



## Research article

# Incidence of short-term complications after sterilization between pre-operative antibiotic versus pre- and post-operative antibiotic administration in female cats

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## Abstract

A sterilization program is implied to control the cat population and set up as national rabies control activities. In Thailand, a few studies have been conducted on postoperative complications and undesired incidents after massive sterilization. This study determined the incidence of short-term sterilization complications in cats with or without postoperative antibiotic administration and the risk of short-term surgical complications. The investigators conducted a clinical trial study. Female cats (n=492) who participated in Chiang Mai municipal birth control activity were assessed and recorded those complications between with and without postoperative antibiotics. The risk factors were analyzed using risk ratios (RR) with a 95% confidence level. Twenty-five cats (5.08%) showed short-term complications in the study. The incidence of short-term complications was not significantly different between cats with postoperative antibiotics (4.92%) and without postoperative antibiotics (5.24%). Cats with external parasites had 2.35 times a short-term complication (RR=1.05-5.27;95%CI). Duration in captive area, this factor showed that prolong of a cat kept in cage or indoor area play role as a protective factor which less than 2-day in a cage or indoor as the baseline, the risk ratios were 0.38 in 5-day and 0.18 in 7-day, respectively. In conclusion, cat sterilization without post-operative antibiotic administration could be performed under ordinary operation with an aseptic concept.

**Keywords:** Cat sterilization, Chiang Mai municipality, Complication, Postoperative antibiotic, Thailand

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## INTRODUCTION

According to the global rabies problem and overpopulation of dogs and cats was driven progress towards by WHO's rabies elimination. In Thailand, community participation is one of the critical rabies-free factors, including community attitudes, knowledge, and practices (Kiratitana-Olan et al., 2021). The Thai government has considered setting up a sterilization program to control their population and implement it into national rabies control activities. In condition, sterilization surgeries including ovariohysterectomy and castration indicated a complication rate around 0.0–4.9% (Vasseur et al., 1985; Beal et al., 2000). In 2017, 6% of animals that were sterilized by the Chiang Mai Municipal Animal Birth Control Program developed postoperative wound complications (Chutipongvivate et al., 2019). Not only, sterilization procedures need to be performed by an experienced surgeon to prevent postoperative complications (Adin, 2011) but the factors such as operation duration, incision site, and reported risks also should be considered (Brown et al., 1997; Mayhew et al., 2012; Turk et al., 2015). There was evidence that multidrug-resistant bacteria had increased because of antibiotic using for surgical site infection (SSI) treatment after operation (Leonard et al., 2006; Perreten et al., 2010). The leading cause of SSI is an opportunistic bacterial infection caused by bacteria on the animal skin (Nicholson et al., 2002; Eugster et al., 2004; Vengust et al., 2006). However, an operation without post-operative antibiotics can be provided with a low level of surgical complications (Airikkala-Otter et al., 2018). According to scientific evidence, an operation with appropriate surgical antibiotic prophylaxis and no postoperative antibiotic administration is showed no increase in the risk of SSI (Classen et al., 1992; World Health Organization, 2018). Human and animal studies mentioned that the most critical strategy to reduce bacterial infection is the aseptic technique during surgery (Vasseur et al., 1985). Pain and stress can interrupt wound healing processes (Woo, 2012). Ovariohysterectomy (OHE) can cause moderate pain associated with soft tissue pain. Consequently, pain management should be applied in companion animal operation protocols (Hansen et al., 1997).

In Thailand, a few studies have been conducted on postoperative complications and undesired incidents after massive sterilization. Most Thai veterinarians believe that antibiotics used for postoperative administration can prevent postoperative complications. This study hypothesizes that the sterilization operation with or without post-operation antibiotic administration can show the same results to prove that belief or myth (Chow et al., 2008). Rare complication incidence was assessed after a clinical trial. The objective of this study was to determine/investigate the incidence of short-term sterilization complications in cats with/without antibiotic administration after sterilization and to study the association between short-term surgical complications and other relevant factors. This study suggested an alternative protocol and referenced a future study related to antibiotics used after sterilization.

## MATERIALS AND METHODS

### Data source and study design

Census sampling data was collected from female cats and owners. The data was collected from the owners by using the questionnaire. The sample size in this study was calculated using sample size calculation for a binary outcome from the equivalence clinical trial study (parallel study). The formula for sample size calculation is shown in Figure 1 by using proportion in group 1 ( $p_1$ ) = 0.062, proportion in group 2 ( $p_2$ ) = 0.058 (Pirun et al., 2017) with 6.7% as the margin ( $\delta$ ), Alpha ( $\alpha$ ) = 0.05 Beta ( $\beta$ ) = 0.20, and ratio ( $k$ ) = 1. The calculated sample size was at least 244 in each group. The inclusion criteria were healthy female cats between 6 months-4 years old with body weight >1.8 kg that received aseptic operation under Chiang Mai Municipality Animal Birth Control Program. Exclusion criteria were considered related to animal welfare and ethics, such as urogenital infection, neoplasia, or any infections that may require treatment.

$$n_2 = \frac{(z_{1-\alpha} + z_{1-\beta})^2}{(\delta - |\epsilon|)^2} \left[ \frac{p_1(1-p_1)}{k} + p_2(1-p_2) \right]$$

$$\epsilon = p_1 - p_2$$

$$k = \frac{n_1}{n_2}$$

$$n_1 = kn_2$$

**Figure 1** A Sample size calculation for a binary outcome from an equivalence trial

The study protocol and questionnaire were ethically reviewed and approved by the Animal care and use committee, Faculty of Veterinary Medicine Chiang Mai University Research Ethics Committee (Rf. No. S30/2562). In addition, blood samples were collected before the operation for checking complete blood count, platelet count, and blood parasite infestation (smearing) profile. The surgical protocol for sterilization in female cats in this study was the same as a standard surgical protocol in Thailand (Table 1). The sterilization in all cats was performed by ovariohysterectomy surgery in the lateral flank approach. Equipment used in operation was cleaned and disinfected with autoclaved to destroy contaminated microorganisms. Three experienced surgeons were in this study. A spay hook was used for minimizing the incision site. Polyglactin suture was used as a suture material in all cats. All physical examination and vital signs were monitored and recorded, including an anesthetic record during the operation. The cats were randomized into 2 groups; cefazolin (IV 22 mg/kg) was given as antibiotic prophylaxis for 30 minutes before the operation (Whittem et al., 1999; Gonzalez et al., 2017). Group A cats were given postoperative antibiotics for 7 days. All cats were given anti-inflammatory drugs 2 days postoperatively.

**Table 1** The surgical protocol in this study

	Group A (Antibiotic group)	Group B (Without antibiotic group)
<b>Incision site and surgeon hand scrubbing</b>	Chlorhexidine scrub solution (5 min) and rinse with 70% alcohol	
<b>Sedative</b>	Xylazine HCl (1mg/kg IM)	
<b>Analgesic drug</b>	Tramadol (4 mg/kg IV)	
<b>Prophylaxis intravenous</b>	Cefazolin (IV 22 mg/kg) 30 min before the operation	
<b>Anesthesia and maintenance</b>	Tiletamine-Zolazepam (5 mg/kg IV)	
<b>Fluid</b>	Lactate ringer's solution (10 ml/kg/hr)	
<b>Postoperative medicine</b>		
Anti-inflammation	Mefenamic acid (20mg/kg,PO) s.i.d 2	Mefenamic acid (20mg/kg,PO) s.i.d 2 d
Antibiotic	Cephalexin(22.2mg/kg,PO) b.i.d 7d	None

### Postoperative assessment

The postoperative care period for this study was 7 days after the operation. Although cats were sent back home for recovery, they were brought back for wound monitoring by the three surgical veterinarians on 2, 5, and 7 days postoperatively. After that, the owners were interviewed via phone after 30 days of operation. The Worldwide Veterinary Service International Training Centre (WVS ITC) postoperative wound scoring was used for wound evaluation, as shown in [Table 2](#). During the postoperative care period, cats with a wound score >1 or applying any intervention involving operation such as wound flushing, wound reopening, the administration of antibiotics or anti-inflammatory were recorded as outcomes that indicated a short-term complication ([Airikkala-Otter et al., 2018](#)). Additionally, the short form of composite measure pain score was a valuable assessment tool for pain assessment in cat, and pain scores were recorded by the visual appearance of the cat and its reaction to gentle touch around the surgical with cat behavior that was interviewed. ([Reid et al., 2017](#))

**Table 2** WVS ITC's postoperative wound scores ([Airikkala-Otter et al., 2018](#))

Wound score	Description
0	Perfectly healing wound, edges in apposition
1	Mild redness on the skin around the wound
2	Swelling or discharge or exposed subcutis
3	Partial opening of the wound
4	Complete opening of the wound

### Data collection and analysis

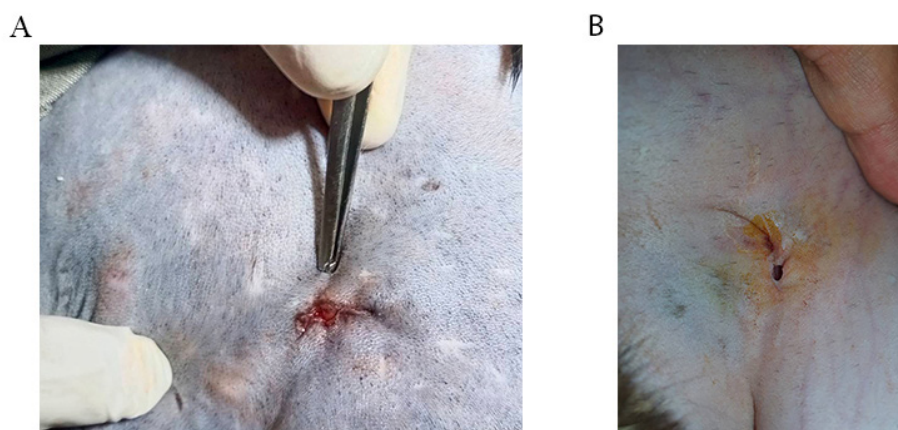
Data were recorded with MS Excel and analyzed by Epi Info for Windows 7. Interested variables were recorded ([Table 3](#)). Relative risk and their 95% confidence intervals were calculated for each variable. Chi-square was used to define the statistical difference between Group-A and Group-B (p-value<0.05).

**Table 3** Classification for the variables in the study

Variable	Classification
<b>Dependent variable(case)</b>	
Short-term complication	Wound score>1 or applied any intervention involving operation during 7 days.
<b>Independent variable</b>	
Mucous membrane	Pink color or not
Hydration status	Skin tent test
External parasite	Flea tick or lice found
Duration in captive area	Duration of the cat was always kept in a cage or indoor area
Thrombocytopenia	Platelet count < 300,000 cells/mm <sup>3</sup>
Anemia	RBC count <5x10 <sup>6</sup> cells/mm <sup>3</sup> or Hematocrit<30% or Hemoglobin<10g/dl

## RESULTS

Five hundred female cats participated in this study, but 8 cats were excluded because of pyometra. The information of 492 cats was used in the study, which composed 244 in group A and 248 in group B. We found the incidence of short-term complications (5.08%, n=25/492), including group A (n=12/244) and group B (n=13/248) (Table 4). 5.74% of cats had blood profiles as thrombocytopenia and 5.41% as anemia. None of the blood smear samples was found blood parasite by microscopic finding technique. In Table 5 showed the most intervention during the postoperative care period. Wound flushing was used in 9 cats (7 in group A, 2 in group B), 8 cats (4 in group A, 4 in group B) were given an anti-inflammatory. 6 cats in group B were treated by wound flushing and antibiotic given. All cats with postoperative complications or wound score of > 1 (Figure 2) were appropriately treated until their wound entirely recovered.



**Figure 2** Postoperative complications during the post-care period that were applied intervention. (a) swelling wound: score-2 and (b) partial opening wound: score-3

**Table 4** The incidence of short-term complications in the antibiotic giving group (Group A) and without (Group B).

	Group-A(n=244)		Group-B(n=248)		Total(n=492)		RR (95%CI)
	No. of complication	(%)	No. of complication	(%)	No. of complication	(%)	
Mucous membrane							
Pink							
Not pink	8/199	4.02	11/215	5.12	19/414	4.59	0.59(0.24-1.45)
Hydration status	4/45	8.89	2/33	6.06	6/78	10.26	
Dehydration							
Normal	1/9	11.11	0/4	0	1/13	7.69	1.54(0.22-10.50)
Skin lesion	11/235	4.68	13/244	5.33	24/479	5.01	
Yes							
No	1/9	11.11	0/4	0	1/13	7.69	1.53(0.22-10.50)
External parasite	11/235	4.68	13/244	5.33	24/479	5.01	
Yes							
No	3/43	6.98	5/39	12.82 <sup>a</sup>	8/82	9.76 <sup>b</sup>	2.35(1.05-5.27)
Duration in captive area	9/201	4.48	8/209	3.83 <sup>a</sup>	17/410	4.15 <sup>b</sup>	
2 days	3/49	6.12	9/52	17.31	12/101	11.88 <sup>c</sup>	ref
5 days	6/94	6.38	3/107	2.80	9/201	4.47 <sup>c</sup>	0.38(0.16-0.86)
7 days	3/101	2.97	1/89	1.12	4/190	2.1 <sup>c</sup>	0.18(0.06-0.54)
Thrombocytopenia							
Yes	4/67	5.97	3/55	5.45	7/122	5.74	1.19(0.50-2.75)
No	8/177	4.52	10/193	5.18	18/370	4.86	
Anemia							
Yes	2/45	4.44	2/29	6.90	4/74	5.41	1.08(0.38-3.05)
No	10/199	5.03	11/219	5.02	21/418	5.02	
<b>Total</b>	<b>12/244</b>	<b>4.92</b>	<b>13/248</b>	<b>5.24</b>	<b>25/492</b>	<b>5.08</b>	

<sup>a,b</sup> statistical difference with p<0.05 by fisher-exact tests

<sup>c</sup> statistical difference with p<0.05 by chi-square (X<sup>2</sup>=6.89, df=2)

There was no association between short-term complications status and study groups (RR=0.98,95%CI 0.44-2.02; p=0.87). The external parasite was a risk factor for short-term complications. Cats with external parasites had 2.35 times to have short-term complications more than cats without external parasites in overall cats, and it was 3.35 times in group-B(RR=1.23-9.70;95%CI). Duration in the captive area factor showed that a prolonged cat kept in a cage or indoor area plays a role as a short-term complication protective factor. According to 2-day or less in restrict area as a baseline, the risk ratio were 0.38 and 0.18 for 5-day and 7-day in a cage or indoor, respectively. However, there was no significant difference in the other factors, including mucous membrane status, dehydration status, a cat with a skin lesion, anemia, and thrombocytopenia.

**Table 5** The interventions during 7 days after the operation.

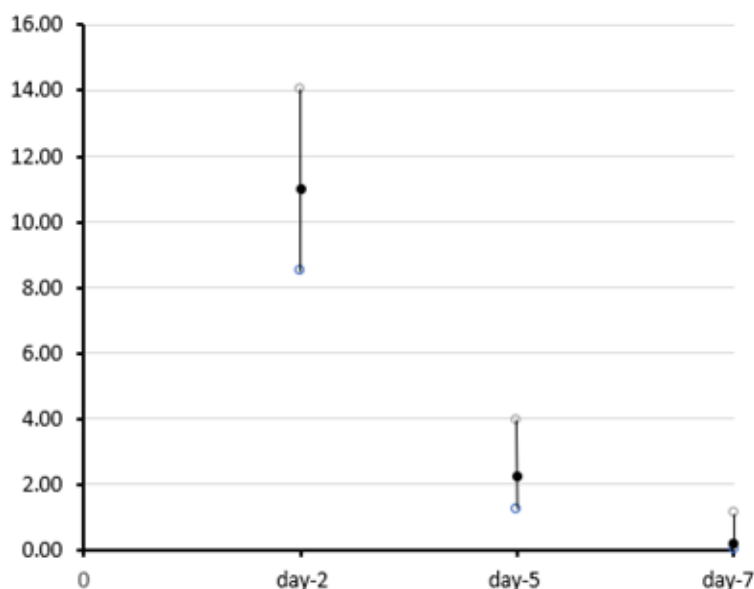
Intervention	No. of cat	
	Group-A	Group-B
Wound flushing	7	2
Wound flushing with antibiotic administration	0	6
Wound flushing with anti-inflammatory administration	1	0
Anti-inflammatory administration	4	4
Antibiotic with anti-inflammatory administration	0	1
<b>Total</b>	<b>12</b>	<b>13</b>

Wound flushing by betadine-diluted then rinse with NSS  
 Antibiotic administration : Cephalaxin 25 mg/kg,PO b.i.d  
 Anti-inflammatory administration : Tofedine 4 mg/kg,SC

The average wound and pain score are shown in Table 6. The proportion of pain score >0 was 10.98% on 2-day after the operation, and the highest score was 14. The proportion decreased to 2.24% on day 5, and the highest score was 8. Only one cat showed signs of pain on 7-day with a pain score=2. The results of the pain assessment were plotted as shown in Figure 3

**Table 6** The average wound and pain score.

	Group-A(n=244)	Group-B(n=248)
Avg. wound score		
Day-2	0.09(±0.38)	0.06(±0.33)
Day-5	0.03(±0.17)	0.02(±0.13)
Day-7	0	0
Avg. pain score		
Day-2	0.64(±2.08)	0.50(±1.90)
Day-5	0.11(±0.63)	0.06(±0.58)
Day-7	0.01(±0.13)	0



**Figure 3** Pain score during day-2, day-5, and day-7 of the postoperative period; The proportion of cats with a pain score > 0 with 95% confidence intervals

## DISCUSSION

In the present study, the incidence of postoperative complication for female cats undergone surgery with or without postoperative antibiotic were compared. Our result indicated that incidences from both groups were not statistically different. According to ovariohysterectomy is classified as a clean operation; the study showed the incidence of postoperative complication in both groups was acceptable level which reported in previous studies reported a wound infection rate of 0.0–4.9% in clean surgeries (Vasseur et al., 1985). Moreover, the sterilized operation can be provided without postoperative antibiotic administration, which encouraged the previous study results in

Thailand (Chutipongvivate et al., 2019) and is similar to the study of WVS in India (Airikkala-Otter et al., 2018). A short follow-up period can be indicated only short-term complications. However, a 30-day phone interview was set up to interpret any under-reported complications after 7-day. Therefore, the phone interview should be interpreted with caution because it can cause bias. Fortunately, there were no complications reported by phone interview.

Generally, an equivalence clinical trial study aims to demonstrate or confirm efficacy before choosing an appropriate treatment or practice (Chow et al., 2008). This type of observational study is not advisable for finding the associated factors. However, Table 7 showed that the average surgical duration and body weight which were reported as association risk factors were statistically different between Group A and B, which might play the role of confounders (Brown et al., 1997; Mayhew et al., 2012; Turk et al., 2015). In the future, measuring or assessing the relationship between intriguing factors and cohort or case-control should be set up (Munnangi and Boktor, 2022).

**Table 7** Animal characteristics between in antibiotic giving group (Group A) and without (Group B).

	Group A (n=244)	Group B (n=249)	P-value
Avg. Incision length(cm)	0.631 (±0.527)	0.504 (±0.243)	0.8599
Avg. BW (kg)	2.694 (±0.634)	3.052 (±0.794)	<0.05
Avg. Surgical duration(min)	24.461 (±11.783)	27.061 (±12.288)	<0.05

The study was decided to leave the cat's postoperative care to the owner because the duration of the postoperative intensive care unit or animal shelter has been associated with an increase in the risk of SSI (Airikkala-Otter et al., 2018). According to homecare, the post-operation intervention indicated short term complication was used, including wound scoring at day 2, 5, and 7, and they might be helpful in a study in follow-up assessing. Unfortunately, this study did not prove infection in animals with wound scores>0. Therefore, the bacterial culture and resistance pattern should be done before giving an antibiotic to provide appropriated treatment planning (Somrup et al., 2018). An interesting point from this study outcomes exhibited that prolonged restricted housing on 7-days can cause lower postoperative complications than 5-days and 2-days housing, although it controversially with Eugster's study, which reported prolonged periods of rising in a kennel affected to increasing stress-inducing wound complications (Eugster et al., 2004). Furthermore, the study's postoperative pain scores by pain management in this study demonstrated that pain management could contribute to wound healing and is an essential method in postoperative care that supported the previous evidence (McGuire et al., 2006; Airikkala-Otter et al., 2018).

Although the government agency in Thailand, which is responsible for the massive dog and cat sterilization, usually operates without a blood profile test before the surgery, the blood count profile is accomplished in all cats in this study. In the baseline blood profile part, many cats revealed anemia conditions. There was no significant difference between anemia and none-anemia and in thrombocytopenia and none- thrombocytopenia animals. Notwithstanding, the evident mechanism has been reported about the correlation of the iron-deficiency anemia may impair wound healing (Wright et al., 2014).

For further, surveillance activities should identify risk factors and improve the operation protocol that can help support the aseptic operation



without antibiotic administration. Therefore, the appropriate assessment of postoperative complications besides wound and pain scores should be considered in the surveillance system or future study.

Although mefenamic acid is not recommended as a good NSAID in cats but our study is based on Chiang Mai municipal routine protocols which are under limited resources and budget that mefenamic acid is used in the protocol. However, Tofenamic acid or another NSIAD should be provide for safty and welfare. As mentioned earlier, the preoperative blood profile test is not only essential to check anemic status or thrombocytopenia; the liver and renal function should be assessed along with other tests before surgery

## CONCLUSION

The result of this study showed strong evidence that a low incidence of post-operation short-term complication in female cat sterilization without antibiotic administration can be operated under aseptic technique operation and a pain management. Following the result, an external parasite infestation was the relevant factor of short-term complication, and prolonging a cat kept in a cage or indoor area plays a protective factor.

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## AUTHOR CONTRIBUTIONS

**Pirun Chutipongvivate:** Investigation, Methodology, Writing - Original Draft  
**Veerasak Punyapornwithaya:** Validation, Writing - Review & Editing

**Kannika Na Lampang:** Data Curation

**Kriangkrai Thongkorn:** Conceptualization, Resources, Project administration, Writing - Review & Editing.

## CONFLICT OF INTEREST

None of the authors have any conflicts of interest to declare.

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