this question satisfactorily.

Reasons for which juvenile castration would be considered	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
Surplus of cats	92% (173/189)	± 4.0% 88%-96%
Request from breeder; without medical necessity	19% (35/189)	± 5.5% 14%-25%
Request from pet owner; without medical necessity	19% (35/189)	± 5.5% 14%-25%

Table 13: Data on the motivations for which respondents would consider juvenile castration, with corresponding 95% confidence intervals.

The veterinarians were asked to indicate how they assessed the following statement: “In the future juvenile castration will have to be applied more frequently in cats in order to resolve the surplus of cats”. Results are presented in table 14.

Statement: “In the future juvenile castration will have to be applied more frequently in cats in order to resolve the surplus of cats”	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
Strongly agree	6.1% (14/231)	± 3.1% 3.0%-9.2%
Agree	28% (65/231)	± 5.8% 22%-34%
Neither agree nor disagree	28% (64/231)	± 5.8% 22%-33%
Disagree	29% (66/231)	± 5.8% 23%-34%
Strongly disagree	9.5% (22/231)	± 3.8% 5.7%-13%

Table 14: Data on the respondents’ opinion on the statement that, in the future, juvenile castration will have to be applied more frequently in cats in order to resolve the surplus of cats, with corresponding 95% confidence intervals.

4.5.1 Procedural, behavioural and health concerns

Respondents were asked to indicate which concerns they have regarding performing juvenile castration in cats of 6-10 weeks and 10-16 weeks of age respectively when compared to castration in a healthy, adult cat. The complete results are presented in tables 15 and 16.

For both age groups anaesthetic complications were the major concern among the majority of veterinarians. For the age group of 6-10 weeks 50% (115/231) are concerned about anaesthetic complications and another 37% (86/231) have strong concerns regarding this aspect. In the age group of 10-16 weeks 55% (128/231) are concerned about anaesthetic complications and another 19% (43/231) have strong concerns.

Over one third of the respondents are concerned about obesity when castrating at any age between 6-16 weeks.

The possibility of delayed closure of the epiphyseal growth plates is a concern among the majority of veterinarians in the age group of 6-10 weeks where 49% (114/231) have concerns and another 6.1% (14/231) have strong concerns. In the age group of 10-16 weeks this is slightly less with 46% (106/231) and 3.0% (7/231) respectively. There is some degree of concern about the occurrence of Salter-Harris fractures in the age group of 6-10 weeks (15%; 34/231) as well as in the age group of 10-16 weeks (13%; 30/231). One respondent added to have seen several cases of Legg–Calvé–Perthes syndrome after castrating young male cats. Another responded by mentioning the risk of the development of hip dysplasia in the Main Coon.

The majority of the respondents have no concern about increased aggression or shyness in both age groups. Whether shyness it is not expected as a possible consequence of early age neutering or whether it is not perceived as an actual problem is unclear.

Other mentioned concerns regarding early age neutering in general are ethical objections such as the risk of creating a narrow genetic base and disapproval of economical motives as reason to perform juvenile castration. An aesthetical concern mentioned is that male cats will not develop as beautifully as they do when they are castrated at a later age.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
<u>Procedure</u>						
	Complications arising from anaesthesia	3.5% (8)	6.1% (14)	3.5% (8)	50% (115)	37% (86)
	Surgical complications	12% (27)	36% (84)	19% (43)	25% (58)	8.2% (19)
<u>Behavioural changes</u>						
	Aggression	13% (30)	40% (93)	34% (78)	10% (23)	3.0% (7)
	Shyness	13% (29)	36% (83)	31% (72)	18% (42)	2.2% (5)
<u>Effects on health</u>						
	Perioperative infections	16% (36)	45% (104)	25% (58)	13% (29)	1.7% (4)
	Immune deficiencies	14% (32)	40% (92)	31% (71)	12% (28)	3.5% (8)
	Diabetes Mellitus	15% (35)	44% (102)	36% (82)	3.5% (8)	1.7% (4)
	Urine Incontinence	12% (28)	39% (91)	30% (69)	16% (37)	2.6% (6)
	Feline lower urinary tract disease (FLUTD)	10% (24)	34% (78)	26% (60)	25% (56)	5.2% (12)
	Perivulvar dermatitis	11% (26)	36% (82)	36% (83)	14% (33)	3.0% (7)
	Dermatological conditions	13% (30)	45% (104)	35% (81)	5.2% (12)	1.7% (4)
	Stunted growth	13% (29)	36% (84)	23% (52)	26% (60)	2.6% (6)
	Delayed closing of the epiphyseal growth plates	5.6% (13)	15% (35)	24% (55)	49% (114)	6.1% (14)
	Salter-Harris fractures	8.2% (19)	19% (44)	58% (134)	12% (27)	3.0% (7)
	Obesity	8.2% (19)	26% (60)	31% (74)	32% (74)	2.6% (6)
	Cardiac conditions	11% (26)	32% (74)	42% (97)	11% (26)	3.5% (8)

Table 15: The extent to which veterinarians have concerns regarding castration in cats of 6-10 weeks of age compared to castration in a healthy adult cat. Results are presented in percentages and the number of respondents (n=231), presented in brackets. Results per concern which were most often selected are marked in green.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
<u>Procedure</u>						
	Complications arising from anaesthesia	3.9% (9)	14% (33)	7.8% (18)	55% (128)	19% (43)
	Surgical complications	13% (30)	42% (97)	21% (49)	21% (49)	2.6% (6)
<u>Behavioural changes</u>						
	Aggression	13% (31)	42% (97)	33% (75)	10% (24)	1.7% (4)
	Shyness	13% (30)	39% (90)	31% (71)	17% (38)	0.9% (2)
<u>Effects on health</u>						
	Perioperative infections	16% (38)	47% (108)	27% (63)	9.1% (21)	0.4% (1)
	Immune deficiencies	13% (31)	41% (95)	34% (78)	10% (23)	1.7% (4)
	Diabetes Mellitus	15% (34)	45% (104)	35% (80)	4.8% (11)	0.9% (2)
	Urine Incontinence	12% (27)	41% (95)	31% (72)	15% (35)	0.9% (2)
	Feline lower urinary tract disease (FLUTD)	11% (26)	36% (84)	25% (57)	24% (56)	3.5% (8)
	Perivulvar dermatitis	13% (30)	38% (88)	36% (83)	12% (28)	0.9% (2)
	Dermatological conditions	14% (32)	42% (98)	37% (85)	6.1% (14)	0.9% (2)
	Stunted growth	11% (26)	40% (93)	27% (62)	20% (47)	1.3% (3)
	Delayed closing of the epiphyseal growth plates	6.5% (15)	18% (42)	26% (61)	46% (106)	3.0% (7)
	Salter-Harris fractures	9.1% (21)	23% (54)	55% (126)	11% (25)	2.2% (5)
	Obesity	8.7% (20)	25% (58)	31% (71)	34% (79)	1.3% (3)
	Cardiac conditions	13% (29)	33% (76)	42% (96)	11% (26)	1.7% (4)

Table 16: The extent to which veterinarians have concerns regarding castration in cats of 10-16 weeks of age compared to castration in a healthy adult cat. Results are presented in percentages and the number of respondents (n=231), presented in brackets. Results per concern which were most often selected are marked in green.

4.6 Juvenile castration

Juvenile castration is performed by 23% (53/231) of the respondents. Only 5.7% (3/53) of the 53 veterinarians that perform juvenile castration are in paid service of an animal shelter, all others are in paid service of a veterinary practice.

The following factors will be examined for a possible relationship with the likeliness to operate on cats <4 months of age.

N.B. “Likeliness” : respondents indicated to perform juvenile castration.

- A. Gender.
- B. Curriculum in which the veterinarian started.
- C. Employment either by a veterinary clinic or an animal shelter.
- D. Facilities that group house cats as clientele.
- E. Receiving the question to castrate cats <4 months of age from animal shelters.
- F. Breeders as clientele.
- G. Number of breeders as clientele.
- H. Receiving the question to castrate cats <4 months of age from breeders.
- I. Opinion on the existence of a surplus of cats in the Netherlands.
- J. Opinion on the duty of a veterinarian in trying to solve the problem of the surplus of cats in the Netherlands.
- K. Opinion on the question whether juvenile castration will have to be applied more frequently in the future to resolve the surplus of cats.

The following hypotheses were constructed to establish whether there are relationships between these factors and the likeliness to operate on cats <4 months of age

- A. H₀: There is no difference in the likeliness to castrate cats <4 months of age between genders.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between genders.
- B. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who started in different curricula.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who started in different curricula.
- C. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who are in paid service of a veterinary clinic and those who in paid service of an animal shelter.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who are in paid service of a veterinary clinic and those who in paid service of an animal shelter.
- D. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do and do not have facilities that group house cats as clientele.

- H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do and do not have facilities that group house cats as clientele.
- E. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from animal shelters.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from animal shelters.
- F. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do and do not have breeders as clientele.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do and do not have breeders as clientele.
- G. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians with varying numbers of breeders as their clientele.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians with varying numbers of breeders as their clientele.
- H. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from breeders.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from breeders.
- I. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel there is a surplus of cats in the Netherlands.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel there is a surplus of cats in the Netherlands.
- J. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel veterinarians ought to play a role in resolving the problem of a surplus of cats in the Netherlands.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel veterinarians ought to play a role in resolving the problem of a surplus of cats in the Netherlands.
- K. H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel that juvenile castration will have to be applied more frequently in the future in order to resolve the problem of a surplus of cats in the Netherlands.
H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel that juvenile castration will have to be applied more frequently in the future in order to resolve the problem of a surplus of cats in the Netherlands.

Because this involves binary variables the above mentioned hypotheses are tested ($p < 0.05$) by means of the Chi-square test. Full results can be found in appendix 8.1. Table 17 shows the

factors examined and whether the corresponding null hypotheses are rejected or not, with their corresponding p -value.

Assessed factors	H_0 rejected yes/no (p -value)	When rejected, in favour of:
A. Gender	No p : 0.4127	
B. Curriculum in which the veterinarian started	No p : 0.290	
C. Employment either by a veterinary clinic or an animal shelter	Yes p : 0.002	Those employed by an animal shelter are more likely to perform juvenile castration.
D. Facilities that group house cats as clientele	Yes p : 0.025	Those that have facilities that group house cats as clientele are more likely to perform juvenile castration.
E. Receiving the question to castrate cats <4 months of age from animal shelters	Yes p : 0.000	Those that receive the question to castrate cats <4 months of age from animal shelters are more likely to perform juvenile castration.
F. Breeders as clientele	Yes p : 0.041	Those that have breeders as clientele are more likely to perform juvenile castration.
G. Number of breeders as clientele	No p : 0.660	
H. Receiving the question to castrate cats <4 months of age from breeders	Yes p : 0.000	Those that receive the question to castrate cats <4 months of age from breeders are more likely to perform juvenile castration.
I. Opinion on the existence of a surplus of cats in the Netherlands	No p : 0.695	
J. Opinion on the duty of a veterinarian to work on the problem of the surplus of cats in the Netherlands	No p : 0.921	
K. Opinion on the question whether juvenile castration will have to be applied more frequently in the future to tackle the surplus of cats.	Yes p : 0.000	Those that are of the opinion that juvenile castration will have to be applied more in the future are more likely to perform juvenile castration.

Table 17: Factors examined and whether the null hypotheses are rejected or not, with their corresponding p -value.

Note on the results

Unfortunately the sample size does not have enough power. The 95% confidence intervals are very wide, some more than others. For exact data see appendix 8.1. Some null hypotheses are rejected on the basis of the result of the chi squared test. Because of this sample size, results should be seen as a mere assessment and indication rather than facts.

4.7 Additional results from veterinarians not performing juvenile castration

The 178 respondents who indicated not to perform juvenile castration were presented with a set of statements as to why they do not perform juvenile castration. The results are presented in table 18. The sense that it feels wrong to operate on such young animals without medical necessity is reason for 68% (121/177) not to perform juvenile castration. Also, the sense that the appliance of anaesthesia, irrespective of the protocol, is not justifiable in such young animals when there is no medical necessity is reason for 65% (115/177) not to perform juvenile castration. The idea that a lack of experience in the field of surgery and anaesthesia the respondents deem necessary to perform surgery on such young animals is reason not to perform this procedure is not supported by 59% (105/177). The possible lack of a correct anaesthesia protocol for surgery in such young animals as a reason not to castrate on cats <4 months of age is rejected by 60% (107/177). The small size of the structures in these kittens is no reason not to perform juvenile castration for 66% (117/177) of the respondents. Opinions on possible long term complications as a reason not to perform juvenile castration were more or less evenly divided among agreed, neither agreed nor disagreed and disagreed.

The respondents that do not perform juvenile castration were asked whether they would consider performing juvenile castration when they would be provided with a safe, effective anaesthesia protocol for cats less than 4 months of age. *Anaesthesia protocol: the set of resources and actions which are applied during anaesthesia; in other words the drugs, fluid therapy, monitoring, thermoregulation etcetera etcetera.* The majority of the respondents would not (51%; 90/177), 15% (27/177) would consider and 34% (60/177) might consider juvenile castration given a safe and effective anaesthesia protocol.

Reasons not to perform juvenile castration	Agreed	Neither agreed nor disagreed	Disagreed
It feels wrong to operate on such young animals without medical necessity.	68% (121/177)	10% (18/177)	22% (38/177)
The appliance of anaesthesia, irrespective of the protocol, is not justifiable in such young animals when there is no medical necessity.	65% (115/177)	11% (20/177)	24% (42/177)
A lack of experience in the field of surgery and anaesthesia the respondents deem necessary to perform surgery on such young animals	20% (35/177)	21% (37/177)	59% (105/177)
A lack of a correct anaesthesia protocol for surgery in such young animals.	20% (35/177)	20% (35/177)	60% (107/177)
The small size of the structures in these kittens.	14% (24/177)	20% (36)	66% (117/177)
Possible long term complications	37% (66/177)	31% (54/177)	32% (57/177)

Table 18: Reasons not to perform juvenile castration. Percentage and number of respondents, presented in brackets.

At this point veterinarians who do not perform juvenile castration have completed the questionnaire and the following results are solely from those 53 respondents who have indicated to castrate cats before 4 months of age.

4.8 Additional results from veterinarians performing juvenile castration

53 respondents indicated to perform juvenile castration. Only 51 however chose to answer the subsequent questions designed for this group.

Those veterinarians that indicated to perform juvenile castration were asked in which cats they do so, making a distinction between shelter cats, common household cats and purebred cats with or without pedigree. Juvenile castration is performed in shelter cats by 61% (31/51), in common household cats by 39% (20/51) and in purebred cats with or without pedigree by 43% (22/51).

4.8.1 Number of castrations

Respondents were then asked to indicate the number of castrations in cats they perform per year in cats both older and younger than 4 months of age.

3 of the 51 respondents are in paid service of an animal shelter, of which one is also in paid service of a veterinary clinic. All other veterinarians (48) work solely in paid service of a veterinary clinic.

4.8.1.1 Number of castrations per year for veterinarians in paid service of a veterinary clinic

The following calculations are of the 49 respondents who work in paid service of a veterinary clinic. In total, 715 castrations <4 months of age were performed with a mean of 16 and a median of 5 per veterinarian. In total 9790 castrations >4 months of age were performed with a mean of 200 per veterinarian and a median of 150 per veterinarian.

Calculations were made for each respondent regarding the percentage of the castrations performed in cats less than 4 months of age. These results gave a mean of 8.9% and a median of 3.2%. In this case the median might be more representative than the mean since one respondent indicated to perform 1 castration a cat <4 months of age consequently leading to a percentage of 100. Without this percentage (100%) the mean would be 7.0% instead of 8.9%. The median stays the same (3.2%).

4.8.1.2 Number of castrations per year for veterinarians in paid service of an animal shelter

Calculations for the three veterinarians in paid service of an animal shelter, who performed a total of 109 castrations <4 months of age which resulted in a mean of 36 and a median of 30 per veterinarian. In total 880 castrations >4 months of age were performed with a mean of 293 per veterinarian and a median of 300 per veterinarian. Again, calculations were made for each respondent regarding the percentage of the castrations performed in cats less than 4 months of age. These results gave a mean of 9.0% and a median of 9.1%.

		<i>Veterinarians in paid service of an veterinary clinic (n=49)</i>	<i>Veterinarians in paid service of an animal shelter (n=3)</i>
<i>Castrations < 4 months of age per year</i>			
	<i>Total</i>	715	109
	<i>Mean</i>	16	36
	<i>Median</i>	5	30
<i>Castrations > 4 months of age per year</i>			
	<i>Total</i>	9790	880
	<i>Mean</i>	200	293
	<i>Median</i>	150	300
<i>Percentage of castrations <4 months with respect to the total number of castrations performed by the individual respondent</i>			
	<i>Mean</i>	8.9	9.0
	<i>Median</i>	3.2	9.1

Table 19: Calculations regarding castrations performed in a year in cats both older and younger than 4 months of age, evaluated for their total, mean and median score for both veterinarians in paid service of a veterinary clinic and those in paid service of an animal shelter.

4.8.1.3 Hypotheses testing

Separate calculations were made for those respondents that work for a veterinary clinic and those who work for an animal shelter, to see if this leads to a significant different number of castrations both older and younger than 4 months of age and whether there is a significant different percentage of castrations performed in cats less than 4 months of age. These calculations will be made since it is plausible that those veterinarians who work in paid service of an animal shelter perform more castrations in general due to the nature of their patients. This results in the following hypotheses:

Hypothesis 1:

H0: There is no difference in the mean value of the number of castrations < 4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

H1: There is a difference in the mean value of the number of castrations < 4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

Hypothesis 2:

H0: There is no difference in the mean value of the number of castrations > 4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

H1: There is a difference in the mean value of the number of castrations > 4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

Hypothesis 3:

H0: There is no difference in the mean value of the percentage of castrations performed less than 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

H1: There is a difference in the mean value of the percentage of castrations performed less than 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

The hypotheses will be tested by means of a two sample T-test using $p < 0.05$. Tests are performed using statistical analysis functions in the computer program Microsoft Excel.

4.8.1.4 Results of the two sample T-test

Note: one of the respondents that is in paid service of an animal shelter is also in paid service of a veterinary clinic. This respondent has been included in both calculations.

Hypothesis 1:

H₀: There is no difference in the mean value of the number of castrations < 4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

H₁: There is a difference in the mean value of the number of castrations < 4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

		<i>Veterinarians in paid service of a veterinary clinic (n=49)</i>	<i>Veterinarians in paid service of an animal shelter (n=3)</i>
<i>Castrations <4 months of age per year</i>			
	Mean	15	36
	Variance	704.50	1290.33
	95% confidence interval for the mean	7.2-22	0-77

Table 20: Statistical data regarding the number of castrations < 4 months of age per year

The confidence interval for veterinarians in paid service of an animal shelter for the mean of the number of castrations <4 months of age per year is so wide, that it theoretically even extends below zero. Practically values below zero are not possible. Since this interval is very wide, the information one can gather from it is very limited.

Because the variances of both groups are very far apart, a two sample T-test was used assuming unequal variances. The test gives a p-value of 0.405. The null hypothesis is not rejected because $p > 0.05$. There is no significant difference in the mean value of the number of castrations <4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter. That is, based on these test results one cannot state that veterinarians in paid service of an animal shelter castrate more or less cats <4 months of age per year than veterinarians in paid service of a veterinary clinic do.

Hypothesis 2:

H₀: There is no difference in the mean value of the number of castrations per year > 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

H₁: There is a difference in the mean value of the number of castrations per year > 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

		<i>Veterinarians in paid service of a veterinary clinic (n=49)</i>	<i>Veterinarians in paid service of an animal shelter (n=3)</i>
<i>Castrations > 4 months of age per year</i>			
	Mean	200	293
	Variance	29,010.37	12,133.33
	95% confidence interval for the mean	152-247	169-418

Table 21: Statistical data regarding the number of castrations > 4 months of age per year

The confidence intervals for the mean for both groups are very wide. Especially the confidence interval for the group of veterinarians in paid service of an animal shelter is very wide, which can be expected from the small sample size. One can be 95% sure that the mean for the population lies within this confidence interval. Since this interval is very wide, the information one can gather from it is very limited.

Because the variances of both groups widely spread, a two sample T-test is used assuming unequal variances. The test gives a p-value of 0.275. The null hypothesis is not rejected because $p > 0.05$. There is no significant difference in the mean value of the number of castrations >4 months of age per year between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter. That is, based on these test results one cannot state that veterinarians in paid service of an animal shelter castrate more or less cats >4 months of age per year than veterinarians in paid service of a veterinary clinic do.

Hypothesis 3:

H₀: There is no difference in the mean value of the percentage of castrations performed less than 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

H₁: There is a difference in the mean value of the percentage of castrations performed less than 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter.

		<i>Veterinarians in paid service of a veterinary clinic (n=49)</i>	<i>Veterinarians in paid service of an animal shelter (n=3)</i>
<i>Percentage of castrations <4 months with respect to the total number of castrations</i>			
	Mean	8.9	9.0
	Variance	288	46
	95% confidence interval for the mean	4.2-14	1.3-17

Table 22: Statistical data regarding the percentage of castrations <4 months with respect to the total number of castrations.

Because the variances of both groups are very far apart, a two sample T-test is used assuming unequal variances. The test gives a p-value of 0.9856. The null hypothesis is not rejected because $p > 0.05$. There is no significant difference in the mean value of the percentage of castrations performed less than 4 months of age between veterinarians in paid service of a veterinary clinic and veterinarians in paid service of an animal shelter. That is, based on these test results one cannot state that veterinarians in paid service of an animal shelter castrate relatively more or less cats under the age of 4 months than veterinarians in paid service of a veterinary clinic do.

4.8.2 Anaesthesia and perioperative care

From this point onwards the questionnaire contains questions concerning the preoperative care, anaesthesia and surgery and postoperative care. The reason for gathering this information is to obtain representative values of Dutch veterinary medicine and care concerning the castration of cats <4 months of age.

4.8.2.1 Minimum age and weight limits

Respondents were asked whether they use a minimum age and weight limit and to quantify those when they do. No minimum weight nor age limit is used by 16% (8/51). Both a minimum weight and age limit is applied by 22% (11/51). A minimum weight limit but not a minimum age limit is used by 7.8% (4/51) and a minimum age limit but not a minimum weight limit is applied by 55% (28/51). One respondent who indicated to use both a minimum weight and age limit failed to provide information about those limits which, for the calculation of age and weight limits, lead to a sample size of 50. The mean and median

minimum age limit are 14 and 12 weeks respectively with n=38. The mean and median minimum weight limit are 1.46 and 1.25 kg respectively with n=14. Results are presented in tables 23 and 24.

Minimum age and weight limits	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
No limit	16% (8/51)	±10 % 6%-26%
Both age and weight limit	22% (11/51)	± 11% 11%-33%
Age limit, no weight limit	55% (28/51)	± 14% 41%-69%
Weight limit, no age limit	7.8% (4/51)	± 7.4% 0.4%-15%

Table 23: Data on the use of age and weight limits, with corresponding 95% confidence intervals.

Minimum limits	Median	Mean	95% confidence interval for the mean
Age limit (n=38)	12 weeks	14 weeks	± 1.5 12.5 – 15.5 weeks
Weight limit (n=14)	1.25 kg	1.46 kg	± 0.15 kg 1.31 kg – 1.61 kg

Table 24: Data on the minimum age and weight limits used by respondents, with corresponding 95% confidence intervals.

Juvenile castration solely in cats 10-16 weeks of age is performed by 82% (42 /51) while this is done in both age groups by 18% (9/51) of the respondents.

4.8.2.2 Food and water withholding

Respondents were asked to indicate at which point before anaesthesia they choose to withhold food and water from cats in the age groups of 6-10 and 10-16 weeks. Only those respondents which indicated to perform castration in the age group of 6-10 weeks are asked to fill in the requested information in this particular age group.

Food withholding in the age group of 6-10 weeks. A third (33%; 3/9) chooses to withhold food less than one hour prior to surgery. A full overview of the results is presented in table 25.

Duration of food withholding prior to the operation	Percentage and number of respondents, presented in brackets.
<1 hour prior to the operation	33% (3/9)
1-2 hours prior to the operation	11% (1/9)
2-3 hours prior to the operation	22% (2/9)
3-4 hours prior to the operation	22% (2/9)
4-5 hours prior to the operation	0.0% (0)
>5 hours prior to the operation	11% (1/9)

Table 25: Food withholding prior to anaesthesia in the age group of 6-10 weeks.

Water withholding in the age group of 6-10 weeks. A majority of 89% (8/9) choose not to withhold water from the kittens at all. A full overview of the results is shown in table 26.

Duration of water withholding prior to the operation	Percentage and number of respondents, presented in brackets.
No withholding	89% (8/9)
<1 hour prior to operation	0.0% (0)
1-2 hours prior to operation	11% (1/9)
>2 hours prior to operation	0.0% (0)

Table 26: Water withholding prior to anaesthesia in the age group of 6-10 weeks.

Food withholding in the age group of 10-16 weeks.

Almost a third (32%; 16/50) chooses to withhold food more than five hours prior to surgery.

A full overview of the results is shown in table 27.

Duration of food withholding prior to the operation	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
<1 hour prior to the operation	12% (6/50)	± 9.0% 3.0%-21%
1-2 hours prior to the operation	14% (7/50)	± 10% 4%-24
2-3 hours prior to the operation	16% (8/50)	± 10% 6.0%-26%
3-4 hours prior to the operation	14% (7/50)	± 9.6% 4.4%-24%
4-5 hours prior to the operation	12% (6/50)	± 9.0% 3%-21%
>5 hours prior to the operation	32% (16/50)	± 13% 19%-45%

Table 27: Food withholding prior to anaesthesia in the age group of 10-16 weeks, with corresponding 95% confidence intervals.

Water withholding in the age group of 10-16 weeks.

A majority of 86% (43/50) choose not to withhold water prior to surgery at all.

A full overview of the results is shown in table 28.

Duration of water withholding prior to the operation	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
No withholding	86% (43/50)	± 9.6% 76%-96%
<1 hour prior to operation	6.0% (3/50)	± 6.6% 0.0%-13%
1-2 hours prior to operation	4.0% (2/50)	± 5.4% 0.0%-9.4%
>2 hours prior to operation	4.0% (2/50)	± 5.4% 0.0%-9.4%

Table 28: Water withholding prior to anaesthesia in the age group of 10-16 weeks, with corresponding 95% confidence intervals.

4.8.2.3 Anaesthesia protocol

Anaesthesia protocol: this contains all the resources and actions which are applied during anaesthesia; i.e. the drugs, fluid therapy, monitoring, thermoregulation etcetera.

An anaesthesia protocol adapted specifically for cats <4 months of age is used by 68% (25/37) of the veterinarians whereas 32% (12/37) does not differentiate between cats older or younger than 4 months of age regarding their anaesthesia protocol.

Respondents were asked to answer questions concerning the anaesthesia protocol they use for cats <4 months of age which undergo castration, whether this is specifically adapted to this age group or not.

4.8.2.3.1 Drug dosage

Metabolic weight is used for the calculation of the drug dosage by 14% (5/37) whereas 78% (29/37) uses body weight for this calculation. Some veterinarians use both depending on the body weight of the cat (8.1%; 3/37). Above a certain body weight limit body weight is used to calculate drug dosage, under this weight limit metabolic weight is used. The mean and median weight limit used by these respondents are 1.3 kg and 1.0 kg respectively.

Drug dosage	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
Bodyweight	78% (29/37)	± 13% 65%-91%
Metabolic weight	14% (5/37)	± 11% 3.0%-25%
Either bodyweight or metabolic weight depending on bodyweight	8.1% (3/37)	± 8.8% 0%-17%

Table 29: Data on drug dosage, with corresponding 95% confidence intervals.

4.8.2.3.2 Medication

Respondents were asked to provide information concerning the use of perioperative drugs. These include anaesthetics, analgesics and antibiotics. They were asked to indicate the type of drugs, their dosage and route of administration. 37 respondents provided this information. However, 4 respondents did not provide complete information about the use of anaesthetics and are therefore excluded from the statistics regarding anaesthetics.

4.8.2.3.2.1 Anaesthetics

33 respondents provided information about the type of anaesthetics used during the castration of a cat under the age of 4 months.

An α -2 receptor agonist is part of the anaesthesia protocol in 88% (29/33) of the protocols. Medetomidine is used in 69% (20/29), dexmedetomidine in 28% (8/29) and xylazine in 3.4% (1/29) of the cats.

A majority of 52% (17/33) of the veterinarians uses an α -2 receptor agonist solely in combination with the dissociative anaesthetic ketamine. One of the veterinarians indicates to use this combination in queens, but another in toms. Other frequently used combinations are an α -2 receptor agonist, ketamine, buprenorphine and midazolam (12%; 4/33) and the combination of an α -2 receptor agonist, ketamine and buprenorphine (9%; 3/33).

α -2 receptor agonists are used in combination with ketamine in 93% (27/29) of the protocols, with or without the addition of other anaesthetic drugs.

An overview of all combinations used by the respondents is presented in table 30.

Combinations of anaesthetic drugs	Percentage and number of respondents (n=33), presented in brackets.
α -2 receptor agonist + ketamine*	52% (17/33) *
α -2 receptor agonist + ketamine + buprenorphine + midazolam	12% (4/33)
α -2 receptor agonist + ketamine + buprenorphine	9.1% (3/33)
Midazolam + methadone + propofol	6.1% (2/33)
α -2 receptor agonist + ketamine + buprenorphine + alfaxalone/isoflurane	3.0% (1/33)
α -2 receptor agonist + ketamine + isoflurane	3.0% (1/33)
α -2 receptor agonist + ketamine + midazolam	3.0% (1/33)
α -2 receptor agonist + midazolam + propofol	3.0% (1/33)
α -2 receptor agonist + methadone + local lidocaine**	3.0% (1/33) **
α -2 receptor agonist + butorphanol	3.0% (1/33)
Buprenorphine + isoflurane	3.0% (1/33)
Isoflurane	3.0% (1/33)

Table 30: Combinations of anaesthetic drugs used by respondents, not including non-steroidal anti-inflammatory drugs (NSAIDs)

*One of the respondents uses this combination for a queen but another for a tom

** This respondent (same as in *) uses this combination for a tom but another for a queen

4.8.2.3.2.2 Antibiotics

Antibiotics are used in 38% (14/37) of the cats; amoxicillin is used in 50% (7/14), penicillin in 29% (4/14) and ampicillin in 21% (3/14) of the cats. One respondent indicated to use antibiotics (amoxicillin) only in queens, not in toms.

4.8.2.3.2.3 Postoperative pain management

Painkillers for postoperative period are not prescribed by 51% (19/37). Of the respondents that do prescribe painkillers (49%; 18/37) this is done in a routine fashion by 89% (17/19) and in some cases by 11% (2/19) of the respondents. Overall use of postoperative painkillers were orally administrated NSAIDs given during 3-5 days. Types of NSAIDs mentioned are carprofen, tolfedine, onsior, novacam and metacam. Information about their registration in the Netherlands and their selectivity are presented in table 31.

Analgesics for the postoperative period are not prescribed in 51% (19/37) of the cases. Some of the respondents that prescribe painkillers (49%; 18/37) do this in a routine fashion (89%; 17/19) and the rest of the veterinarians (11%; 2/19) prescribe them in some cases .

The postoperative analgesics were NSAID's administered orally during 3-5 days. NSAID's used are carprofen, tolfenamic acid, robenacoxib and meloxicam. Information concerning the registration of these drugs in the Netherlands and their selectivity is presented in table 31.

NSAIDs	Registered for postoperative pain relief after castration / soft tissue surgery for cats in oral form in the Netherlands?	Selectivity
Carprofen	No	Selective COX-2 inhibitor
Onsior® Robenacoxib	No	Selective COX-2 inhibitor
Novacam® (Meloxicam)	No	Selective COX-2 inhibitor
Tolfedine® (Tolfenamic acid)	Yes	Non-selective
Metacam® (Meloxicam)	Yes	Selective COX-2 inhibitor

Table 31: Data on NSAIDs used, registration and selectivity ^[39].

4.8.2.3.3 Airway patency

A laryngeal mask is used in a routine fashion in 16% (6/37) of the cats and incidentally in 5.4% (2/37). Endotracheal intubation is performed in a routine fashion in 24% (9/37) of the cats and incidentally in 30% (11/37). No technique for securing the airway is used in 32% (12/37) of the patients.

	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
Standard use of laryngeal mask	16% (6/37)	± 12% 4.0%-28%
Occasional use of laryngeal mask	5.4% (2/37)	± 7.3% 0.0%-13%
Standard endotracheal intubation	24% (9/37)	± 14% 10%-38%
Occasional endotracheal intubation	30% (11/37)	± 15% 15%-45%
Neither	32% (12/37)	± 15% 17%-47%

Table 32: Data on the use of laryngeal masks and endotracheal intubation, with corresponding 95% confidence intervals.

4.8.2.3.4 Monitoring

Respondents were asked what type of monitoring was used during anaesthesia. The results are presented in table 33.

Results assessed per respondent revealed that only visual monitoring of the patient's respiration as a means of monitoring is used by 19% (7/37). Other veterinarians (16%; 6/37)

are using visual monitoring of the patient's respiration and incidental measurement of the body temperature as form of monitoring. The patient's temperature is not measured during anaesthesia by 49% (18/37) of the respondents. One respondent indicated to use oscillometric blood pressure measurements in addition to other types of monitoring.

Type of monitoring	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
Respiration, visually	81% (30/37)	± 13% 68%-94%
Heart rate via pulse/ictus	51% (19/37)	±16% 35%-67%
Capnography	27% (10/37)	± 14% 13%-41%
Electrocardiography (ECG)	30% (11/37)	± 15% 15%-45%
Pulse oximetry	24% (9/37)	± 14% 10%-38%
Temperature monitoring: continuous measurement by means of a oesophagus thermometer	16% (6/37)	± 12% 4.0%-28%
Temperature monitoring: incidental measurement with a thermometer	35% (13/37)	± 15% 20%-50%

Table 33: Type of monitoring: Percentage and number of respondents (n=37) which use the different types of monitoring during anaesthesia, with corresponding 95% confidence intervals.

None of the respondents monitors blood glucose during the perioperative period.

4.8.2.3.5 Thermoregulation

Respondents were asked what measures are taken to minimise heat loss during anaesthesia. Results are presented in table 34.

Type of measure	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
Minimal hair clipping	70% (26/37)	± 15% 55%-85%
Disinfection with Betadine® solution	11% (4/37)	± 10% 1.0%-21%
Maintaining an ambient temperature of >24 °C	30% (11/37)	±15% 15%-45%
Heat pads (warm water of electrical)	89% (33/37)	±10% 79%-99%
Bairhugger®	0.0% (0)	
Wrapping in foil or plastic	8.1% (3/37)	± 8.8% 0.0%-17%
Hotpacks	8.1% (3/37)	± 8.8% 0.0%-17%
Hot water bottles (includes self-made devices)	46% (17/37)	± 16% 30%-62%

Table 34: Percentage and number of respondents (n=37) using different types of measures to minimise heat loss during anaesthesia, with corresponding 95% confidence intervals.

Results assessed per respondent show that all use at least one of those measures to minimise heat loss.

4.8.2.3.6 Fluid therapy

Fluid therapy is not provided during the perioperative period by 54% (20/37) of the respondents. Fluid therapy is provided in a routine fashion by 14% (5/37) and on occasion by 32% (12/37). Of the respondents that use fluid therapy normal saline solution is used by 22% (8/17), Lactated Ringer's by 5.4% (2/17), either normal saline solution or Lactated Ringer's by 8.1% (3/17), a combination of normal saline solution and glucose solution by 8.1% (3/17) and Hartmann's solution by 2.7% (1/17). Subcutaneous fluid therapy is provided by 59% (10/17) of the veterinarians, intravenously by 18% (3/17) and either subcutaneously or intravenously by 24% (4/17). Not all respondents gave an exact amount or rate of fluid therapy. Most respondents indicated that the specific amount depends on body weight, the health status of the kitten and/or circumstances. The amount of fluid administered subcutaneously varies from 15-50ml/kitten. The amount of fluid administered intravenously varies from 1-10ml/kg/h.

4.8.2.3.7 Recovery

Anaesthesia is antagonised by 87% (32/37) of the respondents. All use the alpha2-adrenergic antagonist atipamezole hydrochloride (*Antisedan*®, *Atipam*®, *Sedastop*®). One respondent indicated to use flumazenil, a benzodiazepine receptor antagonist when necessary. Respondents were asked at which point in time they choose to antagonise anaesthesia. Two

respondents failed to provide information. Some veterinarians antagonise anaesthesia when the recovery phase is prolonged (17%; 5/30), others antagonise directly after surgery (33%;10/30) and 50% (15/30) of the respondents antagonises minutes after closing the wound, with a mean of 18 minutes and a median of 15 minutes.

The majority of the respondents advises to feed the kitten as soon as it returns home/in the shelter (54%; 20/37), others feed the kitten when it is able stand up (24%; 9/37) and others (22%; 8/37) use different criteria such as time (ranging from 2-5 hours after surgery) or the somewhat arbitrary notion of being “fully awake”.

One respondent indicated to perform surgery on feral cats and “feeding” was not possible. This response was not included in the statistics.

When the kitten does not eat spontaneously after surgery, the majority of the respondents do not proceed to force feed the kittens (68%; 25/37). Respondents that indicated to force feed the kitten when it does not eat spontaneously after surgery (32%; 12/37) were asked at what point in time they do so. Some veterinarians will (advise to) force feed when the kitten will not eat at home with the owner (17%; 2/12). The other respondents (83%; 10/12) have indicated the number of minutes after which they will proceed to force feed. However, due to an imperfection in the question, the answers to this question are difficult to interpret. Those respondents were asked after how many minutes they would proceed to force feeding the kitten. The question should have stated to start counting after the end of surgery. However, because it did not it might have been interpreted as the number of minutes after the time point one would expect the kitten to start eating itself. How every respondent interpreted the question is unclear and therefore the data of this question cannot be interpret correctly and will not be further analysed.

4.8.3 Degree of complexity regarding juvenile castration

The surgical procedure in these young animals is experienced to be more complicated than the same procedure in adult animals by 41% (15/37) of the respondents.

Almost a third feel of the veterinarians experience that it is easier (30%;11/37) and the rest experience no difference in the level of complexity (30%; 11/37).

Degree of difficulty	Percentage and number of respondents, presented in brackets.	95% confidence interval for the percentage of respondents
More complicated	41% (15/37)	± 16% 25%-57%
No difference	30% (11/37)	± 15% 15%-45%
Less complicated	30% (11/37)	± 15% 15%-45%

Table 35: Data on the degree of difficulty experienced by veterinarians regarding juvenile castration, with corresponding 95% confidence intervals.

Reasons mentioned for an increased difficulty are problems with anaesthesia such as difficulty intubating resulting in a decreased level of monitoring, difficulty to calculate the right drug dosage and the increased risk of hypothermia. The procedure in these young animals has proven to take a lot more precautions, time and attention by some and is not performed often. In addition, the ovaries and testicles are smaller making the ovaries more difficult to find and testicles more difficult to handle.

Reasons mentioned for a decrease in difficulty are less abdominal fat resulting in good visibility and access. Flexibility of the tissues, the relative large size of the ovaries in relation to the abdominal cavity, small blood vessels and the possibility to make smaller ligatures are mentioned as favourable physical features in young animals. A smaller incision and a quick recovery from the anaesthesia as well as from the operation itself are favourable consequences.

4.8.4 Mortality

The majority of the veterinarians feel that the mortality in these kittens (<4 months of age) is not higher than in cats > 4months of age (92%; 34/37) whereas others do experience a higher mortality rate (8.1%; 3/37).

5. Discussion

5.1 Work-related data

Veterinarians who are employed by an animal shelter are significantly ($p=0.002$) more likely to perform juvenile castration compared to colleagues employed by a veterinary clinic (*table 17*). However, these results should be interpreted carefully since there were only 3 respondents employed by an animal shelter which all performed juvenile castration. A higher percentage of veterinarians that perform juvenile castration are found among colleagues working for an animal shelter. This might be attributable to shelter policy and-or might be explained by the fact that these veterinarians see the problems regarding overpopulation and poor compliance of new owners on a daily basis. Also, due to the nature of their work they may have acquired a level of experience in performing juvenile castration not generally found in veterinarians working in a veterinary clinic.

5.2 Clientele

5.2.1 Juvenile castration and facilities that group house cats

Veterinarians with professional facilities (animal shelters, traders) as their clientele (24%; 61/250) are significantly ($p=0.025$) more likely to perform juvenile castration than colleagues without those facilities as their clientele (*table 17*). Again, this might be explained by the fact that those veterinarians may have acquired a level of experience in performing juvenile castration not generally found in veterinarians working solely in a veterinary clinic. Also, those facilities might request juvenile castration more often or rather, for a higher number of cats than an individual pet owner.

In addition, veterinarians who are requested by animal shelters to perform juvenile castration are significantly more likely to perform this operation than those who are not (*table 17*). This might be related to the fact that a majority of 56% (130/231) considers juvenile castration in shelter cats (*table 12*). In addition, 92% (173/189) considers juvenile castration to prevent overpopulation which is especially relevant in animal shelters (*table 13*). All this might be of consequence for the ethical part of the decision to perform juvenile castration. The position of the KNMvD is that castration at a very young age (i.e. 6-8 weeks of age) is only acceptable in stray- and shelter cats to prevent overpopulation and should be discouraged when requested for economic reasons ^[27]. The Dierenbescherming, the Dutch society for the protection of animals, is in favour of juvenile castration in stray- and shelter cats in order to prevent overpopulation and also advise to be reserved with juvenile castration in purebred cats because of the risk of the narrowing of their genetic base ^[28]. Schaeffers-Okkens and Overgaauw wrote a report on early age neutering. They state that early age neutering should be restricted to shelter animals and should not be performed in animals owned by individuals or breeders. They warn against the economical motives breeders often have when working with contracts that prevent the new owner from breeding with the kittens and the possible risk of these contracts being replaced with early age neutering. Besides the ethics concerned, it also further decreases the already small gene pool ^[29].

As mentioned before, there are significantly more veterinarians who perform juvenile castration among veterinarians working for an animal shelter as among those that work for a veterinary clinic. However, results (*table 22*) show that there is no significant difference in the percentage of castrations performed under 4 months of age relative to the total number of castrations between veterinarians working for an animal shelter and colleagues working for a veterinary clinic. In other words, veterinarians employed by an animal shelter perform juvenile castration more often than colleagues working for a veterinary clinic. However, castrations in juvenile patients do not constitute a significantly larger part of the total number of castrations they perform (*table 22*).

5.2.2 Juvenile castration and breeders

Of the veterinarians who advise their clients about castration, only 13% (31/231) of the respondents would consider juvenile castration in purebred cats (*table 12*) and 19% (35/189) would consider a request by an owner of a purebred cat without the existence of medical necessity (*table 13*). There is no significant relationship between the number of breeders in the veterinarians client base and the readiness to perform juvenile castration. However, veterinarians who have breeders as their clientele are significantly more likely to perform juvenile castration. Veterinarians who are actually asked by breeders to perform juvenile castration are also significantly more likely to do so than those who are not asked (*table 17*).

As mentioned earlier, both the KNMvD and the Dierenbescherming discourage the appliance of juvenile castration in pedigree cats ^[27,28]. Results seem to indicate that having breeders as clientele, as well as them requesting juvenile castration both have a stimulating influence on the frequency of the appliance of juvenile castration. However, all results should be interpreted carefully due to the small sample size of the study.

5.3 Advised age at castration

The results of this study show that the majority of the respondents advises cats of both sexes to be castrated at an age of 6-9 months (*tables 7 and 8*). A previously conducted limited survey among veterinarians (2012) in the Netherlands showed 85% advises to castrate a cat (male and female) at an age of 6-9 months ^[1]. The percentages of these two surveys conducted in the Netherlands correspond. A survey among veterinarians from the United Kingdom regarding juvenile castration showed that most veterinarians (51%) recommend their client-owned kittens to be castrated at a minimum age of 6 months ^[2]. Other authors also report the traditional age for castration in cats to be 6 months ^[3-5,19,30]. A survey conducted among New York State veterinarians made a distinction between the advised age of castration in shelter and that for client-owned cats in which the median age was 3 and 5 months respectively, for both male and female cats. The younger age advised in shelter cats might be caused by the belief that juvenile castration helps combat overpopulation (79% of respondents) ^[4]. Although there is little scientific data to support the current “traditional” advised age at castration ^[5,9], data from several countries shows that the majority of veterinarians still maintain these minimum age limits ^[1,2,26].

5.4 Juvenile castration

5.4.1 Overpopulation

The opinion of the majority of the respondents is that there is a problem with overpopulation of cats in the Netherlands (88%; 204/231) (*table 9*) and that veterinarians should play a role in addressing these problems (91%; 210/231) (*table 10*). Awareness of the problem and readiness to play an active role in addressing these problems is a first big step in preventing further overpopulation. The next step is to establish what is considered a proper way to accomplish this. However, only 34% of the respondents consider juvenile castration a proper way to prevent overpopulation (*table 14*). Further studies are necessary to establish what Dutch veterinarians see as other proper ways to prevent overpopulation in order to be able to form an effective, practical and generally accepted plan to address and prevent overpopulation and the veterinarian's role in this.

There is no significant relationship between having the opinion that here is a problem with overpopulation of cats in the Netherlands and the likeliness to castrate. Neither is there a significant relationship between having the opinion that veterinarians should play a role in preventing overpopulation (*table 17*). Again, results should be interpreted carefully due to the small sample size (231). However, results may be in line with the low percentage of veterinarians who feel that juvenile castration is a correct means to prevent overpopulation. Veterinarians who feel that juvenile castration should be applied more frequently to prevent overpopulation are significantly more likely to perform juvenile castration (*table 17*) and therefore seem to already actively try to prevent overpopulation although other, not-related factors might also contribute to their decision to perform this operation on kittens.

Further studies assessing the current status of the cat overpopulation problem in the Netherlands are necessary to establish the extent of this problem, its causes, consequences and practical solutions.

5.4.2 Anaesthesia and perioperative care

For both age groups (6-10 and 10-16 weeks) anaesthetic complications were the major concern among the majority of veterinarians. For the age group of 6-10 weeks 50% (115/231) are concerned about anaesthetic complications and another 37% (86/231) of the veterinarians have strong concerns regarding this aspect. In the age group of 10-16 weeks 55% (128/231) are concerned about anaesthetic complications and 19% (43/231) have strong concerns (*tables 15 and 16*).

Particularly the first 12 weeks of life, the paediatric period, are unique from an anatomical and physiological point of view ^[3,19,23]. These physiological differences from mature animals lead to differences in pharmacokinetics and pharmacodynamics. These contribute to increased sensitivity to drugs, prolongation of effects and a limited capacity for cardiovascular compensation. With these young animals, there is also an increased risk of hypoxemia, hypoglycaemia, hypothermia and dehydration ^[3,5,19]. Therefore, it is very important to adjust anaesthesia protocols specifically to paediatric patients considering all those factors.

5.4.2.1 Respiration

This survey shows that 22% of the veterinarians use laryngeal masks and 54% perform endotracheal intubation, both either in a routine fashion or occasionally (*table 32*). The maintenance of a patent airway is essential in kittens because respiratory obstruction occurs easily ^[3,19,32].

The tissue oxygen consumption is two to three times higher in kittens ^[3,5,19,22,23]. Since their tidal volume is more or less the same as in adults (around 8mL/kg) kittens have to increase their respiratory rate two to three times in order to meet their oxygen requirements ^[5,22,23]. Respiratory rate in kittens is approximately 15-35 breaths per minute ^[31]. Ventilation is less efficient and the work of breathing is greater due to compliant lung and chest walls. Respiratory depression or airway obstruction, which can occur during anaesthesia, can therefore result in severe hypoxemia and ventilatory exhaustion ^[3,19,22,23]. It is therefore preferable to provide oxygen supplementation during anaesthesia ^[19].

Most commonly a patent airway is accomplished by endotracheal intubation ^[32] (generally using tracheotubes with a small internal diameter of 2-2.5 mm) ^[23]. However, attempts to intubate can easily damage the cat's trachea and larynx and is often made difficult by the occurrence of laryngospasm. Research shows that cats which received endotracheal intubation during anaesthesia were twice as much likely to die than non-intubated cats, most likely due to laryngeal trauma caused during intubation, laryngeal spasm or oedema. These results were not compared to the cat's age ^[33]. Care and attention for the kitten is important during this procedure to minimise the occurrence of laryngeal trauma. Face masks lead to a relatively large dead space and it is difficult to properly seal off the airway. Laryngeal masks, designed for use in humans but demonstrated to be useful and safe for cats in experimental and clinical studies, are an intermediate between endotracheal intubation and the use of face masks. Laryngeal masks are more easily introduced in the airway, a decreased dose of anaesthetics is sufficient and they are effective in maintaining a patent airway. However, research showed an increased incidence of gastro-oesophageal reflux in kittens when a laryngeal mask was used in comparison with endotracheal intubation. When using a laryngeal mask it is advisable to observe the animal closely in the postoperative period for signs of oesophagitis ^[32].

5.4.2.2 Hypoglycaemia

None of the respondents monitor blood glucose during anaesthesia, yet hypoglycaemia may contribute to a prolonged recovery ^[19]. Kittens are more prone to develop hypoglycaemia than adult animals due to limited hepatic glycogen reserves and a slow glycolysis and gluconeogenesis ^[3,19,22,23]. Therefore they should not be fasted for a prolonged period of time to reduce the risk of hypoglycaemia during surgery. General advice is not to withhold food from animals <5 weeks of age for no longer than 1-2 hours, kittens 6-8 weeks of age no longer than 2-4 hours and older juvenile patients should not be fasted longer than 8-9 hours ^[6,22-24,31]. In cats 6-10 weeks of age the majority (89%; 8/9) of the respondents withhold food for no longer than 4 hours. A majority of 68% (34/50) does the same for cats 10-16 weeks of age, the rest withhold food in this age group for more than 5 hours (*table 25 and 27*). In addition to these measures 3 respondents (18%; 3/17) add a glucose solution to their fluid

therapy protocol as to further reduce the occurrence of hypoglycaemia. Blood glucose can be easily monitored using the standard materials and method used during routine blood glucose measurement in patients with diabetes mellitus by using a test strip from a percutaneous blood sample^[23]. Supplementation of glucose should be started when levels fall below 60 mg/dl using either a 2.5-5% glucose solution (10 ml/kg/h) when there is an intravenous line available^[3,19,23] or by dripping 50% glucose on the oral mucosa^[23]. During the recovery period oral glucose can be administered once the kitten is conscious and able to swallow^[19]. When it is unclear when the kitten had his last meal prior to surgery or will not eat, or when the anaesthesia for some reason is significantly prolonged or other reasons exist for suspecting low blood glucose levels it can be advisable to measure blood glucose levels and when necessary, correct them in the method described above.

5.4.2.3 Dehydration

The current survey shows that in both age groups (6-10 and 10-16 weeks) the majority of the respondents withholds water not at all or no more than one hour prior to surgery (89% and 92% for the age groups respectively) (*tables 26 and 28*). These results are in line with the recommendations derived from literature. These recommendations are not to restrict water for more than an hour prior to surgery^[19] as paediatric patients are more prone to dehydration because of a reduced ability to concentrate urine^[19,23]. Supplementary fluid administration should be carefully considered since a kitten's cardiovascular system cannot deal with large volumes of fluid^[19]. However, the administration of 4-10 ml/kg/h, intravenous or intraosseous, is advised to prevent hypotension due to fluid- and limited blood loss^[22].

5.4.2.4 Hypothermia

Almost half of the respondents (49%; 18/37) does not measure body temperature of the kitten during the entire procedure (*table 33*). In addition to the depressant effects of anaesthetics on thermoregulation, the risk of developing hypothermia in juvenile kittens during surgery and recovery is significantly increased due to low subcutaneous fat reserves, a high body surface area to mass ratio, a smaller ability to shiver and due to the fact that they have a higher critical temperature (i.e. the environmental temperature below which the body is unable to maintain a constant body temperature). Also, kittens lose extra warmth via subcutaneous blood vessels caused by the limited ability to perform peripheral vasoconstriction^[22,23]. Hypothermia during anaesthesia increases the risk of bradycardia, hypotension and decreases the elimination of anaesthetic drugs which results in a slower recovery. Thermo protection during anaesthesia is an important factor in preventing hypothermia. This can be achieved by minimising the duration of surgery and anaesthesia, maintaining an ambient temperature of >24 °C, minimal hair clipping, using an alcohol free disinfectant such as a Betadine® solution, use warm fluids, keeping the kitten as dry as possible, use forms of isolation such as foil or plastic or use warming devices such as a Bairhugger®, hotpacks, heat pads and hot water bottles^[5,19,23,34]. All respondents use at least one of those measures to minimise heat loss. It is essential to measure the body temperature at least once during the procedure but preferably on multiple occasions. This is necessary in order to determine body temperature and monitoring this to prevent and correct hypothermia due to anaesthesia but also to prevent hyperthermia due to

overcorrection. The rectal temperature of kittens after 4 weeks of age is 37.7°C, whereas in an adult cat this is 38.1-39.2 °C^[34]. When performing surgery on littermates it is advisable to return the kittens to their littermates once a similar stage of recovery between them is reached. This stimulates the kittens to eat and play^[23,35].

5.4.2.5 Drug dosage and anaesthesia protocols

The present survey shows that the majority (78%; 29/37) of the veterinarians calculates the drug dosage based on bodyweight. The calculation of drug dosage based on metabolic weight is performed routinely by 14% (5/37) and used in patients under 1.3 kg (mean) by 8.1% (3/37) of the veterinarians (table 29).

On the day of surgery, kittens should be weighed to the nearest hundredth of a kilogram for accurate drug dosing^[24]. The low body fat percentage and the higher percentage of body fluid in comparison with adult animals results in a reduced storage of anaesthetics and a faster redistribution^[23].

Literature states that current licensed intramuscular protocols, which calculate dosages by body weight, produce inadequate levels of anaesthesia in kittens < 1.5 kg^[19,24,25]. This might be attributable to a greater body surface area (BSA) to mass ratio^[19]. This led to the derivation of the so-called ‘quad’ protocol in which the dose is calculated based on body surface area rather than body weight^[23,25]. The first step in this is to convert body mass to body surface area (BSA). $BSA = (K \times BW^{0.67}) / 100$. K = 10.4 (cats). BW is measured in kg. BSA is measured in m². The second step is to multiply the BSA by a factor 0.6 to present the volume (ml) of each agent in the quad combination^[19].

Drug	Dosage
Medetomidine	600 µg/m ²
Ketamine	60 mg/m ²
Midazolam	3mg/m ²
Buprenorphine	180 µg/m ²

Table 36: The drugs and dosages used in the quad protocol^[19,25]

The protocol provides a good depth of anaesthesia, a quick induction and recovery as well as good, multimodal analgesia up to 6-12 hours postoperatively. Another practical advantage of this protocol is that all drugs are administered in equal volumes in a single injection^[19].

The drug combination used in the quad protocol is used by 12% (4/12) of the respondents.

Several other drug protocols are mentioned in literature. An overview is presented in table 37.

Protocols	Dose	Route of administration	Analgesia	Comments
Medetomidine + Ketamine + Midazolam + Buprenorphine [19,23,25]	600 µg/m ² 60 mg/m ² 3mg/m ² 180 µg/m ²	IM IM IM IM	Very good up to 6-12 hours postoperatively	<i>Quad protocol</i> [19,23,25] Equal volumes of each product are administered. The use of dexmedetomidine (5-20 µg/kg) is advised instead of medetomidine [23]. Good depth of anaesthesia Quick induction and recovery Multimodal analgesia Reversal agent can be used (atipamezole)
Atropine + Midazolam + Ketamine + Butorphanol [23,24]	0.04 mg/kg 0.22 mg/kg 11 mg/kg [24] 5-10 mg/kg [23] 0.44 mg/kg	IM IM IM IM	Good Analgesia doubtful in male cats	Good sedation Smooth induction
Medetomidine + Ketamine + Butorphanol [23,38]	10-40 µg/kg [23]; 80 µg/kg [38] 5 mg/kg 0.4 mg/kg	IM IM IV, IM or SC	Good	The use of dexmedetomidine (5-20 µg/kg) is advised instead of medetomidine [23]. Good depth of anaesthesia in kittens > 1.5 kg Smooth recovery Reversal agent can be used (atipamezole)
Medetomidine + Ketamine [19]	80 µg/kg 5 mg/kg	IM IM	Reasonable	The use of dexmedetomidine (5-20 µg/kg) is advised instead of medetomidine [23]. Good depth of anaesthesia in kittens > 1.5 kg
Ketamine + Midazolam [19,24]	5-10 mg/kg [19] Males: 22 mg/kg Females: 11 mg/kg [24] 0.25 mg/kg [3] 0.22 mg/kg [24]	IM IM	Minimal perioperative, poor in males None postoperatively	Poor depth of anaesthesia Gaseous anaesthesia required Excitation and vocalisation on recovery
Acepromazine + Morphine + Atropine + Alfaxalone [37]	0.03 mg/kg 0.3 mg/kg 0.04 mg/kg Induction: 4.7 mg/kg Maintenance: on effect up to 11.1 mg/kg/h	SC SC SC IV	Good	Slow administration of alfaxalone (over a period of 60 seconds) in view of the risk of post- induction apnoea [36].

Acepromazine + Morphine + Atropine + Alfaxalone + Isoflurane ^[37]	0.03 mg/kg 0.3 mg/kg 0.04 mg/kg 4.7 mg/kg On effect	SC SC SC IV Inhalation	Good	Slow administration of alfaxalone (over a period of 60 seconds) in view of the risk of post- induction apnoea ^[36] .
Tiletamine + Zolazepam ^[24]	11 mg/kg	IM	Moderate	
Propofol ^[19,23]	Unpremedicated: 8.0 mg/kg Premedicated: 6.0 mg/kg	IV	Depending on premedication	IV route may be difficult in kittens
Isoflurane ^[19,23]	On effect, mask induction	Inhalation	None	Strong, unpleasant odour Less expensive than sevoflurane Registered in the Netherlands for use in cats ^[39] .
Sevoflurane ^[19]	On effect, mask induction	Inhalation	None	Mild, inoffensive odour Expensive Rapid uptake and elimination compared with isoflurane Not registered in the Netherlands for use in cats ^[39] .

Table 37: An overview of some example anaesthesia protocols derived from literature. IM = intramuscular; IV = intravenous; SC = subcutaneous.

5.4.2.6 Monitoring

Visually monitoring of the patients respiration is performed by 81% (30/37) of the respondents and capnography is used to monitor respiratory parameters by 27% (10/37) (table 33). Visually checking the respiratory rate is a simple and fast way of monitoring and should not be omitted when no other devices such as capnography are used. Monitoring young patients is essential and extra attention should be paid to respiratory depression and/or airway obstruction. It is very important that kittens can maintain their high respiratory rate during anaesthesia ^[23] since they have a limited ability to respond to elevated carbon dioxide concentrations and have little oxygen reserves in their lungs ^[6].

Monitoring the heart rate by counting the pulse or ictus cordis is performed by 51% (19/37) of the respondents. Electrocardiography (ECG) is used by 30% (11/37). Heart rate should also be closely monitored because of the rate-dependent cardiac output in kittens ^[19,34]. Body temperature is measured by 51% (18/37) of the respondents (table 33).

Routinely monitoring respiration and heart rate as well as body temperature during anaesthesia in juvenile patients is essential for early recognition and correction of potential problems.

5.4.2.7 Recovery

All but one of the respondents who specified to use alpha2 agonists administered the alpha2 antagonist atipamezole hydrochloride (Antisedan®, Atipam®, Sedastop®) during recovery, thereby significantly reducing recovery time ^[25].

The current survey shows that a majority of 54% (20/37) advises to feed the kitten as soon as it is at home (with the pet owner or in the shelter). Kittens should be fed a small high energy meal within an hour of standing after surgery ^[23,24]. It might be safe to assume that the time which elapses before the kitten is back home will generally be far more than one hour. On the occasion that the kitten will not eat by itself 32% (12/37) will force feed the kitten. Taking into account the increased risk of hypoglycaemia in kittens, it is essential to feed kittens within one hour after awakening from anaesthesia and proceeding to force feed the kitten when it will not eat spontaneously.

5.4.2.8 Perioperative antibiotics

Antibiotics are used by 38% (14/37) of the respondents although it is not known in which percentage there might have been specific indications such as pre-existing infections or a break in surgical sepsis. Routine perioperative use of antibiotics in healthy kittens is not recommended. When used, they are best administered prior to surgery or as soon as a break in surgical sepsis is noted ^[40].

5.4.2.9 Postoperative pain management

The current survey conducted among Dutch veterinarians (2013), shows that only 49% (18/37) prescribes pain medication following juvenile castration. In this survey no distinction was made between male and female kittens. Research by Hellebrekers conducted in the year 2000 regarding anaesthesia in companion animals in the Netherlands showed that often no post operative analgesia is provided. Female cats received pain medication in 54% of the cases whereas in male cats this was 26% ^[41].

In his article, Hellebrekers also comments on the variety of NSAIDs used of which many are not registered for the cat ^[41]. The present survey (2013) also shows a variety of oral NSAIDs which are not registered for the cat in oral form for this specific indication while there are alternatives available. 'Off label use' of not-registered NSAIDs is not recommended since there are registered alternatives ^[41] such as Tolfedine® (tolfenamic acid) and Metacam® (meloxicam) which are registered in the Netherlands for analgesia following soft tissue surgery in oral form for cats ^[39].

5.4.3 Short-term complications

The current survey shows that Dutch veterinarians have concerns regarding the short-term complications of juvenile castration (4.5.1, tables 15 and 16).

Research into anaesthetic-related death in cats shows that cats weighing less than 2 kg are almost 16 times more likely to die during anaesthesia as those who weigh between 2 and 6 kg. This is most likely related to the fact that smaller animals are more prone to drug overdose, hypothermia and perioperative management difficulties (i.e. endotracheal intubation) ^[33]. Factors which were given specific attention in the study of Howe on the short-term complications of juvenile castration in cats ^[5], which showed no increase of morbidity or mortality in juvenile patients than in traditionally aged (≥ 24 weeks) patients in the first week

after surgery. These studies indicate that surgery on juvenile patients can be performed safely but that appropriate attention should be given to anaesthetic and surgical methods ^[5].

The study by Howe also suggests a relatively high death rate in young patients by infectious diseases, often seen in animal who were admitted to the shelter and vaccinated only 2-3 days before surgery ^[5]. Research indicates that acute stress may enhance some aspects of immune function. Factors such as admittance into a shelter, transportation to the surgical area, anaesthesia and surgical trauma may act as acute stressors ^[53]. A study executed by Reese shows that vaccination of kittens at or near the time of neutering does not lead to a difference in antibody response with kittens that did not undergo surgery ^[52]. However, it is advisable to perform this procedure on animals in the best physical condition ^[5]. Also, by allowing a longer period of time between admittance in a shelter and castration it may be possible to exclude those kittens from surgery which start to show signs of infection.

5.4.4 Long-term complications

The current survey shows that Dutch veterinarians have concerns regarding the long-term complications of juvenile castration (*4.5.1, tables 15 and 16*).

Approximately equal proportions agreed (37%; 56/177), disagreed (31%; 57/177) or were indifferent (32%; 54/177) to the statement that these concerns are a major reason not to perform juvenile castration (*table 18*) among veterinarians not performing juvenile castration.

5.4.4.1 Behaviour

Even though the majority of the respondents have no concern about increased aggression in both age groups, there is some concern as 13% (30/231) and 12% (28/231) of the respondents have expressed some degree of concern regarding the occurrence of aggression in the age groups of 6-10 and 10-16 weeks respectively. Some concern regarding shyness in the age group of 6-10 weeks has been expressed by 20% (47/231) express and by 17% (40/231) for the age group of 10-16 weeks (*4.5.1, tables 15 and 16*).

Howe et al executed a study on 263 cats investigating the effects of early age gonadectomy in cats differentiating between those castrated before and after 24 weeks of age with a 3 year follow up. Early age castration did not result in an increase of behavioural problems when compared to cats castrated at the traditional age nor did it lead to an increased incidence of return rates to animal shelters ^[18].

Spain et al performed a retrospective study on 1660 cats evaluating long term risks and benefits of early age castration, being <5,5 months of age, in comparison to those castrated at the traditional age of >5,5 months. Researchers found that there was a significant ($p < 0.05$) decrease in the occurrence of hyperactivity, classified by Spain as a behavioural condition, in both male and female cats in cats castrated <5.5 months of age. In male cats there was a significant relationship ($p < 0.05$) between early age castration and a decrease in aggression towards veterinarians and sexual behaviour as well as an increase in shyness around strangers and hiding behaviour. The research by Spain shows an increase in certain behavioural conditions and a decrease in others. The importance of these findings depends on the degree

in which these conditions form an actual problem for the owner and the likeliness of these conditions being reason to relinquish the cat (back) to an animal shelter. The male cats which were reported to hide frequently were relinquished in 11% of the cases compared to 4% of male cats without this reported behaviour ^[14].

Another study reported no difference in the occurrence of aggression in general between cats neutered at 7 weeks or 7 months of age ^[8].

These studies suggest that the incidence of aggression in prepubertal castrated cats is the same or even smaller than those castrated at a later age. They also suggest that male cats castrated at an early age show increased hiding behaviour ^[8,14,18], which are reported to have a higher relinquishment rate than those who do not. However, the authors of that study also note that they cannot fully determine whether the shyness and hiding behaviour is fully due to the long term effects of early age castration or due to the stress of being adopted at a young age ^[14].

5.4.4.2 Health

5.4.4.2.1 Obesity

Over one third of veterinarians are concerned about obesity when castrating at any age between 6-16 weeks (*4.5.1, tables 15 and 16*).

Neutering is a risk factor for the development of obesity. Research shows that castration appears to be associated with increased food consumption and a decrease in physical activity but not necessarily with lower metabolic rates ^[42]. Data from other species suggests that estradiol is in indirect control of eating and meal size by means of advancing the onset of satiety thereby influencing the amount of food consumption. A decrease in estradiol, caused by castration, would consequently delay the onset of satiety resulting in an increase of food consumption which therefore, when not compensated by increased physical activity, could lead to obesity ^[43]. Body mass, body condition score and the quantity of fat in the falciform ligament were found to be higher in cats castrated at 7 weeks or 7 months in comparison to intact cats ^[44]. However, retrospective studies have found no correlation between the prevalence of obesity and the age at castration ^[8,14,18]. The aetiology of obesity is multifactorial ^[9,19,45] and advice should be given to the owner of any castrated cat regardless of its age, about the risks of obesity and possible necessary changes in diet and exercise.

5.4.4.2.2 Orthopaedic problems

The possibility of delayed closure of the epiphyseal growth plates is a concern among the majority of veterinarians in the age group of 6-10 weeks (55%; 128/231). In the age group of 10-16 weeks this is slightly less (49%; 113/231). Some degree of concern about the occurrence of Salter-Harris fractures in the age group of 6-10 weeks is expressed by only 15% (34/231) of the respondents and by 13% (30/231) in the age group of 10-16 weeks (*4.5.1, tables 15 and 16*).

The gonadal hormones estradiol and testosterone facilitate maturation of cartilage in the growth plate. The reduction of these hormones after castration results in a delay of physal cartilage maturation and delayed physal closure. Compared to intact animals, cats castrated at 7 weeks or 7 months of age show a significant ($p < 0.05$) delay in closure of the distal radial

physis. However, the age at castration (7 weeks or 7 months) had no effect on this phenomenon. No significant difference in the length of the mature radius between cats castrated at 7 weeks, 7 months or sexually intact animals was detected ^[8,46].

Clinical significance of delayed closure of the epiphyseal plates is debated since several studies have showed no association between the age at castration and the occurrence of skeletal problems ^[6,14,18].

However, other research seems to indicate that castration at an early age increases the chance of developing epiphysiolysis, or slipped capital femoral epiphysis in male cats ^[47].

Epiphysiolysis of the femoral head is seen in cats, which can occur with minimal trauma. In the case of epiphysiolysis the epiphyseal plate generally detaches at an age of 14-16 months, at which age it should already have been closed. Normally the epiphyseal plates in cats close at an age of 7-10 months. Obesity is a risk factor for developing epiphysiolysis ^[47,48] although it is yet unclear whether this is simply due to the increased trauma of additional weight or that the damage is another manifestation of a metabolic disease that causes both physal dysplasia and obesity ^[48]. The larger and heavier posture cats generally acquire as a consequence of the delayed epiphyseal closure, might be a predisposing factor in itself. Epiphysiolysis seems to occur more often in Main Coons and Siamese cats. This might indicate the presence of a genetic base. However, the larger and heavier physique of Main Coons might also contribute to the increased incidence in this breed ^[47,49].

The evidence of the studies that seem to indicate a relation between early age castration and an increased incidence of epiphysiolysis in male cats is debatable. One ^[49] was a study with a small sample size (n=26) in which all cats with fractures were overweight and their weight was also significantly higher than the healthy control cats. The other study ^[47] was also a small scale (n=23) study in which the weight of several patients was unknown. It is therefore unclear what role early age castration plays and to what extent obesity was a risk factor for developing epiphysiolysis. However, these studies indicate that more research is needed. A study preferably executed with a large sample size and weight notations on all of the cats. However, as described before the larger physique of juvenile castrated cats at a later age, a direct result of early age castration, might also be a predisposing factor. It might not be possible to completely distinguish the impact of weight and early age castration on the development of epiphysiolysis.

5.4.4.2.3 Feline lower urinary tract disease (FLUTD)

For both age groups more than a quarter of respondents have concerns regarding the occurrence of FLUTD as a possible consequence of juvenile castration (*4.5.1, tables 15 and 16*).

Speculation about associations between early age castration and the occurrence of feline lower urinary tract disease (FLUTD) may have caused a reluctance in veterinarians to perform castration at a young age ^[14,19]. Research has shown that both castrated male and female cats have an increased risk of specific types of FLUTD in comparison to intact cats ^[21]. However, a long-term retrospective study has recorded a decrease in the occurrence of FLUTD in male cats that underwent early age castration in comparison to those castrated ≥ 24 weeks of age.

This study was performed on 263 cats of which 108 were male and which had a follow up period of three years ^[18]. Another retrospective study by Spain et al followed 1,660 cats with a median follow up time of 3.9 years and showed the lack of correlation between the incidence of FLUTD as well as urethral obstruction and the age at which a cat is neutered ^[14]. A study that used urethral pressure profiles showed no variation of urethral diameter and urethral dynamic function between male cats castrated at 7 weeks, 7 months or as intact adult cats ^[20]. However, the part of this study that focused on male cats was comprised of a rather small sampling group of 18 males in total, i.e. 3 male cats per age group. The statistical reliability might therefore be rather low in this study and might improve when the study is repeated with a larger sampling group. Another study with thirty male cats also showed no difference in the urethral diameter between intact cats and prepubertal castrated cats ^[31,50].

Whether there is a relationship between early age castration and the occurrence of FLUTD as well as the nature of this possible relationship cannot be deduced from these varying research results. More research with a large sample size, a full history, a combination of diagnostic methods and a longer follow-up period might give a better change of unambiguous results.

5.4.4.2.4 Urine incontinence

The possibility of the development of urine incontinence as a result of juvenile castration is not a major concern among the respondents (*4.5.1, tables 15 and 16*).

An epidemiologic study of risk factors for lower urinary tract diseases in cats reviewed the records of 22,908 cats with FLUTD and 263,168 cats without FLUTD. Urine incontinence as a form of FLUTD was seen in only 4% of cats. The study showed that sexually intact females had a reduced risk of developing urine incontinence, but no relation to the age of castration was examined. Male castrated cats had no increased risk for urine incontinence ^[21].

5.4.4.2.5 Perivulvar dermatitis

The possibility of the development of perivulvar dermatitis as a result of juvenile castration is not a major concern among the respondents (*4.5.1, tables 15 and 16*). The external genitalia of prepubescent neutered animals retain an infantile appearance. Females maintain an infantile vulva, but the perivulvar dermatitis that can be seen in bitches does not seem to be a clinically significant problem in queens ^[7,19].

5.4.4.2.6 Miscellaneous

The possibility of the development of cardiac and dermatological conditions, immune deficiencies or diabetes mellitus as a result of juvenile castration are not a major concern among the respondents (*4.5.1, tables 15 and 16*).

The retrospective study performed by Howe et al reports that early age castration does not affect problems associated with the integumentary or the cardiopulmonary system ^[18]. Furthermore, early age castrated (<5.5 months) cats in the study by Spain et al were not significantly more likely than cats castrated at 5.5 months of age to develop any conditions that might be associated with long term immune suppression. More so, early age castrated cats had a lower incidence of gingivitis which is a condition often associated with immune suppression ^[14]. The same study showed that the development of diabetes mellitus is not

related to age at castration. However, the incidence of this condition was very low (< 10 cats) and the statistical power for finding a subtle difference was low. Also, since diabetes often presents itself in middle-aged to older cats ^[51] and the longest follow up period in this study was 11 years (median 3.9 years) it might take a study with a longer follow up period and a control population to determine whether there is a relationship between age at castration and the likeliness to develop diabetes mellitus.

5.4.5 Degree of complexity regarding juvenile castration

Respondents argued both for an increased and decreased level of complexity. Some are related to monitoring which might be a lesser problem in larger, well equipped clinics which are also able to have a separate staff member responsible for monitoring anaesthesia in comparison to small clinics with few staff members available. Some argue for decreased visibility where others plead for an increase in visibility. This can be due to inter-animal variation but can also be related to the difference of evaluating similar situations by different people, perhaps partially based on character but also on factors such as experience. A longer duration of the entire procedure was mentioned and might well be due to all the perioperative precautions necessary. However, the duration of surgery itself is significantly less in animals younger than 12 weeks of age than those older than 12 weeks ^[5].

5.4.6 Mortality

The present survey showed that few (8.1%; 3/37) of Dutch veterinarians that perform juvenile castration experience an increased mortality in juvenile patients undergoing castration in comparison with older cats. This can be attributable to the small sample size but might also be due to extra attention paid to delicate patients not often presented for surgery or a combination of these. Research shows that cats weighing less than 2 kg are almost 16 times more likely to die during anaesthesia as those who weigh between 2 and 6 kg. These findings are most likely related to the fact that smaller animals are more prone to drug overdose, hypothermia and perioperative management difficulties (i.e. endotracheal intubation) ^[33].

5.4.7 Reasons not to perform juvenile castration

Results from respondents not performing juvenile castration show that a majority feels they do have a proper anaesthesia protocol (60%; 107/177), enough experience (59%; 105/177) and that the structures are not too small to perform a castration at that age (66%; 117/177) (*tables 18*). As mentioned before in 5.4.4, opinions were divided regarding the statement that possible long term complications are a major reason not to perform juvenile castration.

A majority of 68% (121/177) feels (strongly) that it is wrong to operate on such young animals without medical necessity (*table 18*). It might be interesting to start a discussion among veterinarians about the philosophy behind these thoughts and feelings. One may ask the question whether it is possible to apply some nuances when considering the impact juvenile castration might have on the decrease of the current overpopulation and its welfare implications. In relation to this, a majority (65%; 115/177) (strongly) agrees that applying anaesthesia is not justifiable in such young animals without medical necessity (*table 18*). These two seem to be the major, ethical reasons for rejection of juvenile castration.

6. Conclusion

6.1 Current situation in the Netherlands

Currently juvenile castration is performed by a minority of Dutch veterinarians (21%; 53/256). These numbers might be higher or lower considering non-response bias (non-response in this study was 69%; 578/834). Among veterinarians that perform juvenile castration, this procedure constitutes only 8.9% of all castrations in veterinarians working in a clinic and 9.0% in those working for an animal shelter. Veterinarians working for an animal shelter or those working for a veterinary clinic that have (a) shelter(s) as a client(s) and/or those that are asked by a shelter to perform juvenile castration are more inclined to do so than those who do not. This is possibly due to their close association with shelters and the associated problems with overpopulation or simply by being requested by the shelter to do so. A similar result for respondents with breeders as clients indicates that despite the probable economical motives associated with these requests and the advice of the KNMvD against this ^[27], (some) veterinarians will perform juvenile castration in these purebred kittens.

In correspondence with other countries, the majority of veterinarians in the Netherlands advises to castrate cats between 6 and 9 months of age even though there is little scientific data to support this ^[5,9].

Reasons not to perform juvenile castration seem to relate for a great part to ethics and concerns regarding short- and long-term complications. A complete disquisition on the ethics of juvenile castration is beyond the scope of this paper. However, several authorities (KNMvD, Dierenbescherming) ^[27,28] have stated their position on the matter which might serve as a guideline. Also, statistical information regarding the actual overpopulation and short- and long-term complications might help to apply some nuances in the personal process of deciding whether or not and in which situations juvenile castration should be performed. However, personal convictions and experience will remain important factors in making these decisions.

The majority of veterinarians believes there is currently an overpopulation of cats and that they should play a role in solving this problem. At the same time, many do not see juvenile castration as the right intervention to solve and prevent further overpopulation. By creating a discussion among shelter personnel, researchers, veterinarians and the professional society for veterinary medicine ideas regarding different solutions and practically applicable action plans may be created for long-term solutions regarding the current cat overpopulation.

6.2 Anaesthetic procedure

For both age groups (6-10 and 10-16 weeks) anaesthetic complications were the major concern among the majority of veterinarians. The first step towards decreasing these concerns and increasing the safety of anaesthesia is knowledge of what the specific risks are for juvenile patients and being able to adequately adjust anaesthesia protocols. Specific risks are hypotension, reduced cardiac output, hypoxia, hypoglycaemia, dehydration, hypothermia, increased sensitivity to drugs and inadequate levels of anaesthesia in patients <1.5 kg ^[19,23,25].

Preanaesthetic clinical evaluation, precise weighing of the patient, carefully selecting and dosing anaesthetics, monitoring the patient during anaesthesia, taking thermoregulatory measures and specific care during recovery (such as the use of an antagonist to shorten recovery time and feeding within one hour of recovery) are some of the measures covered previously in the discussion, which help to enhance the safety of anaesthesia in juvenile patients.

Based on the survey, particularly temperature monitoring needs more attention since only 51% of the respondents measures the patients temperature during anaesthesia. It also shows that improvements can be made regarding the monitoring of blood glucose levels perioperatively as well as preventing hypoglycaemia postoperatively by feeding kittens within one hour after awakening from anaesthesia and proceeding to force feeding when the kitten will not eat.

6.3 Postoperative pain management

In view of the variety of available drugs and the veterinary knowledge regarding effective pain medication and considering that in the present survey only 49% (18/37) prescribes pain medication there are still improvements to be made in this field ^[41]. Keep in mind that NSAIDs should only be used in kittens older than six weeks of age ^[39].

6.4 Antibiotics

In view of the current discussion on the use of antibiotics, reserving the use of antibiotics for specific indications rather than using them in a routine fashion is also relevant when performing juvenile castration.

6.5 Short term complications

Howe's study on the short-term complications of juvenile castration in cats suggests castration can be performed safely in these patients when appropriate attention is given to anaesthetic and surgical methods.

6.6 Long term complications

Current research fails to support many of the concerns veterinarians have regarding long term complications. An increase in shyness and hiding behaviour in male cats is seen of which the latter can lead to a higher relinquishment rate compared to those cats who do not exhibit this behaviour ^[8,14,18]. There seems to be no correlation between the age at castration and the development of obesity ^[8,14,18], or problems associated with the integumentary and cardiopulmonary system ^[18]. Neither does juvenile castration appear to induce long term immune suppression nor the development of diabetes mellitus ^[14], although research with a control group and a sufficiently long follow up period is needed to fully discard these concerns. Perivulvar dermatitis which can be seen in bitches does not seem to be a clinically significant problem in queens ^[7,19]. Urine incontinence does not seem to be a major problem in cats and although intact females have a reduced risk of developing urine incontinence, a relationship with age at castration has yet to be examined ^[21].

There might be a relationship between early age castration and epiphysiolysis although several studies failed to proof an increase of skeletal problems in early age castrated cats. Further research with a large sample size, a control group and weight notations is needed to establish whether there is a relationship between early age castration and skeletal problems, the nature and severity of these and when possible to distinguish between obesity and early age castration in itself as risk factors for developing skeletal problems such as epiphysiolysis [6,8,14,18,47,49].

The impact of early age castration on the development of FLUTD is not completely clarified since some research suggest a decrease in the occurrence of some types of FLUTD and others find no correlation between the occurrence of FLUTD and the age at neutering. More research with a large sample size, a full history, a combination of diagnostic methods and a longer follow-up period might give a better change of unambiguous results [14,18-21].

Juvenile castration is not performed by many veterinarians in the Netherlands nor is it an often performed procedure among those who do. Many veterinarians have ethical objections and still have concerns regarding short- and long-term complications. Furthermore, not many veterinarians view juvenile castration as the solution to the overpopulation of cats in the Netherlands. Research shows that short-term complications are similar to those in adult cats when appropriate care is taken and many possible long term complications are either rejected or remain unproven. Further studies both regarding an assessment of the cat overpopulation problem in the Netherlands as well as short- and long-term complications from juvenile castration are necessary. Communication between shelter personnel, researchers, veterinarians and the professional society for veterinary medicine can lead to a better insight and understanding among all parties and make way for long term solutions and cooperation.

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8. Appendices

8.1 Performing juvenile castration: examining the existence of a relationship with several other factors

23% (53/231) applies castration in cats under the age of 4 months whereas 77% (178/231) does not. Only 5.7% (3/53) of the 53 veterinarians that perform juvenile castration are in paid service of an animal shelter, all others are in paid service of a veterinary practice.

The following factors will be examined for a possible relationship with the likeliness to operate on cats <4 months of age.

N.B. “Likeliness” : respondents indicated to perform juvenile castration.

- A. Gender.
- B. Curriculum in which the veterinarian started.
- C. Employment either by a veterinary clinic or an animal shelter.
- D. Facilities that group house cats as clientele.
- E. Receiving the question to castrate cats <4 months of age from animal shelters.
- F. Breeders as clientele.
- G. Number of breeders as clientele.
- H. Receiving the question to castrate cats <4 months of age from breeders.
- I. Opinion on the existence of a surplus of cats in the Netherlands.
- J. Opinion on the duty of a veterinarian in trying to solve the problem of the surplus of cats in the Netherlands.
- K. Opinion on the question whether juvenile castration will have to be applied more frequently in the future to tackle the surplus of cats.

To establish the relationships between the above factors and the likeliness to perform surgery on cats <4 months of age hypotheses have been conducted. Because this involves binary variables these hypotheses are tested ($p < 0.05$) by means of the Chi-square test using a *Texas Instruments TI-83 Plus Graphing Calculator*.

Hypothesis A: Gender

H₀: There is no difference in the likeliness to castrate cats <4 months of age between genders.

H₁: There is a difference in the likeliness to castrate cats <4 months of age between genders.

		Women	Men
Respondents performing juvenile castration			
	Percentage and number	24% (33/138)	19% (18/93)
	95% confidence interval	±7.1% 17%-31%	±8.0% 11%-27%
Respondents not performing juvenile castration			
	Percentage and number	76% (105/138)	81% (75/93)
	95% confidence interval	±7.1% 69%-83%	±8.0% 73%-89%

Table 38: Data on respondents that do/do not perform juvenile castration: gender. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2=0.6710$$

$$P =0.4127$$

$$Df=1$$

The H₀ hypothesis is not rejected because $p>0.05$. There is no significant difference in the likeliness to castrate cats <4 months of age between women and men.

Hypothesis B: Curriculum

Veterinarians from earlier curricula may have been taught less on the subject of juvenile castration however they may feel freer to do so because of the amount of experience they have gained during the years. Veterinarians from recent curricula may have been taught more on the subject of juvenile castration however they may feel some reluctance doing so because of a lack of experience.

H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who started in different curricula.

H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who started in different curricula.

		≤ 1969	1982	1995	2001	2007	2001+2007
Respondents performing juvenile castration							
	Percentage and number	15% (10/66)	20% (22/112)	30% (14/47)	19% (5/27)	50% (2/4)	23% (7/31)
	95% confidence interval	± 8.7% 6.3%-24%	± 7.4% 13%-27%	± 13% 17%-43%	± 15% 4.0%-34%	± 49% 1.0%-99%	± 15% 8.0%-38%
Respondents not performing juvenile castration							
	Percentage and number	85% (56/66)	80% (90/112)	70% (33/47)	81% (22/27)	50% (2/4)	77% (24/31)
	95% confidence interval	± 8.7% 76%-94%	± 7.4% 73%-87%	± 13% 57%-83%	± 15% 66%-96%	± 49% 1.0%-99%	± 15% 62%-92%

Table 39: Data on respondents that do or do not perform juvenile castration: curriculum. Percentage, number and 95% confidence interval.

All 95% confidence intervals are relatively wide, however the 95% confidence interval of the 2007 curriculum is extremely wide due to the small sample size. The small size of the sample of the curriculum 2007 is to be expected since the survey was carried out in the first half of 2013 when only a minority of the students of the 2007 curriculum will have been able to graduate. The assumption is made that the curricula of 2001 and 2007 do not differ greatly in the teaching subject of castration on a very young age. To give the data of the 2007 group more statistical validity, the groups of 2001 and 2007 are made into one group. The 95% confidence interval of this combined group is slightly larger than that of the 2001 group however it is much smaller than that of the 2007 group.

The data were imported in a R X C contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 3.74$$

$$P = 0.290$$

$$Df = 3$$

The H_0 hypothesis is not rejected because $p > 0.05$. There is no significant difference in the likeliness to castrate cats <4 months of age between veterinarians who started in different curricula.

Hypothesis C: Employment

Veterinarians who work in paid service of an animal shelter might be more ready to perform juvenile castration because they see first-hand the problems regarding the surplus of cats in the Netherlands.

H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who are in paid service of a veterinary clinic and those who in paid service of an animal shelter.

H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who are in paid service of a veterinary clinic and those who in paid service of an animal shelter.

		Veterinarians working for a veterinary clinic	Veterinarians working for an animal shelter
Respondents performing juvenile castration			
	Percentage and number	22% (51/229)	100% (3/3)
	95% confidence interval	± 5.4% 17%-27%	
Respondents not performing juvenile castration			
	Percentage and number	78% (178/229)	0.0% (0/3)
	95% confidence interval	± 5.4% 73%-83%	

Table 40: Data on respondents that do or do not perform juvenile castration: employment. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 10.0$$

$$P = 0.002$$

$$Df = 1$$

The H₀ hypothesis is rejected because $p < 0.05$. Veterinarians in paid service of an animal shelter are significantly more likely to castrate cats <4 months of age than veterinarians in paid service of a veterinary clinic. Due to the very low frequency in the group “veterinarians working for an animal shelter” and wide 95% confidence intervals in general this result should be seen rather as an indication than a factual representation of the true population.

Hypothesis D: Facilities that group house cats as clientele.

H₀: There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who have/do not have facilities that group house cats as clientele.

H₁: There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who have/do not have facilities that group house cats as clientele.

		Facilities that group house cats in client base	No facilities that group house cats in client base
Respondents performing juvenile castration			
	Percentage and number	34% (19/56)	19% (34/175)
	95% confidence interval	± 12% 22%-46%	± 5.9% 13%-25%
Respondents not performing juvenile castration			
	Percentage and number	66% (37/56)	81% (141/175)
	95% confidence interval	± 12% 54%-78%	± 5.6% 75%-87%

Table 41: Data on respondents that do or do not perform juvenile castration: Facilities that group house cats as clientele. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 5.05$$

$$P = 0.025$$

$$Df = 1$$

The H_0 hypothesis is rejected because $p < 0.05$. Veterinarians with facilities that group house cats as clientele (animal shelters, traders etcetera) are significantly more likely to castrate cats <4 months of age than veterinarians who do not have facilities that group house cats as clientele

Hypothesis E: Receiving the question to castrate cats <4 months of age from animal shelters

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from animal shelters.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from animal shelters.

		Received question from animal shelters	Not received question from animal shelters
Respondents performing juvenile castration			
	Percentage and number	79% (19/24)	28% (20/72)
	95% confidence interval	± 16% 63%-95%	± 10% 18%-38%
Respondents not performing juvenile castration			
	Percentage and number	21% (5/24)	72% (52/72)
	95% confidence interval	± 16% 5.0%-37%	± 10% 62%-82%

Table 42: Data on respondents that do or do not perform juvenile castration: receiving the question to castrate cats <4 months of age from animal shelters Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2= 19.7$$

$$P = 0.000$$

$$Df= 1$$

The H_0 hypothesis is rejected because $p < 0.05$. Veterinarians who have received the question to castrate cats <4 months of age from animal shelters are significantly more likely to castrate cats <4 months of age than veterinarians who did not receive this question from animal shelters.

Hypothesis F: Breeders as clientele.

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do and do not have breeders as clientele.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do and do not have breeders as clientele.

		Breeders in client base	No breeders in client base
Respondents performing juvenile castration			
	Percentage and number	51% (24/47)	29% (15/52)
	95% confidence interval	± 14% 37%-65%	± 12% 17%-41%
Respondents not performing juvenile castration			
	Percentage and number	49% (23/47)	71% (37/52)
	95% confidence interval	± 14% 35%-63%	± 12% 59%-83%

Table 43: Data on respondents that do or do not perform juvenile castration: breeders as clientele. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 4.16$$

$$P = 0.041$$

$$Df = 1$$

The H_0 hypothesis is rejected because $p < 0.05$. Veterinarians which have breeders as clientele are significantly more likely to castrate cats <4 months of age than veterinarians who do not have breeders as clientele.

Hypothesis G: Number of breeders as clientele.

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians with varying numbers of breeders as their clientele.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians with varying numbers of breeders as their clientele.

		0-10 breeders in client base	10-30 breeders in client base	30-60 breeders in client base	>60 breeders in client base	> 30 breeders in client base
Respondents performing juvenile castration						
	Percentage and number	19% (23/123)	0	33% (2/6)	100% (1/1)	33% (3/9)
	95% confidence interval	± 6.9% 12%-26%		± 38% 0%-71%		± 31% 2.0%-64%
Respondents not performing juvenile castration						
	Percentage and number	81% (100/123)	0	67% (4/6)	0	67% (6/9)
	95% confidence interval	± 6.9% 74%-88%		±38% 29%-100%		±31% 36%-98%

Table 44: Data on respondents that do or do not perform juvenile castration: the number of breeders in the veterinarians client base. Percentage, number and 95% confidence interval.

The data were imported in a 2 x 2 contingency table where the group of 10-30 breeders was left out because its frequency is zero. Groups 30-60 and >60 were combined in group “>30 breeders” due to the low number of frequencies in both groups which can be observed in table 44. The Chi-squared test was performed with the following results:

$$X^2 = 0.193$$

$$P = 0.660$$

$$Df = 1$$

The H_0 hypothesis is not rejected because $p > 0.05$. There is no significant difference in the likeliness to castrate cats <4 months of age between veterinarians with varying numbers of breeders as clientele.

Hypothesis H: Receiving the question to castrate cats <4 months of age from breeders

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from breeders.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from breeders.

		Received question from breeders	Not received question from breeders
Respondents performing juvenile castration			
	Percentage and number	51% (24/47)	16% (29/184)
	95% confidence interval	± 14% 37%-65%	±5.3% 11%-21%
Respondents not performing juvenile castration			
	Percentage and number	49% (23/47)	84% (155/184)
	95% confidence interval	± 14% 35%-63%	± 5.3% 79%-89%

Table 45: Data on respondents that do or do not perform juvenile castration: receiving the question to castrate cats <4 months of age from breeders. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 26.40$$

$$P = 0.000$$

$$Df = 1$$

The H_0 hypothesis is rejected because $p < 0.05$. There is a significant difference in the likeliness to castrate cats <4 months of age between veterinarians who have and have not received the question to castrate cats <4 months of age from breeders. Veterinarians who do receive the question to castrate cats <4 months of age from breeders are more likely to perform juvenile castration than those who do not receive this question from breeders.

Hypothesis I: Opinion on the existence of a surplus of cats in the Netherlands

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel there is a surplus of cats in the Netherlands.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel there is a surplus of cats in the Netherlands.

		Surplus	No surplus
Respondents performing juvenile castration			
	Percentage and number	23% (46/204)	26% (7/27)
	95% confidence interval	± 5.8% 17%-29%	± 17% 9.0%-43%
Respondents not performing juvenile castration			
	Percentage and number	77% (158/204)	74% (20/27)
	95% confidence interval	± 5.8% 71%-83%	± 17% 57%-91%

Table 46: Data on respondents that do or do not perform juvenile castration: opinion on the existence of a surplus of cats in the Netherlands. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 0.154$$

$$P = 0.695$$

$$Df = 1$$

The H_0 hypothesis is not rejected because $p > 0.05$. There is no significant difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel there is a surplus of cats in the Netherlands.

Hypothesis J: Opinion on the duty of a veterinarian trying to solve the problem of the surplus of cats in the Netherlands

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel veterinarians ought to play a role in resolving the problem of a surplus of cats in the Netherlands.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel veterinarians ought to play a role in resolving the problem of a surplus of cats in the Netherlands.

		Role	No role
Respondents performing juvenile castration			
	Percentage and number	23% (48/210)	24% (5/21)
	95% confidence interval	± 5.7% 17%-29%	±18% 6.0%-42
Respondents not performing juvenile castration			
	Percentage and number	77% (162/210)	76% (16/21)
	95% confidence interval	± 5.7% 71%-83%	±18% 58%-94%

Table 47: Data on respondents that do or do not perform juvenile castration: opinion on the duty of a veterinarian to work on the problem of the surplus of cats in the Netherlands. Percentage, number and 95% confidence interval.

The data were imported in a 2 X 2 contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 0.979E^{-2}$$

$$P = 0.921$$

$$Df = 1$$

The H_0 hypothesis is not rejected because $p > 0.05$. There is no significant difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel veterinarians ought to play a role in resolving the problem of a surplus of cats in the Netherlands.

Hypothesis K: Opinion on the question whether juvenile castration will have to be performed more frequently in the future to resolve the surplus of cats.

H_0 : There is no difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel that juvenile castration will have to be applied more frequently in the future in order to tackle the problem of a surplus of cats in the Netherlands.

H_1 : There is a difference in the likeliness to castrate cats <4 months of age between veterinarians who do or do not feel that juvenile castration will have to be applied more frequently in the future in order to tackle the problem of a surplus of cats in the Netherlands.

Respondents were able to answer: strongly disagree, disagree, neither disagree nor agree, strongly agree, agree. The groups “strongly disagree” and “disagree” have been combined as have the groups “strongly agree” and “agree”.

		Apply more frequently	Indifferent	Do not apply more frequently
Respondents performing juvenile castration				
	Percentage and number	56% (62/110)	19% (12/64)	11% (10/88)
	95% confidence interval	± 9.3% 47%-65%	±9.6% 9.0%-29%	±6.6% 4.4%-17%
Respondents not performing juvenile castration				
	Percentage and number	44% (48/110)	81% (52/64)	89% (78/88)
	95% confidence interval	± 9.3% 35%-53%	± 9.6% 71%-91%	±6.6% 82%-96%

Table 48: Data on respondents that do or do not perform juvenile castration: opinion on the question whether juvenile castration will have to be applied more frequently in the future to tackle the surplus of cats. Percentage, number and 95% confidence interval.

The data were imported in a R X C contingency table and the Chi-squared test was performed with the following results:

$$X^2 = 52.3$$

$$P = 0.000$$

$$Df = 1$$

The H_0 hypothesis is rejected because $p < 0.05$. There is a significant difference in the likeliness to castrate cats <4 months of age between veterinarians with different opinions regarding the statement that juvenile castration will have to be applied more frequently in the future in order to tackle the problem of a surplus of cats in the Netherlands. Those who feel that it should be applied more frequently are significantly more likely to perform juvenile castration than those who do not feel this way.

8.2 Anaesthesia in kittens: additional information

This section discusses information deduced from literature relevant for the companion animal veterinarian. This information is not provided in the discussion on anaesthesia and perioperative care (5.4.2) since there were no results from the survey to compare this information to.

8.2.1 Preoperative care

Kittens should receive a full preanesthetic clinical evaluation, be properly vaccinated related to their age and should also be treated for intestinal- and ectoparasites several days prior to surgery. 6-14 week old kittens have lower hematocrits (29.8%-33.1%) than adults do, and therefore parasites that contribute to anaemia may be dangerous ^[24,31].

8.2.2 Cardiovascular physiology

Cardiovascular compensation mechanisms are still underdeveloped in kittens ^[23]. The cardiac output of kittens depends mainly on heart rate (reference for kittens ± 200 bpm) ^[31] since they have a reduced ability to increase stroke volume due to a higher proportion of non-contractile tissue and limited ventricular compliance. Also, the immaturity of their sympathetic nervous system restricts the ability to increase heart rate. The same immaturity leads to a higher risk of developing hypotension, while kittens already have a lower blood pressure than adult animals ^[3,19,23]. This means that these young animals cannot respond adequately to a sudden drop of blood pressure as can happen during anaesthesia or as a result of blood loss during surgery (as little as 5ml/kg) ^[19] because they are unable to increase peripheral vascular resistance by means of vasoconstriction ^[23].

8.2.3 Haematology

After birth, haemoglobin levels decrease caused by a lower erythrocyte production, a shorter erythrocyte life span and hemodilution due to the expanding blood volume. In addition to cardiovascular reasons mentioned before, it is therefore especially important to minimise blood loss during surgery since even small amounts of blood loss may therefore result in anaemia ^[22].

8.2.4 Anaesthetics

Protein-bound drugs such as propofol are potentiated by the hypoalbuminaemia that exists up until 8 weeks of age ^[19,23]. Up to 12 weeks of age immature hepatic enzyme systems exist. This leads to a reduced speed of drug transformation and metabolism, thus prolonging hypnotic effects. However, clinical research suggests that existing dose guidelines for injectable anaesthetics used in adults can be safely used in kittens after 6 weeks of age without evidence of prolongation of the effects ^[22,24]. In these young animals the termination of drugs which are cleared via renal excretion is affected by immature glomerular filtration rates, reduced renal blood flow and a limited filtration fraction. As a result the excretion of anaesthetics by the kidneys is slower than in adult animals and its effects are prolonged ^[19,23]. The precise measuring of body weight, accurate dosing and the use of an anaesthetic which

can be antagonized are therefore preferable. In this way the amount of drugs the kitten has to metabolise is minimized thereby reducing recovery time.

8.2.4.1 Premedication

Premedication provides a positive effect on anaesthetic depth, muscle relaxation, analgesia^[23] and depending on drugs used lowers the required dosage of drugs used for induction and maintenance^[36]. In kittens the effects of the parasympathetic nervous system dominate. Anticholinergic drugs, such as atropine (0.02-0.04 mg/kg) or glycopyrrolate (0.01-0.02 mg/kg), should be routinely administered prior to general anaesthesia to maintain heart rate^[22,23]. Another advantage of these drugs is the decrease of excretion in the airways which helps to prevent airway obstruction^[23] which occurs easily in kittens^[19,32].

Benzodiazepines are relatively safe since they cause moderate effects on the respiratory and cardiovascular system such as vasodilatation and hypotension. When necessary these effects can be counteracted by administering the antagonist flumazenil. Benzodiazepines provide no analgesia^[23,36] and while they provide a good level of sedation in very young kittens, it is advisable to combine them with other sedatives in older kittens. The use of phenothiazines is discouraged in animals younger than 12 weeks of age. They induce cardiovascular effects which lead to peripheral vasodilatation potentially causing hypotension and hypothermia^[23]. Alpha2 agonists such as (dex)medetomidine have strong sedative and analgesic properties and have a significant drug-sparing effect. Alpha2 agonists should be used with caution in kittens since they cause a reduction in cardiac output and bradycardia^[23,36]. Bradycardia in itself can also cause a reduction of cardiac output in young animals since their cardiac output depends highly on heart rate^[19,36]. Alpha2 agonists are metabolised by the liver and excreted via the kidneys. In young animals this may lead to a prolonged recovery. Research suggests that the use of dexmedetomidine is preferable since it contains merely the active dextro-rotatory variant and not the levorotatory variant which would be an additional burden on the liver and kidneys^[23]. The administration of the alpha2-adrenergic antagonist *atipamezole hydrochloride* significantly reduces recovery time^[25]. Narcotic analgesics such as butorphanol and buprenorphine provide good analgesia and when used as premedication, they reduce the required dose of other anaesthetics. Pure μ -agonists such as morphine and methadone, should be used with restraint due to the dose related cardiovascular and respiratory effects such as bradycardia and hypoventilation.

8.2.4.2 Induction and maintenance

Dissociative anaesthetics such as ketamine give only a slight respiratory depression and have an indirect stimulatory effect on the cardiovascular system. They are often combined with benzodiazepines to provide improved muscle relaxation. Increased salivation can lead to upper airway obstruction and a combination with parasympatholytics is therefore advised^[36]. Propofol can be used with relative safety in kittens older than 8 weeks if it is slowly injected over a period of one to two minutes. It can be used for both induction and maintenance and provides a quick, short lasting anaesthesia with good muscle relaxation but limited analgesia. Due to the hypoalbuminaemia that exists until 8 weeks of age^[19,23], in this age group a larger portion of the protein-bound drug propofol circulates in its unbound, active form. Inhalation

anaesthetics such as isoflurane can be used both for induction and maintenance. One can choose to induce anaesthesia by means of by mask using a volatile agent instead of using propofol because of the difficulty of the placement of an IV catheter in these small patients. However, isoflurane has a strong unpleasant odour^[36] which makes it less suitable for induction without premedication which is sometimes still performed in practice. A recent study evaluating the neuroactive steroid alfaxalone as an induction agent in 12 week old cats^[37] showed that it is a suitable alternative for induction with a mean dose of 4.7 mg/kg intravenous. In cases where maintenance with an inhalant anaesthetic is not possible, maintenance can be achieved using supplemental doses of alfaxalone with acceptable to excellent anaesthetic effectiveness. However, this information should be interpreted with care since only eight kittens received maintenance by supplemental intravenous administration of alfaxalone which were all females. The mean dose required to maintain anaesthesia with alfaxalone, in addition to the induction dose, was 11.1 mg/kg/h. Alfaxalone maintained heart rate better than isoflurane which is preferable, considering the fact that the cardiac output of young kittens is highly rate-dependent^[37]. Alfaxalone can cause post- induction apnoea (>30 seconds without inspiration) and should be injected slowly over a period of 60 seconds^[36], although the incidence of post-induction apnoea in this study was restricted to one patient^[37].

8.3 Long-term complications: additional information

This section discusses information deduced from literature relevant for the companion animal veterinarian. This information is not provided in the discussion on long-term complications (5.4.4) since there were no results from the survey to compare this information to.

8.3.1 Penile extrusion

In a study by Root complete penile extrusion was possible in 100% of the intact cats, in 60% of cats neutered at 7 months of age and in none of the cats neutered at 7 weeks of age.

However, the clinical relevance of incomplete penile extrusion in a neutered cat is unknown [20].