A simplified manual for clinical treatment of common marmosets

Miki MIWA*, Akihisa KANEKO, Katsuki NAKAMURA*

Cognitive Neuroscience Section
Center for the Evolutionary Origins of Human Behavior, Kyoto University

Key words: common marmoset, anorexia, diarrhea, constipation, vomiting, respiratory disorder, oral disorder, injury, emergency care

*Corresponding authors
Miki MIWA
Cognitive Neuroscience Section, Center for the Evolutionary Origins of Human Behavior, Kyoto University. 41-2 Kanrin, Inuyama, Aichi 484-8506, Japan.

Katsuki NAKAMURA
Cognitive Neuroscience Section, Center for the Evolutionary Origins of Human Behavior, Kyoto University. 41-2 Kanrin, Inuyama, Aichi 484-8506, Japan.

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Introduction

The common marmoset (*Callithrix jacchus*), often used in experiments pertaining to the medicine and life science domains, sometimes experiences progression from minor discomfort to fatal conditions owing to its small body size. Sensitivity to symptoms, that is, responding appropriately to the signs of discomfort, is crucial in the health management of the common marmoset.

Regarding the detection of symptoms and abnormalities, Miwa et al. (2022) explained, aspects to be considered during daily observations to the initial response when abnormalities were detected. Therefore, in this study, we present treatment methods for common problems encountered in marmoset husbandry in Japan, such as anorexia, diarrhea, constipation, vomiting, respiratory disorders, and dental/gum abnormalities. Additionally, we have described the injury responses and initial emergency care. We decided to use a symptom-based description rather than a disease-based description so that this manual can be useful when confronted with these symptoms in daily husbandry. Therefore, we have tried to be as specific and concise as possible in our description. Because the content is based on our experience at Kyoto University, and it may not be appropriate for some facilities; however, we hope that this manual can be of benefit in common marmoset health management.

[1] Anorexia

Anorexia is one of the most frequently observed symptoms in common marmosets in captivity. Reduced food intake can easily occur owing to factors such as disease, environmental changes (e.g., cage change and construction), and stress from experimental procedures. Due to their small body size and rapid metabolism (McWhorter & Karasov, 2007), dehydration, electrolyte imbalances, and malnutrition may develop if not treated promptly, leading to more severe conditions. Therefore, care should be exercised when treating anorexia in the common marmoset. Figure 1 presents a flowchart for anorexia treatment.

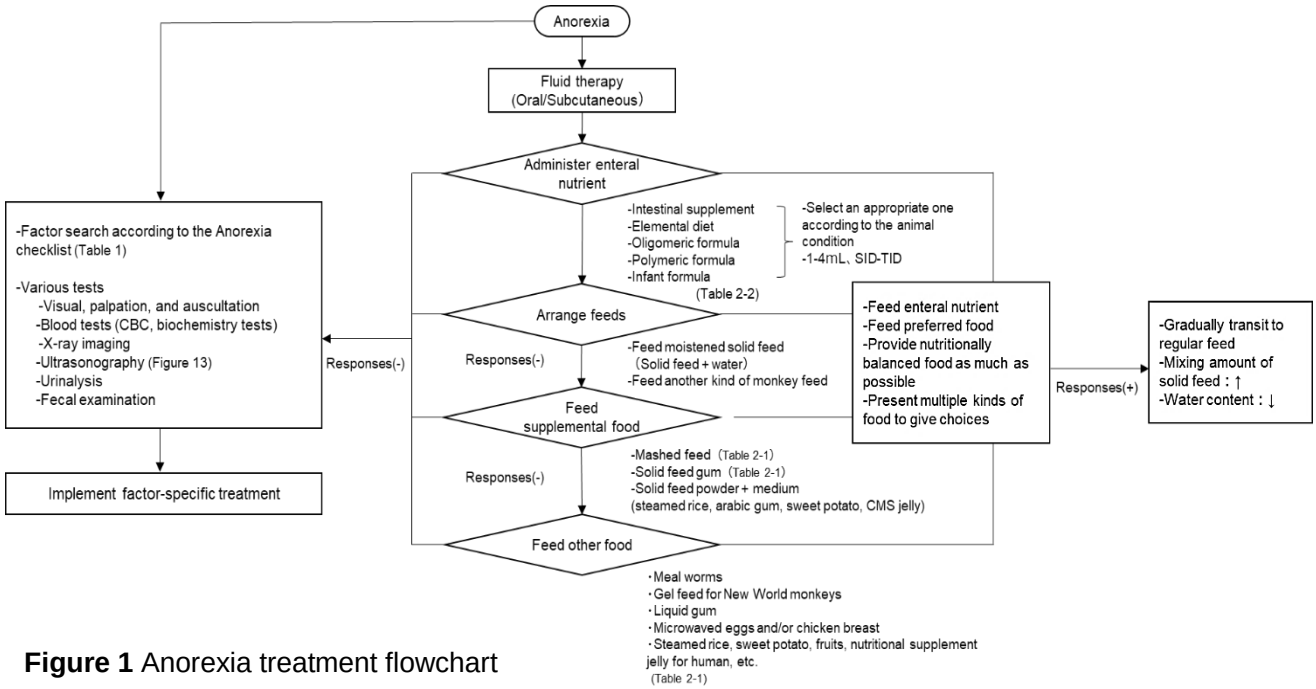

Figure 1 Anorexia treatment flowchart

Decreased food intake was defined as an increase in leftover food and a decrease in spilled food. Anorexia can also result in decreased stool volume, increased hard stools, weight loss, and deteriorated coat conditions. Systemic symptoms, such as decreased activity, may also occur in severe cases.

The causes of anorexia are generally multifactorial (Shimizu, 2014), include medical conditions and environmental factors, such as stress. A checklist for investigating these factors in the common marmoset with anorexia is presented in Table 1.

When investigating these causes, it is important to initiate fluid and nutritional supplementation (oral/subcutaneous hydration). Nutritient supplementation can be initiated with an intestinal supplement (such as GFO®) and easily digestible enteral nutrient liquid. The intestinal supplement containing glutamine, dietary fiber, and oligosaccharides are effective in maintaining intestinal mucosal condition and immune function. In addition to using the commercial

Table1-1 Checklist for anorexia (Disease causes)

Disease Cause	
Checklist	Items
Are there any abnormalities in facial expression, movement, or vital signs?	-Body temperature -Respiratory rate -Facial expression -Location -Posture -Activity level
Are there any gastrointestinal symptoms?	-Nausea, vomiting -Diarrhea, constipation -Mucous, bloody stools, black stools, rectal bleeding
Are there any problems with oral cavity or swallowing function?	-Gingivitis -Root abscess -Tooth mobility or loss
Is there anemia?	-Iron deficiency -Vitamin B12 deficiency -Folate deficiency -Renal anemia
Is there a possibility of taste disorders?	-Iron deficiency -Zinc deficiency -Chronic renal failure
Is there any pain?	-Injury (bites, fractures, etc.) -Surgery -Abscess
Could there be side effects of medications?	
Could there be effects of experimental or therapeutic procedures?	
Are there any cachexia diseases?	-CLE（WMS） -Chronic infections (ex. pneumonia) -Chronic liver failure -Chronic renal failure -Chronic heart failure -Malignant tumors

CLE: Chronic lymphocytic enteritis, WMS: Wasting marmoset syndrome

＊Reference: Shimizu 2014

Table1-2 Checklist for anorexia (Environmental causes)

Environmental Causes	
Checklist	Items
Are there any issues with the feed?	-Contents (brand, lots, etc.) -Feeding amount -Storage conditions -Excessive supplementary feeding
Are there any issues with feeding or water supply	-Feed box (shape, location, etc.) -Abnormalities in water, malfunction of water supply
Are there any issues with the housing conditions?	-Temperature, humidity, ventilation, noise, lighting -Position of the cage -Adjacent and facing individuals -Number of individuals housed in the cage
Is there excessive stress?	-Power dynamics within the group -Changes in group composition -Pairing -Cage or room change -Construction work (noise, vibration, odors, etc.) -Experimental procedures -Human presence (excessive entry and exit, newcomers, etc.)

∗ Reference: Shimizu 2014

product, homemade supplements with glutamine, soluble fiber, and oligosaccharides can be prepared. If homemade, the fiber material should be gum arabic, which a preference of the common marmoset, rather than guar gum used in the commercial product. (Pupe et al., 2011; Miwa et al., 2015a; Miwa et al., 2019). Enteral nutrients should be selected based on the condition of the animal. Concurrently, the method of administering the solid feed should be adjusted. Sprinkling water on the solid feed softens the feed and encourages feeding. If different solid feed products for New World monkeys are available, those should be offered. If intake increases, continue feeding with such products. In case of poor response with the solid feed, supplemental feed should also be provided. First, supplemental feed containing solid feed should be considered, and if the response continues to be poor, other supplements must be provided, as providing the animal's preference is crucial to improving feeding. Additionally, provide items with excellent nutritional balance as much as possible. Multiple types of supplements are provided according to the condition of the animal. Once eating was encouraged, the amount of solid feed included in the supplemental feed was gradually increased while reducing the amount of water and gradually transitioning to regular solid feed. Table 2 presents the list of supplements and enteral nutrients.

[2] Diarrhea

Diarrhea is the most frequently observed symptom in captive common marmosets in Japan. Diarrhea occurs when there is an abnormal acceleration of intestinal peristalsis, leading to a shortening of the transit time. It also occurs when there are abnormalities in water regulation within the intestines (increased secretion into the intestines and impaired water reabsorption), resulting in increased water content in stools (Gallagher, 2022; Gotfried, 2022b). Early detection and treatment are crucial for preventing disease progression. During the diagnosis, the individual

animal conditions (overall condition, appetite, fur condition, facial expression, posture, movement, perianal condition, weight, relationship with group members, and nearby individuals), onset time

Table 2-1 Supplemental feedings

Supplemental feedings	Ingredients/Components
Mealworms	larvae, pupae, adults
Mashed feed	90 g solid monkey feed powder + 20 g Arabic Call SS (gum arabic) + 10 g probiotics preparation + 40 mL water
Solid feed gum	50 g Arabic Call SS (gum arabic) + 10 g solid feed powder + 10 g probiotics preparation + 1.3 g Morinaga E-Akachan (infant formula) + 1.3 g Meiji Meiprotein® (protein powder) + 1 g glutamine powder+ 29 mL water
Arabic gum with additives	-5 g Arabic Call SS (gum arabic) + 1 g probiotics preparation + 3 mL IsoCal® Junior - 8 g Arabic Call SS (gum arabic) + 11 g steamed rice +0.5 g probiotics preparation + (+ sufficient water)
Liquid gum	10 g Arabic Call SS (gum arabic) + ≦10 mL water
Arabic gum crystals	Gum arabic
CMS jelly (For New World monkeys)	150 mL CMS jelly powder＋150 mL Water＋10 g solid monkey feed powder
Eggs and chicken breast	Microwave-heated eggs and chicken
Sweet potatoes	raw, boiled, dried
Steamed rice	cooked and mashed
Others	apples, bananas, Calorie Mate® jelly

＊Probiotics preparation: A mixture of equal volumes of LAC-B® R powder, MIYA-BM® fine granules, BIO-THREE®, LEBENIN® powder, and 0.1% biotin dry syrup

Table 2-2 Enteral nutrition

Type	Product name	Manufacture	Compounding
Elemental diet	Elental® P combination powder	EA Pharma	1.5 g + 5 mL water
Oligomeric formula	Tube Diet® <High- Calorie/High Protein>	Morinaga Sunworld	1.6 g + 10 mL water
Polymeric formula	Isocal® 1.0 Junior	Nestlé Health Science	
Infant formula	Morinaga E-Akachan	Morinaga Milk Industry	1.3 g + 10 mL hot water
Glutamine, fiber, and oligosaccharides (intestinal supplement)	GFO®	Otsuka Pharmaceutical	0.5 g + 5 mL water

＊Reference: Shimizu 2011, Higashiguchi 2006

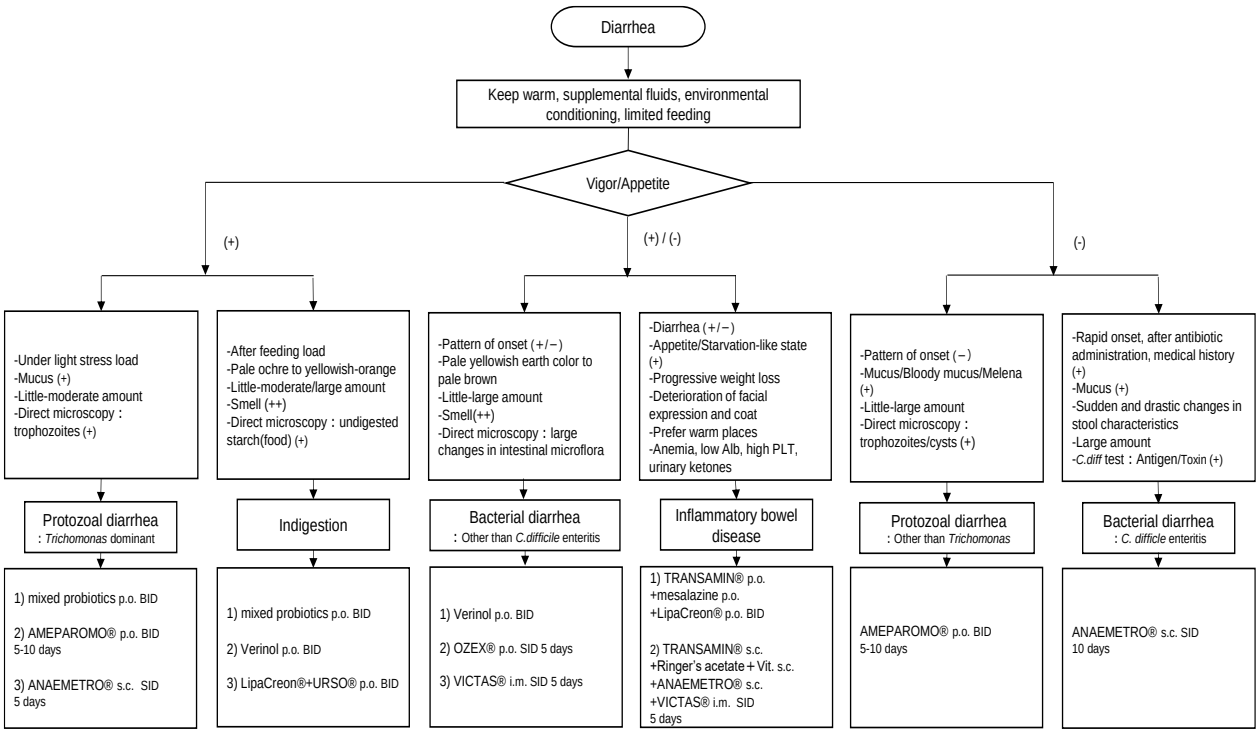

Figure 2 Diarrhea treatment flowchart

(environmental and psychological stressors, feeding loads, etc.), and stool status (amount of stool, frequency of diarrhea, water content, color, odor, mucus, bloody mucus, and bloody stools) should be evaluated. Whenever possible, direct microscopic examination (observation of a small amount of stool diluted with saline under a light microscope) is performed each time diarrhea occurs to confirm the presence of parasites such as protozoa, intestinal flora condition, the appearance and amount of undigested material, and any foreign bodies. If a sample is too small or fresh stool cannot be obtained, it can be collected directly from the anus, as required. Saturated saline flotation, Sudan III staining, and iodine staining should be performed, as required. Check whether antibiotics have been administered to animals.

When diarrhea is observed, regardless of the cause, keep the animal warm, perform fluid therapy, try to improve the environment, and implement feeding restrictions. Implement small, frequent feedings (divide 70–100% of the daily amount of solid feed into 4–6 portions) and provide as many intervals as possible. In cases of severe diarrhea, the feed content should be adjusted. While subcutaneous fluid therapy is administered, fasting is performed for a short period (from a few hours to half a day), and feeding is resumed with rice porridge, thick rice gruel, and sugar-included oral rehydration solution (prepared from dissolved oral rehydration powder in 5% glucose solution). Adjust the feed content to approach normal feed while searching for an amount and feeing frequency that do not cause diarrhea, and gradually transition to normal dry solid feed. Figure 2 shows a flowchart for dealing with diarrhea at our institute, and Figure 3 presents photographs of stool characteristics during diarrhea. A list of medications used at our institute is shown in Table 3, and the symptoms and treatments for each cause are summarized in Table 4.

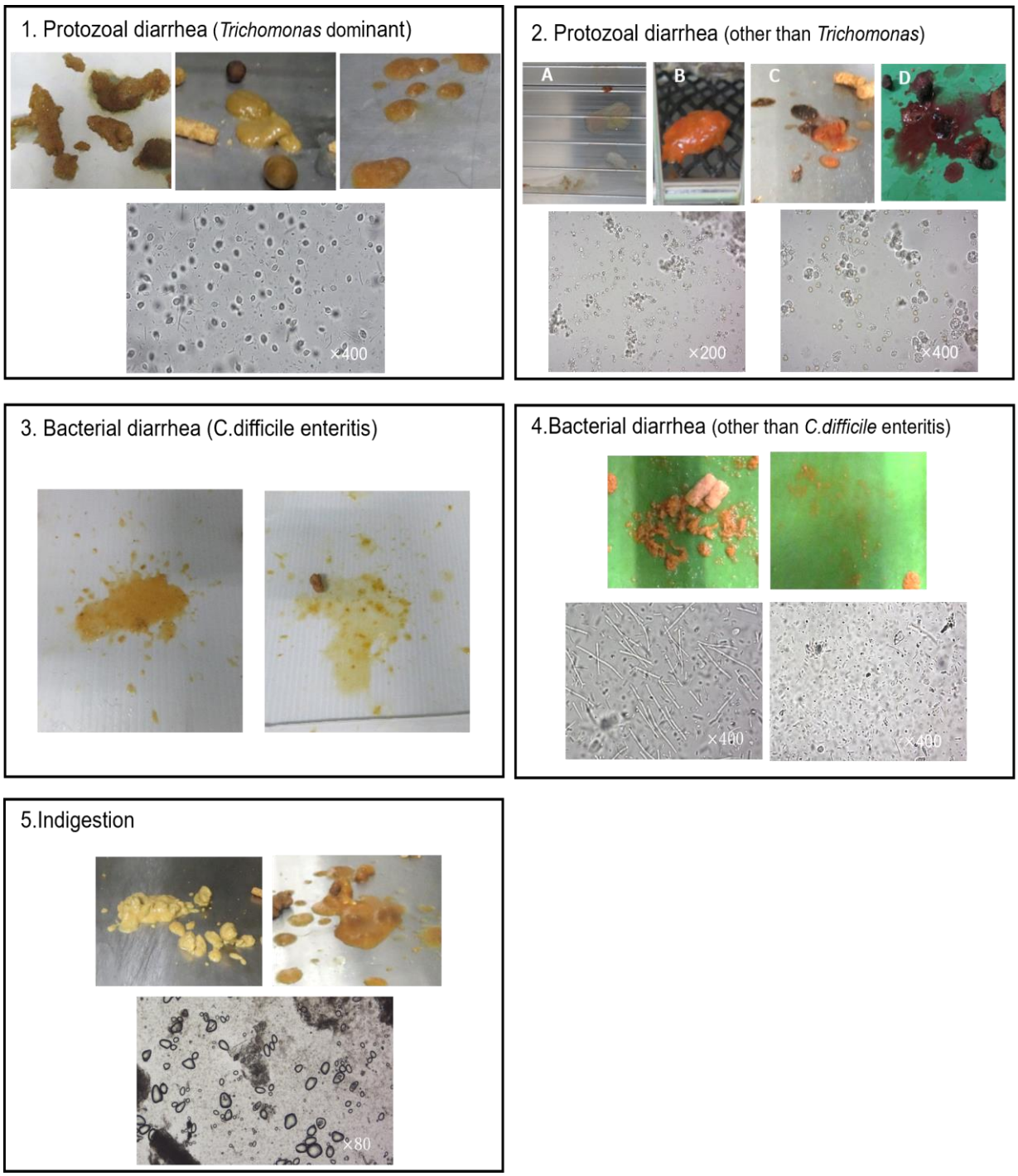

Figure 3 Diarrhea stool characteristics.

Macroscopic and direct microscopic images of various types of diarrhea. 1. Protozoal diarrhea (*Trichomonas* dominant): Mucous mixed muddy stools with a large number of *Trichomonas* trophozoites. 2. Protozoal diarrhea (other than *Trichomonas*): mucous stools (A), mucous-bloody muddy stools (B-C), and mucous bloody stools with hemorrhage (D). 3. Bacterial diarrhea (*C. difficile* enteritis): Pale muddy watery stools. 4. Bacterial diarrhea (other than *C. difficile* enteritis): Pale muddy watery stools. Rod-shaped bacteria dominant case (A) and short rod-shaped bacteria dominant case (B). 5. Indigestion: Light yellow-brown muddy stools (A) and orange muddy stools (B). Undigested starch and food residue.

Table 3 Formulary

Drug name	Product name	Dose/Route/Frequency
Electrolytes		
Ringer's acetate solution → Subcutaneous Infusion	SOLACET F Infusion, SO-RYUGEN® F Injection	1.0-1.5 mL/100 g BW s.c.
Oral electrolytes →Oral rehydration solution	SOLITA®-T Granules No.3	0.4 g/10 mL water, 1-5 mL p.o.
Gastrointestinal Agents		
Pancrelipase	LipaCreon® Granules	0.01 g/head p.o. BID
Ursodeoxycholic Acid	URSO® granules 5%	0.01 g/head p.o. BID
Mosapride Citrate Hydrate	GASMOTIN® Powders	0.02 g/head p.o. BID
Dimethicone	GASCON® Powders 10%	0.05 g/head p.o. BID
Bethanechol chloride	Besacolin® Powder	0.005 g/head p.o. SID
Trepibutone	SUPACAL® Fine Granules 10%	0.01 g/head p.o. BID
Taurine	Taurine powder 98% 「Taisho」	0.01 g/head p.o. SID
Diisopropylamine dichloroacetate	LIVERALL® Powder 10%	0.01 g/head p.o. SID
<Ani.>Gastrointestinal preparation for animals	Verinol Powder A	0.065 g/head p.o. BID
Rebamipide	REBAMIPIDE Tablets 100 mg	Crash→0.02 g/head p.o. BID
Famotidine	FAMOTIDINE Injection 20 mg	0.03-0.05 mL/head i.m. SID
<Ani.> Maropitant citrate	Cerenia® injectable solution	0.1 mL/kg s.c. SID
Glutathione	Tathion® 100 mg for injection	Dissolve Tathion® in NEO-MINOPHAGEN C→0.1 mL/head s.c. SID
Glycyrrhizin, glycine, cysteine combined drug	STRONGER NEO-MINOPHAGEN C® Inj. 5 mL	
Antibiotics-Resistant Lactic Acid Bacteria	LACB®-R Powder	Mix equal amounts of these four types and biotin = "Mixed lactic acid bacteria preparation" 0.02 g/head p.o. BID
Clostridium butyricum	MIYA-BM® FINE GRANULES	
Clostridium butyricum combined drug	BIO-THREE®	
Antibiotics-Resistant Lactic Acid Bacteriae	LEBENIN® POWDER	
Hemostatic Agents and Anti-inflammatory Agents		
Tranexamic Acid	TRANSAMIN® POWDER 50%	0.01–0.02 g/head p.o. BID
Tranexamic Acid	TRANSAMIN® INJECTION 10%	0.05–0.1 mL/head s.c. SID
Non-Steroidal Anti-Inflammatory Drugs (NSAIDS)		
Acetaminophen	CALONAL® Fine Gran. 20%	0.05 g/head p.o. BID
Mesalazine	MESALAZINE GRANULEA 50% 「AKP」	1/12 package/head p.o. BID
<Ani.>Meloxicam	Metacam® 0.5 mg/mL oral suspension for cats	0.2 mL/kg p.o. SID
<Ani.>Meloxicam	Metacam® 5 mg/ml solution for injection	5-fold dilution with saline →0.1 mL/kg s.c. SID
<Ani.>Robenacoxib	Oncior® 6 mg tablets for cats	1/18 tb/head p.o. SID
<Ani.>Robenacoxib	Oncior® 20 mg/mL injection for cats and dogs	0.05 mL/kg s.c. SID
Neuropathic pain treatment agents		
Pregabalin	PREGABALIN OD Tablets 2mg 「Pfizer」	1/20 tb/head p.o. BID

Steroidal anti-inflammatory drugs		
dexamethasone sodium phosphate	DECADRON® Phosphate Injection 1.65mg	0.05–0.1 mL/head i.m. SID
Respiratory Drugs		
Budesonide	Pulmicort® Respules 0.25 mg	Inhalation with nebulizer for 5-10 minutes
Acetylcysteine	Mucofilin® Inhalation Solution 20%	Inhalation with nebulizer for 5-10 minutes
Salbutamol Sulfate	Venetlin for Inhalation 0.5%	Inhalation with nebulizer for 5-10 minutes
Procaterol Hydrochloride	Meptin® inhalation solution 0.3 mL	Inhalation with nebulizer for 5-10 minutes
Antibiotics		
Paromomycin Sulfate	AMEPAROMO® capsules 25 mg	1/10 cp/head p.o. BID
Metronidazole	ANAEMETRO® Intravenous infusion 500 mg	4.0 mL/kg s.c. SID
<Ani.>Orbifloxacin	VICTAS®SInjection-5%	0.03–0.05 mL/head i.m. SID
Tosufloxacin Tosilate Hydrate	OZEX® Fine granules 15% for pediatric	0.02 g/head p.o. SID
Oxytetracycline Hydrochloride	OXYTETRA DENTAL CONE 5 mg	Embed small pieces in the root of the extracted tooth
<Ani.> Ampicillin Hydrate	Ampicillin Sol 15% 「KS」	0.03-0.05 mL/head i.m. SID
<Ani.> Ampicillin sodium	Ampiclear injection	Dissolve in 5 mL Injection Water/Saline→0.02–0.04 mL/head s.c. SID
Ampicillin sodium	VICCILLIN® FOR INJECTION 0.25 g	Dissolve in 5 mL saline→0.1 mL/head s.c. BID
Minocycline Hydrochloride	MINOMYCIN® GRANULES 2%	0.03-0.06 g/head p.o. SID 0.015-0.03g/head p.o. BID
Diuretics		
Furosemide	Lasix® Injection 20 mg	0.05-0.1 mL/head i.m. SID
Torasemide	TORASEMIDE Tab. 4 mg 「KO」	crash→0.6 mg/head p.o. SID
Intracranial Pressure Elevation and Intracranial Edema Treatment		
Concentrated glycerin, fructose	GLYCEOL® for I.V. Infusion	0.1–0.2 mL/head i.v. bolus/ slow infusion→ then as needed 0.1–0.2 mL/head i.v. slow infusion
Vitamin and Mineral Preparations		
Vitamin B/C combination preparation	C-PARA® Injection	0.1 mL/head s.c. (added to Ringer's solution)
Cyanocobalamin	Cyanocobalamin Injection 1 mg	0.05 mL/head s.c. (added to Ringer's solution)
Complex Vitamin B Preparation	VITAMEDIN® Combination Powder	0.01 g/head p.o. BID
Mecobalamin	Mecobalamin Capsules 250 μg 「Nissin」	0.01 g/head p.o. SID
Ascorbic acid	Ascorbic acid	0.01 g/head p.o. BID
Alfacalcidol	ALFAROL® Solution 0.5 μg/mL	1 drop
Folic Acid	FOLIAMIN® POWDER 10%	0.01 g/head p.o. SID
Biotin	Biotin Dry Syrup 0.1% 「Hoei」	0.1 g/head p.o. BID

Sodium ferrous citrate	Ferromia® Granules 8.3%	0.01 g/head p.o. SID
<Ani.>Iron/copper/vitamin B preparation agent	FCV liquid®	1 drop
Calcium lactate	calcium lactate	0.01 g/head p.o. SID
Calcium Gluconate Hydrate	CALCICOL® Powder	0.01 g/head p.o. SID
External medicine		
Hydrocortisone, fradiomycin sulfate combination preparation	HAEMOLEX OINTMENT	quantum sufficient
<Ani.> Canine and feline gingivitis symptom relievers	InterBerry α®	Dissolve in water and apply on gum
White Petrolatum	White Petrolatum	quantum sufficient
Heparinoid	Hirudoid® Cream/Soft Ointment/Lotion 0.3%	quantum sufficient
Zinc Oxide	Zinc Oxide ointment	quantum sufficient
<Ani.> Combination preparation	Bruns's solution →below	quantum sufficient

*Abbreviations: SID: once daily administration, BID: twice daily administration, p.o.: oral administration, i.m.: intramuscular administration, s.c.: subcutaneous administration, i.v.: intravenous administration, <Ani.>: veterinary medicine

*Vitamin supplemented subcutaneous infusion: Ringer's acetate solution 3-5 mL + C-PARA® Injection 0.1 mL + Cyanocobalamin 0.05 mL s.c.

* Verinol pellets: 2 g of verinol powder with 3 g of steamed rice, 6 g of arabic gum powder, and 1.5 mL of water in a vinyl bag and kneaded until firm. Divide into 32 equal portions, each portion contained 0.065 g of verinol, which was the dose required for one adult marmoset. Cover surface of the portions with potato starch and freeze for storage.

*Bruns' solution (Nakamura et al., 1969): iodine 1 g + dl-camphor 2 g + olive oil 20 mL + diethyl ether 20 mL. Mix well and store in a light-resistant container in the refrigerator. Its shelf life is approximately 1-2 weeks. It is used to deter licking and chewing of wounds and to promote granulation tissue formation.

*Inhalation using a nebulizer (Figure 8): Place the individual in a chamber connected to a nebulizer and allow them to inhale the medication for 5-10 minutes.

Table 4 Diarrhea

1. Protozoal Diarrhea (*Trichomonas* dominant)	
Etiology	Disturbance in the gastrointestinal microbiota, stress, predisposing factors, etc.
Symptoms	- Vigor and appetite are normal. - Symptoms often manifest with mild stress (e.g., when humans enter the room in the morning or when observing the capture of other individuals). - Stools are often mucous and muddy in consistency. Sometimes, there are fecal particles with reduced moisture content. - The volume of stool ranges from small to moderate.
Diagnosis	- Perform direct microscopic examination. Fresh samples show active, rugby ball-shaped trophozoites. Older samples may show trophozoites on the verge of death (reduced motility and distorted shape) or dead trophozoites (appear rounded, resembling cysts). Disturbance in the intestinal bacterial flora may also be observed.
Treatment:	- Oral or subcutaneous fluid therapy. - If Trichomonas is found in large numbers and diarrhea persists for 2-3 days or worsens, administer paromomycin orally for 5 days. If oral administration causes diarrhea or the animal refuses to ingest paromomycin due to taste preferences, administer metronidazole subcutaneously, especially if there is significant disruption in the bacterial flora. - If symptoms persist after 5 days of treatment or if there are recurrent episodes, continue treatment for 7-10 days.
2. Protozoal Diarrhea (Other than *Trichomonas*)	
Etiology	Disturbance in the gastrointestinal microbiota, stress, predisposing factors, etc.

Symptoms	- Inactivity - depression. Lack of appetite. Will not eat supplementary food. Poor facial expression and movement. Tail curled up or caged in the nest box. - Muddy or watery stools. Muddy-watery stools with mucus. Mucus may be the only discharge. Mucus and blood are also observed. Worse, the stools may be hemorrhagic. -The volume of stools is usually small to moderate but may become large when the condition worsens.
Diagnosis	Perform a direct microscopic examination. Protozoan cysts and trophozoites are observed. This is especially common in the mucus area. Cysts are seen first, and trophozoites and trophozoites in the excystation increase over time and with worsening symptoms. The degree of diarrhea and general condition correlates with the life stage progression of the protozoa.
Treatment	- Oral or subcutaneous fluid therapy. - Administer paromomycin orally for 5 days. - In cases of severe diarrhea or anorexia, subcutaneous fluid should be administered. - If symptoms persist after 5 days of treatment or if there are recurrent episodes, continue treatment for 7-10 days.
3. Bacterial Diarrhea (*Clostridium difficile* Enteritis)	
Etiology	Disruption of the gastrointestinal microbiota due to antibiotic use, bacterial infection, stress, aging, underlying diseases, etc.
Symptoms	- Inactivity - depression. Lack of appetite. Will not eat supplementary food. Poor facial expression and movement. Tail curled up or caged in the nest box. - Rapid onset and worsening. Often seen after antibiotics or in individuals with pre-existing disease. Without medication, the disease worsens with time. - Stools are muddy-watery with mucus. Pale in color. Color changes markedly and abruptly. - Stool volume is large.
Diagnosis	- Use the simple diagnostic kit C.Diff Quik Chek Complete®. Positive for antigen or toxin.
Treatment	- Oral or subcutaneous fluid therapy. - Administer metronidazole subcutaneously for 10 days.
4. Bacterial Diarrhea (Other than *Clostridium difficile* Enteritis)	
Etiology	Disturbances of the microflora in the gastrointestinal tract (e.g. due to antibiotic use, etc.), causative bacterial infection, stress, aging, underlying disease, etc.
Symptoms	- Vigor and appetite vary from individual to individual. - Stress may cause the onset of the disease. - Stools may be muddy or watery. Pale ochre to pale brown. Smell is strong. - Fecal volume vary from small to large.
Diagnosis	- Perform a direct microscopic examination. Changes in the intestinal microflora are evident. The predominant bacteria vary from case to case, including long rods (e.g., megabacteria-like long rods or bent rods), short rods, cocci, and migratory bacteria (e.g., those that spin around on the spot or run through the field of vision like shooting stars). When such bacteria that are not usually observed or are inferior to other bacteria become predominant and there are no other pathogens, such as protozoa, that may cause diarrhea, the case is considered to be bacterial.
Treatment	- Small frequent feedings (70–100% of the daily dose in 4–6 divided feedings). - Oral or subcutaneous fluids should be administered. - If symptoms are severe, persist for 2 days, or worsen with each episode of diarrhea, or in high-risk individuals (e.g., elderly or postoperative), antibiotics (intramuscular orbifloxacin or oral tosufloxacin) should be administered.

5. Indigestion	
Etiology	Overeating, overeating, stress, and disturbance of the microflora in the gastrointestinal tract, etc.
Symptoms	- Vigor and appetite are normal. The patient has a healthy appetite. Often show a high appetite and gives the impression of hunger. - Diarrhea worsens and lightens according to the feeding interval (worsens from noon to evening, lightens from evening to the next morning). - Stools are soft and muddy, sometimes watery. Pale ochre, yellowish stools or stools with an orange tinge. Odor is strong. - Small to large amounts of stools.
Diagnosis	- Perform a direct microscopic examination. Undigested starch, fatty droplets, and food residues are prominent. There are also changes in the intestinal microflora.
Treatment	- Small frequent feedings (70–100% of the daily dose in 4–6 divided feedings). - Oral or subcutaneous fluids should be administered. - Administer probiotics, Gastrointestinal preparation for animals, and digestive enzymes (pancrelipase, pancrelipase+ursodeoxycholic acid) orally.
6. Inflammatory Bowel Disease, Wasting Marmoset Syndrome	
Etiology	Chronic malnutrition, stress, underlying diseases, etc.
Symptoms	- Vigor and appetite are normal initially. Often show a high appetite and gives the impression of hunger. Increased aggression toward humans and other animals in the group when feeding. Activity decreases except when feeding, and the animal prefers to be in a place where it can keep warm. - Continuous weight loss and emaciation despite feeding and supplementation. - Deterioration of fur coat condition (especially at the base and/or ventral side of the tail, fading of the black fur around head and neck, the tail and trunk become greasy, etc.). - Diarrhea may occur under stress or feeding stress. Diarrhea may not be observed. - Stools may be soft, muddy, or watery. The stools may be soft, muddy, or watery, light ochre or brown in color. Hard stools or normal stools may be present. - Stool volume may be small to large.
Diagnosis	- Persistent weight loss (>0.05% of peak body weight/day, continuously). - Anemia, hyperthrombocytosis, hypoalbuminemia, positive urine ketones. - Perform a direct microscopic examination. Disturbance of the intestinal microflora, undigested starch or fatty droplets, and food residues are present. No specific findings may be noted.
Treatment	Oral or subcutaneous fluids should be administered. · Feeding intestinal nutrients, liquid nutrients, gel feed for New World monkeys, protein powder, vitamins and minerals, mashed feed, and solid feed gums (Tables 2-1 and 2-2). - Small frequent feedings (70–100% of the daily allowance divided into 4–6 feedings). - When diarrhea subsides, add supplemental solid feed (mashed feed, moistened feed, etc.). <Mild case> Administer probiotics and anti-inflammatory drugs (tranexamic acid orally, and mesalazine as needed) (BID). If anemia is present, vitamin B12 + folic acid + iron should be administered orally (SID). <Severe case> Administer broad-spectrum antibiotics (intramuscular orbifloxacin + subcutaneous metronidazole), anti-inflammatory agents (subcutaneous tranexamic acid) and subcutaneous fluids (vitamins added) for 5 days (SID). In the absence of diarrhea, the patient should first be treated with subcutaneous tranexamic acid and subcutaneous fluids (vitamins added) for 5 days (SID) and then monitored. If necessary, administer digestive enzymes (pancrelipase) orally (BID).

*References： Baxter et al., 2013; EAZA, 2017; Gallagher, 2022; Inoue, 2018; Inoue et al., 2023; National Academies, 2019; Niimi et al., 2019; Yoshimoto et al., 2016a; Yoshimoto et al., 2016b

[3] Constipation

Constipation is a condition where stools that should be excreted from the body are not excreted adequately (quantity) and comfortably (Ajimura et al., 2019), and this is often observed in captive common marmosets. Constipation is broadly classified into functional constipation due to abnormal colonic function and structural constipation due to changes in colonic shape (Ajimura et al., 2019; Gotfried 2022a). Functional constipation includes reduced defecation frequency due to disease or insufficient oral intake, and difficulty in defecation due to hardened stool or decreased abdominal pressure and rectal sensation. Structural constipation includes narrowing of the intestinal lumen due to colon tumors and difficulty in defecation due to intestinal dilation, such as megacolon (Ajimura et al., 2019). Chronic functional constipation can progress to structural constipation, leading to excessive accumulation of stools in the colon and the transition to structural constipation. When accompanied by symptoms such as vomiting or depression or when defecation ceases, it is necessary to consider the possibility of functional/structural intestinal obstruction and duodenal dilatation. Constipation is often observed in elderly individuals, under stressors such as experiments or cage change, and during the chronic course of inflammatory bowel disease. The early detection and treatment of constipation are also important.

Symptoms include decreased stool volume, decreased defecation frequency, hardening of feces, difficulty in defecation (prolonged time between assuming a position to defecate and actual defecation), rubbing of the perianal area against the floor, abdominal distension, and lethargy. Reduced food intake (increased leftovers and decreased spillage), depression, vomiting, and abnormal facial expressions may also be observed.

The diagnosis is made using palpation and X-ray

Table 5 Rectal enema

Rectal enema	
Equipment	Syringe (5 mL), warm water, olive oil, pet sheets, injectable anesthetic (KETALAR® for intramuscular injection 500 mg 0.1 mL/head i.m. + atropine sulfate injection 0.5 mg 0.02 mL/head s.c.) or inhalation anesthesia kit, topical cream for hemorrhoids, zinc oxide cream, cleansing oil, towel, hair-dryer.
Procedure	- Anesthetize the animal. Ketamine and atropine are typically used, but inhalation anesthesia may be used for weak or mildly affected individuals. - Insert 1 mL of olive oil into the rectum using a syringe and leave it for approximately 1 min, then inject 5 mL of warm water. - After injection, gently lift the hindquarters while pressing the anus with a finger, and gently massage the abdomen to distribute the water throughout the colon and soften the feces. - Next, massage along the course of the colon on the abdominal wall, dissolving the feces and pushing them towards the anus for expulsion. - Repeat this process of warm water injection, feces softening, and expulsion several times. - During rectal enema, be careful not to excessively extend or perforate the colon. Pay attention to the injection volume and speed of warm water, as well as the pressure for fecal expulsion. - After the enema, apply cleansing oil to the dirty fur to remove olive oil residue, then bathe and dry the animal. Additionally, apply a small amount of topical cream for hemorrhoids to the anus and zinc oxide ointment to the lower abdominal skin for friction irritation care.

imaging. Abnormal accumulation of feces and gas in the intestine is confirmed.

In mild cases, oral hydration, gum arabic supplementation, probiotic administration, and increased physical activity are recommended. Massage is also recommended for constipation (Figure 4) in captured and stabilized animals. If these measures are ineffective, medications that promote gastrointestinal motility and gas discharge are to be initiated. In cases of severe constipation, where there is significant fecal retention in the intestines and severe symptoms such as marked reduction in food intake, loss of appetite, depression, and vomiting, rectal enema and fecal removal are performed under anesthesia (Nelson & Couto, 2001). Table 5 details rectal enema, and Figure 4 presents the massage technique for constipation.

[4] Vomiting

Vomiting occurs under conditions that affect the vomiting center. The causes are broadly categorized into gastrointestinal and central nervous system disorders and can also be accompanied by diseases such as renal failure (Gotfried, 2022c). Gastrointestinal disorders include intestinal obstruction, gastroenteritis, and hepatitis. Duodenal dilation is a specific condition that is observed in common marmosets. It is an idiopathic condition characterized by frequent vomiting due to obstruction and dilation of the upper duodenum, with reported domestic and international cases (Fitz et al., 2020; Inoue et al., 2023; Kwak et al., 2022; Mineshige et al., 2020; Sheh et al., 2022).

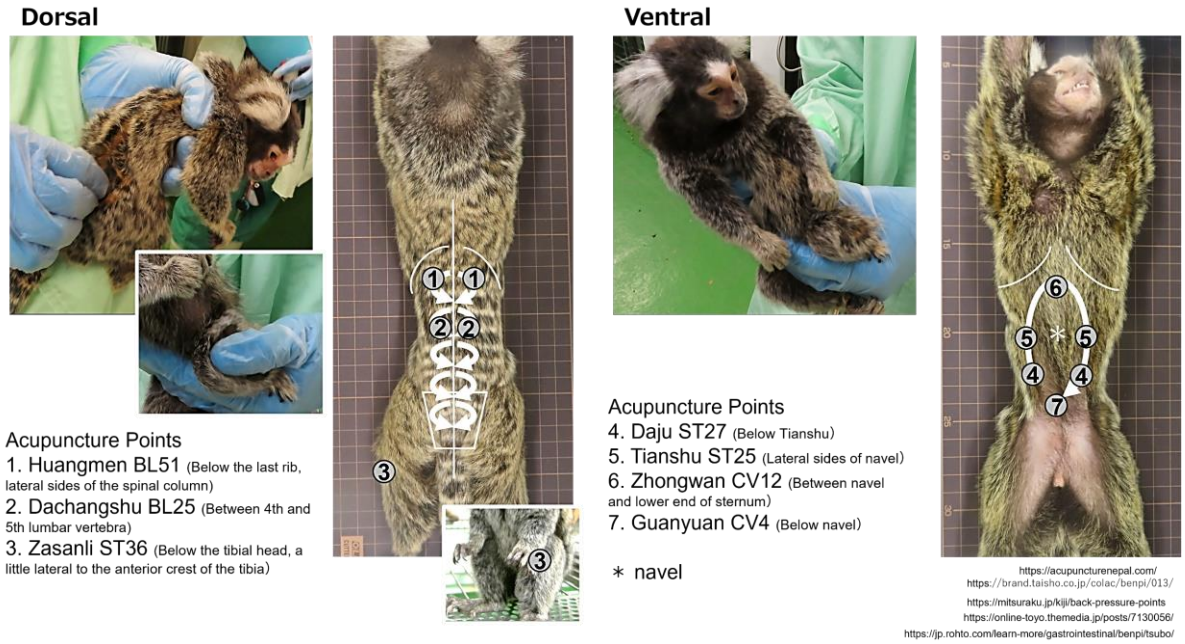

Figure 4 Massage for constipation.
Hold the marmoset in hand and stimulate effective acupuncture points for constipation.
Dorsal: Gently press the sides of the spine with the thumb and index finger from below the thoracic vertebrae to the anterior tail vertebrae. Stimulates the acupuncture points on the back (Huangmen BL51 and Dachangshu BL25). Lightly press the outer side of the knee slightly below the fibula, with the shinbone directly below, to stimulate Zasanli ST36.
Ventral: Gently press the thumb in a circular motion from the right side of the abdomen, below the ribs, to the left side of the abdomen, following the course of the colon and rectum. Stimulates the acupuncture points on the abdomen (Daju ST27, Tianshu ST25, Zhongwan CV12, and Guanyuan CV4).

Inflammation involvement due to some form of inflammation between the descending duodenum and ascending colon, genetic factors, and the involvement of *Clostridium perfringens* have been considered, although the frequency of occurrence varies among the colonies (Sheh et al., 2022). In addition to these disease causes, the side effects of anesthetics, such as ketamine, and invasive experimental techniques on the central nervous system can cause vomiting.

Symptoms include nausea and vomiting of the stomach contents. Vomit may consist of recently ingested food, and it may contain blood (red or coffee-colored if digested), bile (greenish yellow), or only mucus. Reduced activity, worsening appearance, and decreased food intake were also observed. With chronic progression, dehydration (decreased skin turgor), electrolyte imbalances, emaciation, weight loss, deteriorated fur condition, and reflux esophagitis may occur. In severe cases of duodenal dilatation, bile vomiting may occur. If increased intracranial pressure due to experimental procedures is the cause, symptoms may be pronounced with the animal appearing depressed with lowered head. In cases of cholestatic liver disease, the stool may become pale, and

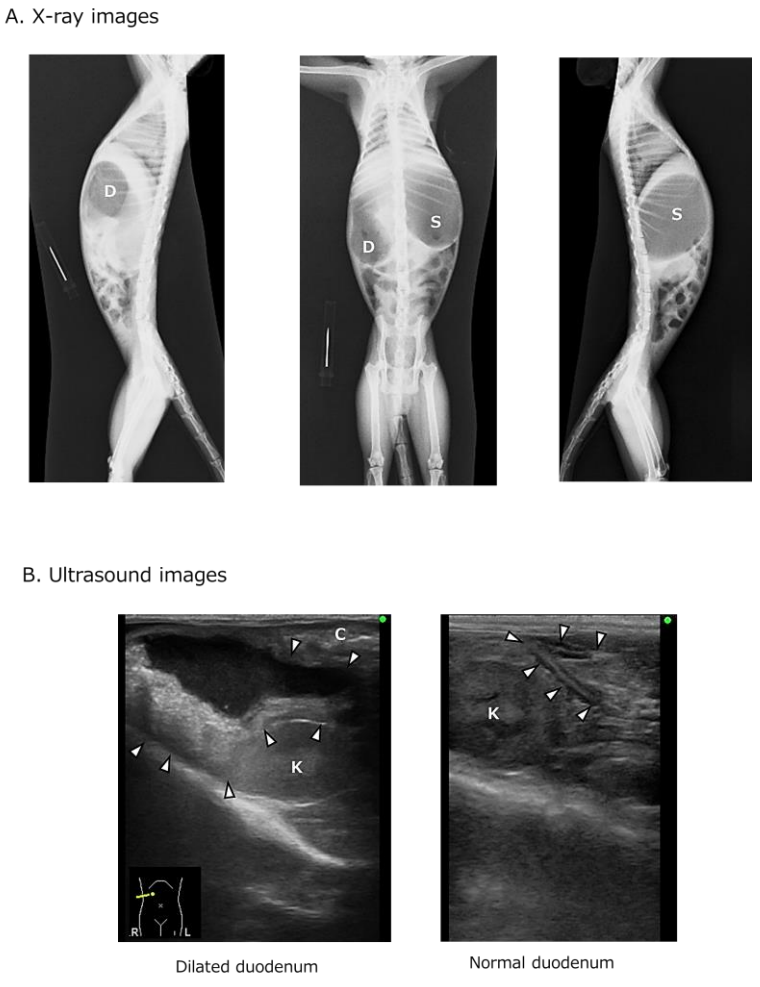

Figure 5 X-ray and ultrasound images of severe duodenal dilatation.
In cases of severe duodenal dilatation, radiographs show dilation and gas retention in the duodenum (D) and stomach (S). Ultrasound images show dilation and content retention in the descending part of the duodenum (arrowhead) above the right kidney (K). C: Transverse colon.

urine may become dark (yellow).

Diagnoses are made based on medical history (diet, medical history, experimental conditions, and medication), X-ray imaging, ultrasound examination, blood tests, and urine tests. In cases of liver disease, ultrasound examination may reveal hepatomegaly, liver edge blunting, and coarse echogenicity of the parenchyma. Blood tests may reveal elevated alanine aminotransferase (ALT), gamma-glutamyl transferase (γ-GPT), and bilirubin levels, whereas urine tests may show increased specific gravity and bilirubin levels. In case of renal diseases, ultrasound examination may reveal irregular renal outlines, thinning of the renal parenchyma, and increased echogenicity. Blood tests may reveal elevated blood urea nitrogen (BUN) and creatinine levels, whereas urine tests may show proteinuria and hematuria. Severe cases of duodenal dilation may present duodenal dilation and gas accumulation based on radiographic evaluation (left lateral view). Ultrasound examination may reveal duodenal dilation, intersection of the duodenal and gastric contents, differences in peristaltic movements before and after the stenotic site, enlargement of and an increased number of mesenteric lymph nodes (Figure 5). If vomiting is observed, subcutaneous or oral fluid therapy is initially administered. Subcutaneous fluid therapy is administered in cases of vomiting triggered by eating stimulation or in severe cases. Appropriate measures according to the underlying disease should be considered. In case of duodenal dilation, frequent feeding and environmental adjustments to reduce stress are implemented, and oral administration of parasympathomimetic agents such as mosapride or bethanechol for enhanced gastrointestinal motility and dimethicone for gas expulsion are administered. Oral gastric medications (rebamipide) and anti-inflammatory agents (mesalazine) are also administered for mucosal protection due to gastrointestinal content crossover. For increased intracranial pressure or cerebral edema, concentrated glycerin and fructose preparations are administered intravenously (bolus or drip infusion). Decompression through cranial windowing may also be considered. When invasive procedures are performed on the cranial bones, antibiotics (ampicillin oil suspension injection) and steroids (dexamethasone) are administered intramuscularly once daily for 3–5 days. For liver damage, ursodeoxycholic acid, taurine, and dichloroacetic acid diisopropylamine are administered orally. In cases of bile stasis, trepibutone is administered orally in addition to the drugs mentioned above. However, ursodeoxycholic acid should not be administered to patients with complete biliary obstruction. For severe liver damage, subcutaneous injections of glutathione dissolved in glycyrrhizin preparations are administered along with subcutaneous fluid. Maropitant is administered preoperatively to prevent vomiting during anesthesia (Goodroe et al., 2020). X-ray and ultrasound images of severe cases of duodenal dilation are presented in Figure 5.

[5] Respiratory Disorder

Respiratory disorders are conditions in which normal breathing, which involves taking oxygen and exhaling carbon dioxide, is impaired. Abnormalities in respiratory rate (tachypnea or bradypnea), labored breathing (using respiratory muscles that are not normally used), and dilated nostril (nasal wings) may be observed (Nakamura 1979, Japan Society of Emergency Medicine 2009, Mochizuki 2023). Often, only general symptoms such as lethargy and anorexia are apparent, without specific respiratory symptoms (Nelson & Couto, 2001). The causes can be broadly categorized into abnormalities in control systems (control abnormalities in the respiratory center

caused by conditions such as intracranial diseases, hypoglycemia, and electrolyte abnormalities), abnormalities in the respiratory driving system (airway narrowing, pleural effusion, pneumothorax, respiratory muscle weakening, and decreased cardiac function), abnormalities in gas exchange systems (pneumonia, pulmonary edema, etc.), and other abnormalities (shock, severe anemia, pain, etc.) (Mochizuki, 2023).

When making a diagnosis, consciousness, respiration, breath sounds (such as rales), heart murmurs, body temperature, pulse rate, percutaneous oxygen saturation (SpO_2), and the presence of foreign objects in the oral cavity should be checked. Oxygen is administered, and if there is apnea or unresponsiveness,

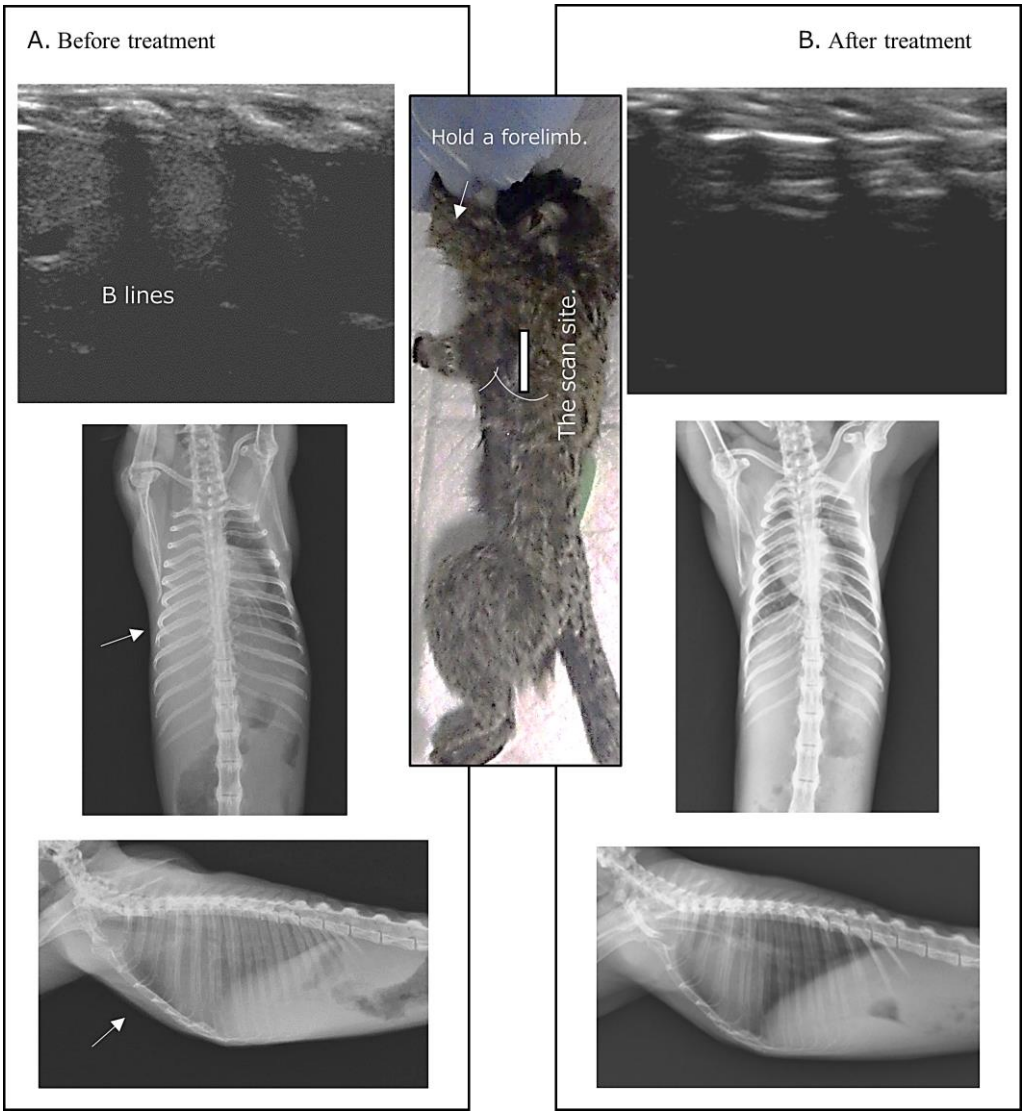

Figure 6 Ultrasonographic and radiographic findings in pneumonia.
During ultrasonography, the forelimb on the scanning side is raised and held, and the probe is placed on the chest under the axilla. In this case of pneumonia (A), vertical bright linear artifacts (B-lines) extending from beneath the pleura are observed on ultrasonography, and shadowing (→) in the right lung is observed on X-ray. Both symptoms disappeared after antibiotic administration (B).

Figure 7 X-ray imaging during cardiopulmonary evaluation

Holding the animal in an upright position during X-ray imaging allows for evaluation without compression of the thoracic cavity by abdominal organs, which occurs during supine positioning (Sawada et al., 2022).

cardiopulmonary resuscitation as described in [8] emergency treatment is performed, and further evaluation is conducted through visual inspection, auscultation, X-ray imaging, ultrasound examination, and blood tests. In cases of pneumonia or pulmonary edema, ultrasonography shows longitudinal hyperintense linear artifacts (B-lines: Figure 6) from the pleura to the depth. The presence of B-lines without lung sliding (movement of the pleural line during respiration) suggests pleural adhesions, whereas the absence of both B-lines and lung sliding suggests pneumothorax (Lichtenstein, 2009; Image Diagnosis Summary 2023). Radiographic imaging is performed to check for narrowing of the upper airway. In cases of pneumonia, consolidation, or other opacities can be observed on radiographic assessments. Heart failure may present with increased cardiac and vascular shadows in the upper lung field due to pulmonary edema and pleural effusion (Image Diagnosis Summary 2023). Imaging in the upright position, as shown in Figure 7, is effective for cardiac evaluation (Sawada et al., 2022). Although the shadows of pneumonia and pulmonary edema may appear similar, pneumonia tends to be localized, whereas pulmonary

Figure 8 Inhalation therapy.
Place the conscious marmoset in a nebulizer-connected chamber and administer vaporized medication for 5–10 minutes. Create a hiding place by covering part of the chamber with a towel if necessary.

edema is often bilateral and has a characteristic distribution (Image Diagnosis Summary 2023).

When pneumonia is diagnosed, hydration (oral administration for mild cases, subcutaneous administration for severe cases) is administered along with antibiotics (oral tosufloxacin, intramuscular orbifloxacin) and gastric medication (oral rebamipide, intramuscular famotidine). Bronchodilators are inhaled using a nebulizer (Figure 8). Re-examination is conducted after one week to determine whether the medication should be continued. In cases of heart failure, management is conducted in a high-oxygen room, and diuretics (furosemide) are administered if edema and pulmonary edema are observed. After confirming urination, an oral diuretic (torasemide) is administered. Vitamin B12, folic acid, and iron supplements should be administered orally when anemia is observed.

Ultrasound and X-ray images of pneumonia are shown in Figure 4. X-ray images for cardiopulmonary evaluation are shown in Figure 7, and inhalation therapy is presented in Figure 8.

[6] Dental and Gingival Abnormalities

Periodontal disease (dental plaque and tartar deposition, gingivitis, dental malposition, tooth loss, and root abscesses) is common in captive common marmosets (Friedman et al., 1972; Miwa et al., 2020). In the wild, most feeding time is spent gnawing on bark to obtain gum (Power, 2010), and the mandible and teeth, especially the incisors and canines, have evolved to specialize in gnawing bark (Casteleyn & Bakker, 2019). However, in captivity, the staple diet is majorly comprised of short, hard, and dry solid feed exclusively processed using the molars (Miwa et al., 2020). Inevitably, the incisors and canines receive far less physical stimulation, which is believed to be the cause of the high incidence of oral disease in these scenarios (Kramer, 2019; Miwa et al., 2020). In addition, the first premolar, which is adjacent to the canine teeth and is prone to food debris accumulation,

is susceptible to oral diseases. The first molar, which is heavily used when eating hard objects, may become damaged, worn, or missing with age (Miwa et al., 2020). Although behaviors such as gnawing and scent marking of trees are observed in the wild, many captive environments lack suitable wood for gnawing.

Table 6 Scaling and tooth extraction

Scaling	
Equipment	Hand scaler or ultrasonic scaler, hypochlorous acid water, small cotton or non-woven gauze shaped to fit inside the marmoset's oral cavity, cotton swabs, pet sheets, injectable anesthesia (KETALAR® for intramuscular injection 500 mg 0.1 mL/head i.m. + atropine sulfate injection 0.5 mg 0.02 mL/head s.c.) or inhalation anesthesia.
Procedure	- Anesthetize the individual. Ketamine and atropine are typically used. Inhalation anesthesia may also be used. - Fill the ultrasonic scaler with hypochlorous acid water. - Insert prepared cotton or gauze into the oral cavity. - Secure the animal in a supine position with the head lowered to prevent accidental swallowing of removed plaque/tartar, saliva, or cleaning solution. - Use the scaler to remove plaque and tartar from the teeth, being careful not to damage the tooth crown or gums. - Replace the cotton or gauze in the oral cavity as needed during the procedure. Using a small aspirator to suction saliva and cleaning solution is also helpful. - During the procedure, ensure continuous oxygen supply by placing a mask near the nostrils. - After completion, apply a small amount of InterBerryα® dissolved in water to the gums.
Tooth Extraction	
Equipment	Veterinary dental X-ray imaging equipment, 1.2 mm wide small elevators, ultrasonic scaler, hypochlorous acid water, small cotton or non-woven gauze shaped to fit inside the marmoset's oral cavity, cotton swabs, pet sheets, injectable anesthesia (KETALAR® for intramuscular injection 500 mg 0.1 mL/head i.m. + atropine sulfate injection 0.5 mg 0.02 mL/head s.c.), local anesthetic (ORA® Injection: lidocaine+adrenaline bitartrate), antibiotic (crushed oxytetracycline tablets). s.c.） .
Procedure	- Anesthetize the individual with ketamine and atropine. - Diagnose the affected tooth based on symptoms, then confirm with X-ray imaging. - Administer local anesthesia with adrenaline-supplemented lidocaine to the root of the affected tooth. - Insert a 1.2-mm wide small elevator or ultrasonic scaler into the gap between the tooth and alveolar bone, then cut the periodontal ligament while compressing the alveolar bone along the tooth. - Once the ligament is completely cut, luxate the tooth and extract it with extraction forceps. Marmoset teeth are very small, so be careful not to apply too much pressure to avoid root fracture during cutting of the periodontal ligament. - Ensure continuous oxygen supply during the procedure by placing a mask near the nostrils. - After extraction, thoroughly clean the root with hypochlorous acid water, then bury crushed oxytetracycline tablets into the root. Administer subcutaneous fluids, systemic analgesics (such as robenacoxib or meloxicam), and antibiotics (orbifloxacin). - On the day after extraction and the following day, administer oral analgesics (such as robenacoxib or meloxicam), antibiotics (tosufloxacin), and gastric medication (rebamipide).

＊Reference： Burns and Wachtman 2019

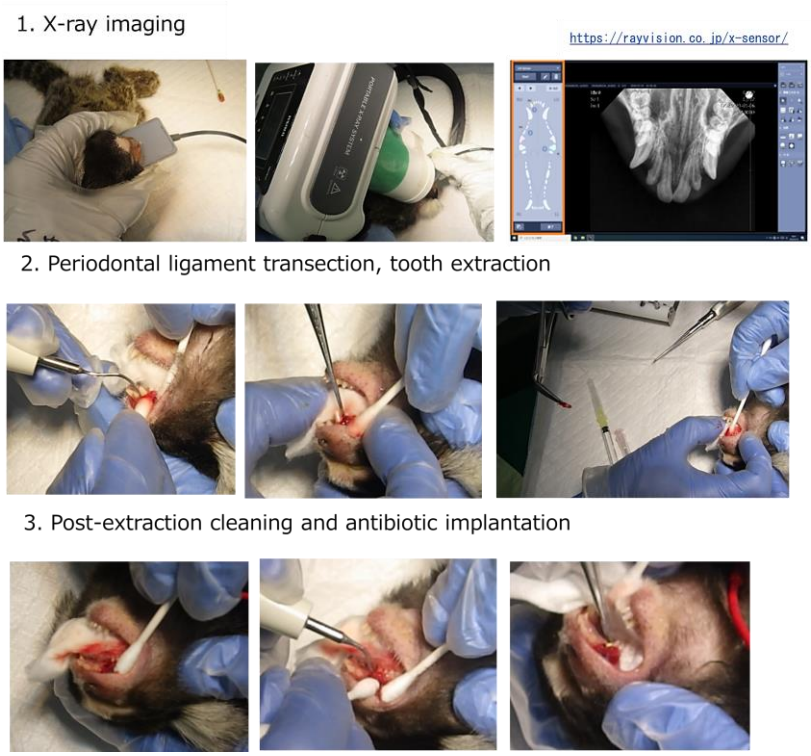

Figure 9 Tooth extraction.
Take X-ray images using dental sensors and a portable X-ray device.
Refer to Table 6 for details on tooth extraction.

This captive environment also contributes to the development of periodontal diseases. Furthermore, bacterial infections leading to dental abscess formation can occur due to crown fractures caused by trauma during capture (Kramer, 2019).

Symptoms include dental plaque and tartar deposition, gingival redness, swelling, bleeding, hyperplasia, dental malposition, tooth mobility, tooth loss, fracture, and redness and swelling of the skin above the affected tooth root, and formation of external or internal dental fistulas. These symptoms are particularly common in the incisors and canines of the upper jaw. In cases of root abscesses in the upper canine teeth, unilateral epiphora due to compression of the lacrimal sac may be observed. Nasal bleeding or purulent nasal discharge may occur if a dental fistula forms in the nasal cavity. Salivation may occur due to the formation of oral-dental fistulas. Symptoms include anorexia, decreased fecal volume, constipation, weight loss, and decreased activity.

Diagnosis is made under anesthesia using dental radiography. The affected tooth is identified by radiographing the area and confirming the presence or absence of abscess formation, drainage, condition of the alveolar bone and root, and presence or absence of fractures to consider appropriate actions.

In cases of tooth mobility, tooth fracture, root abscess formation, or external or internal tooth fistula formation accompanied by worsening of general symptoms, tooth extraction is necessary. The details of the extraction process are presented in Table 6 and Figure 9. If extraction is not indicated, the patient should be managed with dietary and environmental modifications along with regular oral examinations

and scaling. Dry solid feed should be provided. Avoid overfeeding on soft food, high-carbohydrate food, or high-milk fat food. For environmental modifications, provide enrichments that allow the use of incisors and canines. Introducing wood filled with liquid gum (McGrew 1986) or soft wood, such as cedar and balsa, as chewing toys or nesting materials is beneficial. Balsa wood, in particular, is preferred for gnawing irrespective of age, and because the incisors and canines are used in the gnawing process, it helps reduce plaque and tartar buildup (Miwa et al., 2020; Miwa et al., 2021). The scaling procedure is presented in Table 6.

[7] Injury

Injury is broadly categorized into incidents involving only common marmosets and those involving humans.

Common marmosets maintain a family-based social structure and share child-rearing responsibilities within family units (Díaz-Muñoz, 2016; Schultz-Darken et al., 2019). However, even in cases of continued family housing without interactions with other families, conflicts may arise within the family during the growth of the offsprings. These conflicts include twin-fights among same-litter siblings during adolescence (Miwa et al., 2023), and "eviction" fights before 2 years of age. Other injuries observed among group members in captive environments include tail biting in neonates (partial tail loss in neonates due to biting by parents and/or siblings) (Miwa et al., 2015b; Miwa et al., 2017), bites on the auricle and fingertips, a nd tail dislocation due to hanging by younger offspring. Additionally, injuries, such as penile hair strangulation and self-biting, which do not involve other individuals, may occur. Owing to their high aggressiveness towards individuals from other families (Lazaro-Perea, 2001; Poole et al., 1978; Sutcliffe & Poole, 1984), contact conflicts due to escape or cage defects can escalate severely and become life-threatening.

Human-caused injuries include those due to indirect involvement, such as lacerations and fractures of the fingertips caused by cage defects, and those due to direct involvement, such as bruises, lacerations, and fractures caused by being caught and restrained. These injuries tend to be more severe. Caution is especially important in animal facilities, where handling and treatment procedures are frequent. Instead of forcibly catching animals by chasing them, it is necessary to acclimate and catch them without arousing them or using tools to catch them, being aware of the refinement principles of the so-called 3Rs (reduction, refinement, replacement).

The treatment procedures for these injuries vary depending on their location, severity, and type. If the wound is minor and the animal is not licking or gnawing, it can be left untreated. However, if the animal is concerned about the wound, intervention is required.

The symptoms of injury include redness, swelling, lacerations, abrasions, bleeding, tissue loss, displacement, fractures, and impaired movement at the site of injury. Behaviors such as favoring and licking the injured part may also be observed. In the case of limb injuries, differences in movement between injured and healthy limbs may be evident. In some cases, injuries are observed from blood stains in the cage or on the floor beneath the cage.

A diagnosis should be made by promptly catching injured animals to avoid further stress. The wound is first cleaned with warm water or warm hypochlorous acid water to assess its condition (location, severity, size, bleeding, and presence of functional impairment), and the appropriate action is then considered.

If it is difficult to perform the procedure while awake, the animal should be lightly anesthetized using inhalation anesthesia. Radiography is performed to confirm the presence of fractures or dislocations if

Figure 10 Collar for marmosets.

A. Fabrication and Attachment: Create a collar using clear files, strong adhesive tape, fleece, and a stapler according to the procedure in the figure and attach it to the marmoset. Leave enough room for one human finger to comfortably fit around the neck.

B. Appearance and Feeding with Collar: Attach a plastic No. 5 dish with holes to the cage using a laundry clip to allow self-feeding even when wearing a collar.

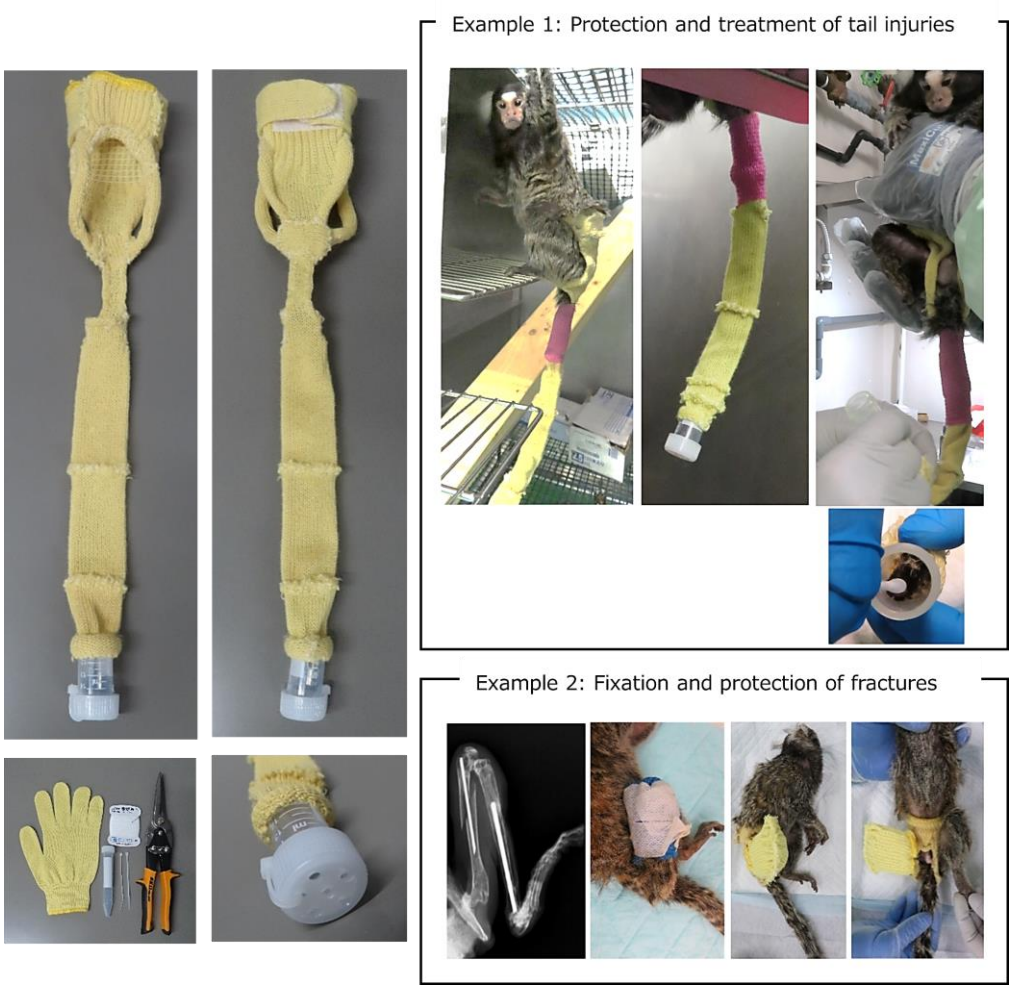

Figure 11 Wound protection cover for marmosets.
Made using Kevlar® thin-cut resistant gloves, a 15 mL centrifuge tube, scissors capable of cutting Kevlar® fibers, and hand-sewing cotton thread.
Example 1: Protection and treatment of tail injuries: By sewing a centrifuge tube with holes in the tip of the tail cover, the injured area can be treated without anesthesia and the removal of the tail cover. When not treated, the cap and the tube are secured with a 10 cm cable tie.
Example 2: Fixation and protection of fractures: By combining the pants and wrist parts of matching gloves, they can be used to reinforce external fixation in cases of femoral fractures or to protect against surgical fixation.

signs of claudication, impaired movement, or displacement are observed.

Treatment is divided into mild (expected to heal with washing and protection), moderate (requiring moist wound care or suturing), and severe (requiring surgical treatment, such as fractures, tail, or digit amputations). In all cases, the first flush with hypochlorous acid water, and then stop the bleeding if present, and remove any cause, such as hair strangulation.

1) Mild cases:

After washing, apply petroleum jelly, heparinoids, or zinc oxide ointment as needed to protect the

affected areas. Be careful with the application of the ointment, as animals may sometimes experience a reaction to it. If the animal is bothered and continue to lick, nibble, or scratch the affected area, Bruns' solution is used (see Table 3 for details) to avoid the area and promote healing. Moreover, care should be taken when applying the solution because it can sometimes cause reactions.

In the case of pain, analgesics (such as acetaminophen or robenacoxib) should be administered along with stomach medicine (rebamipide). Check for other causes of pain that may have been overlooked. In addition, providing enrichment, such as gnawing wood, gum feeders, or empty paper boxes, to distract the animals may be effective. If necessary, collars or covers should be used (see Figures 10 and 11) to prevent access to the affected areas.

2) Moderate cases

At the same time as washing and hemostasis, the animal should be maintained as warm and administer subcutaneous fluid. For tissue loss or extensive or deep wounds, moist wound care (after washing the wound with hypochlorous acid water, applying hydrocolloid dressings, petroleum jelly, or zinc oxide ointment, and covering it with a film dressing or wrap) or suturing is required. In case of necrotic tissue or infection, surgical debridement (removal of infected or necrotic tissue) with a curette should be performed. Protect the treated area with breathable adhesive elastic gauze or self-adhesive elastic bandages. Be careful not to wrap the bandage too tightly as this may cause circulatory problems. During bandaging, attention should be paid to tissues protruding at both ends of the bandage to check f or signs of poor circulation such as edema or discoloration. In some cases, the treated area is protected without using a film or bandages by using tubes for ventilation and fixed covers. Analgesics should be administered for pain and antibiotics in case of infection. If necessary, collars or covers should be used (see Figures 10 and 11) to prevent access to the affected areas.

3) Severe cases

General anesthesia with ketamine and atropine is administered in combination with local anesthesia with bupivacaine. The animals are kept warm throughout the procedure. Antibiotics, analgesics, and famotidine are administered. Subcutaneous fluids should also be administered. After surgery, antibiotics and analgesics are administered orally along with gastric protectants for approximately five days. The administration of neuropathic pain treatment drugs, such as pregabalin, vitamins, and calcium supplements, is required. Collars or covers (see Figures 10 and 11) are used to prevent access to the affected areas. In addition, the animal must be moved to a smaller cage or limiting the range of motion within the cage to ensure cage rest.

In case of fractures, physical examination and radiography are performed to confirm the location and condition of the fracture. Determine whether it is a closed or an open fracture, a pathological fracture, and whether there are fractures in areas showing signs of tenderness or swelling (Mochizuki, 2023). For the limbs, X-ray imaging of the healthy side should also be performed for comparison. In case of open fractures, after thoroughly cleaning the wound with saline or hypochlorous acid water, hair is removed and disinfection is performed around the wound, followed by surgical debridement. Subsequent procedures are performed aseptically (Mochizuki, 2023). Once the condition of the fracture is confirmed, it is decided whether external or surgical fixation such as pinning should be applied. Amputation may be necessary for

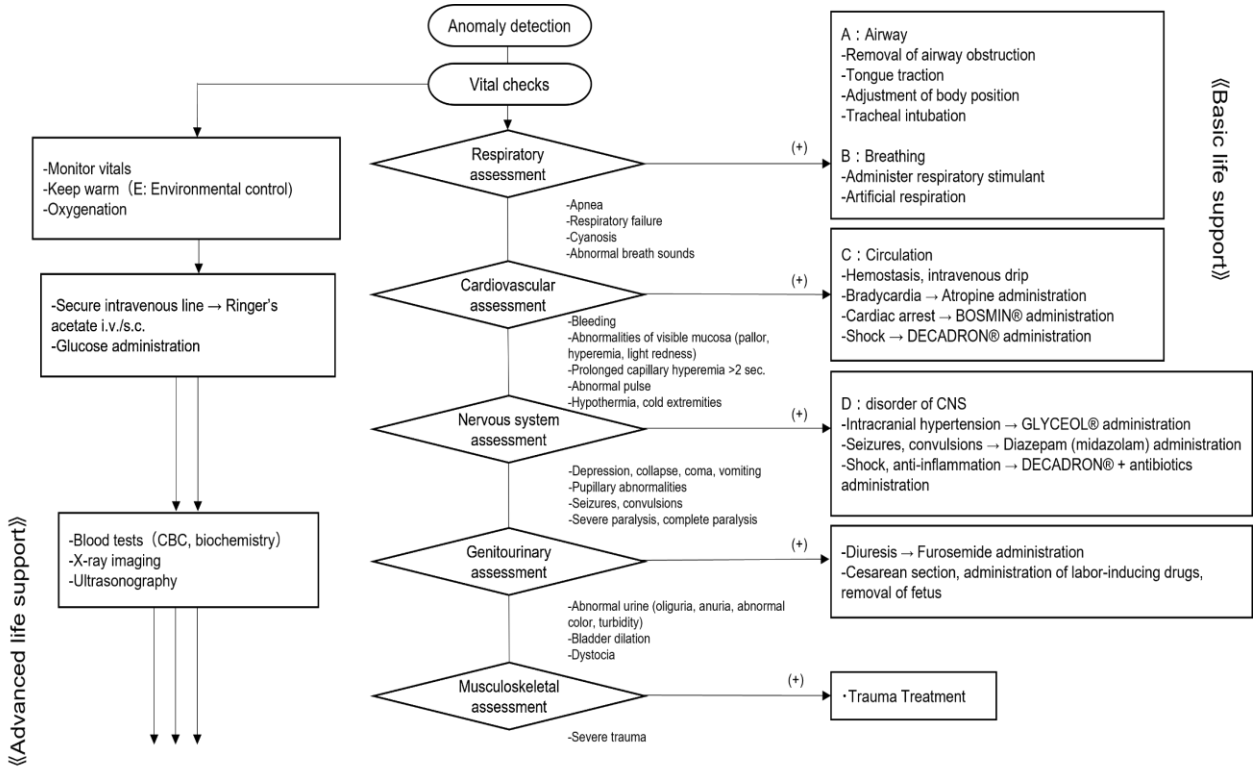

Figure 12 Emergency care flowchart

＊Reference： Hamel & Berry 2018; Mochizuki 2023.

the fingers, tail, and limbs. Splints and casts are commonly used for external fixation. Radiographic imaging is performed before and after fixation to ensure proper repositioning. Care should be taken when wrapping splints or casts to avoid circulatory problems. In pinning, a surgical pin is inserted through a skin incision at the fracture site; however, percutaneous pinning can also be employed.

If amputation is necessary, it is preferable to amputate the joint near the affected area; however, in some cases, amputation may be performed in the middle of the bone. A dental elevator or similar tool is easy to use to detach the muscles and ligaments. If a bone fragment remained, it is trimmed so that the tip is not sharp. After amputation, the affected area is thoroughly rinsed with hypochlorous acid water and filled with a small amount of hydrocolloid dressing, and the wound is closed.

Protective equipment for injuries is shown in Figures 10 and 11.

[8] Emergency care

The sudden onset of illness or injury, exacerbation of a chronic disease, or complications from surgery, anesthesia, or laboratory procedures may cause respiratory arrest, cardiac arrest, bradycardia, seizures, or other life-threatening conditions. In such emergencies, the following "ABCDE approach" is considered: A, airway; B, breathing; C, circulation; D, disorders of the central nervous system (response to external stimuli); and E, environmental control, promptly assess the individual's condition (triage) and treat the most life-threatening problems with the

Table 7 Formulary for Emergency

Drug		Dose/Route/Frequency
Respiratory arrest		
Doxapram hydrochloride hydrate	DOPRAM® injection 400 mg	0.04-0.05 mL/head i.v. or 1 drop on the sublingual mucosa→No spontaneous respiration→Additional doses at 5－10 minute intervals
Dimorpholamine	Theraptique® for Subcutaneous or Intramuscular Injection 30 mg	0.01 mL/head s.c. or i.m. Additional administration of 0.02 mL/head as needed
Ventricular fibrillation, bradycardia（HR＜120）		
Atropine Sulfate	Atropine Sulfate Injection 0.5 mg	0.03 mL/head i.m.
Cardiac arrest		
Adrenaline	BOSMIN® INJECTION 1 mg	10-fold dilution with saline→0.03 mL/head i.m.
Seizure		
Diazepam	CERCINE® INJECTION 5 mg	0.01 mL/head i.v. slow infusion 0.03 mL/head enterocele
Midazolam	Midazolam injection, 10 mg	0.03 mL/head intraoral/intranasal administration
Intracranial hypertension		
Concentrated glycerin, fructose	GLYCEOL® for I.V. Infusion	0.1–0.2 mL/head i.v. bolus/ slow infusion→ then as needed 0.1–0.2 mL/head i.v. slow infusion
Shock, intracranial hypertension		
dexamethasone sodium phosphate	DECADRON® Phosphate Injection 1.65 mg	0.05–0.1 mL/head i.m.
Edema (cardiac, renal, cerebral), pulmonary edema, oliguria during renal failure		
Furosemide	Lasix® Injection 20 mg	0.05–0.1 mL/head i.m.*1
Hypoglycemia		
Purified Glucose	5–10% Glucose injection	1-2 mL i.p. one shot every hour→p.o. once start moving

*Abbreviations: SID: once daily administration, BID: twice daily administration, p.o.: oral administration, i.m.: intra-muscular administration, s.c.: subcutaneous administration, i.v.: intravenous administration,

*1: Dosage used from August 2023. Optimal dosage is under consideration.

highest priority (basic life support) (Linklater & Hanson, 2022; Japan Resuscitation Council, 2020). A, secure airway patency by removing foreign objects such as vomiting, retracting the sunken tongue, adjusting the body position, and intubating the trachea. B, when breathing is compromised, massage the entire thoracic cavity and administer respiratory stimulants if there is no spontaneous breathing; if unsuccessful, provide artificial respiration with an Ambu bag or ventilator while administering oxygen. C, in case of bleeding, stop the bleeding and stimulate circulation by administering atropine for bradycardia or adrenaline for cardiac arrest. D, address any central nervous system abnormalities. For familial seizure

disorders (Yang et al., 2022) or seizures induced by surgery or experimental procedures, the diazepam injection solution should be administered intravenously. If intravenous access is not possible, rectal administration of diazepam injection solution or oral/nasal administration of midazolam injection solution is also an option (Japanese Society of Neurology, Epilepsy Treatment Guidelines Committee,

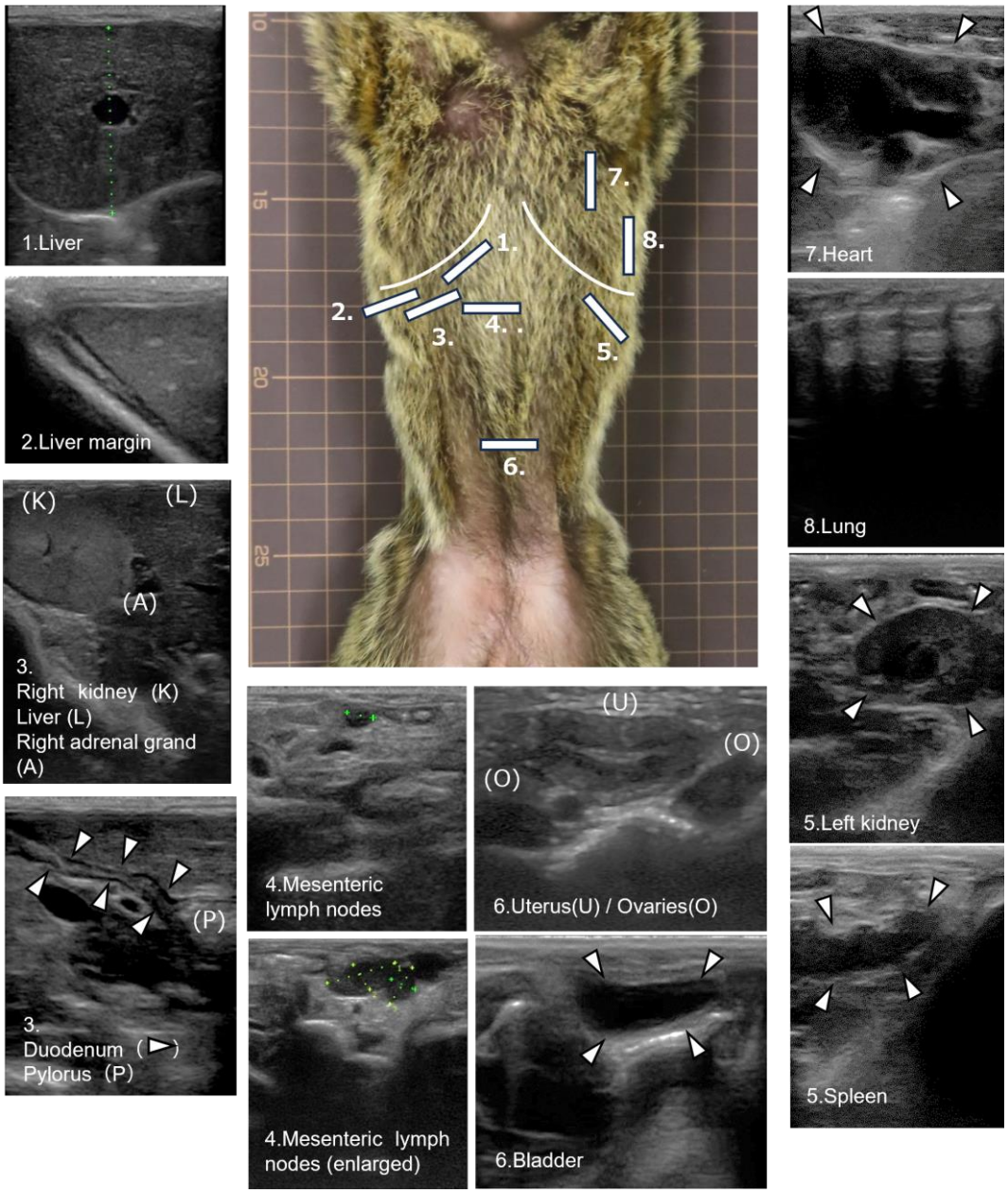

Figure 13 Scan sites and sequence during ultrasonic screening

During ultrasonic screening, depict the liver parenchyma (1), liver margin (presence of ascites) (2), right kidney, right adrenal gland, liver-kidney contrast (kidneys are brighter = white), duodenum to pylorus (3), mesenteric lymph nodes (4), left kidney, spleen (5), uterus, ovaries, bladder (6), heart (7), and lungs (8) in the given order when moving the probe.

2018). If there is a history of seizures or if symptoms of suspected intracranial hypertension (e.g., depression, vomiting, and abnormal pupils) are observed after head surgery or other experimental procedures, concentrated glycerin and fructose preparations are administered intravenously. E: If hypothermia is present, the animal should be kept warm with a hair dryer or warming pad. While preforming the ABCDE approach, secures a venous line from the tail or saphenous vein using a 26G indwelling canula needle or 27G butterfly needle and start Ringer's solution infusion. If venous access is not possible, Ringer's solution is administered intraperitoneally or subcutaneously. The intraperitoneal administration of the glucose solution should be considered as a response to hypoglycemia. when the vital signs are stable. If diuresis is necessary due to edema or oliguria, blood tests (complete blood count [CBC], biochemical tests), radiography, and ultrasound examinations are performed once vital signs are stable. Evaluate individual information such as age, sex, and medical history to determine the cause of the abnormal state and to determine the appropriate treatment (advanced life support) (Linklater & Hanson, 2022; Mochizuki, 2023). The flowchart for emergency treatment is shown in Figure 12, emergency medications are listed in Table 7, and the scanning sites and orders during ultrasound screening are illustrated in Figure 13.

Conclusion

The manual was created based on more than 15 years of experience in common marmoset husbandry management. As with the "Simplified manual for breeding, husbandry, and management of common marmosets," we hope that many people involved in common marmoset management and treatment will take manual with them and use it. However, the current manual is not the final version. Health issues arising from various manipulations, such as experimental animals, often cannot be addressed solely by veterinary knowledge. By sharing information not only from those involved in common marmoset management but also from researchers, and by working closely with researchers and veterinarians, knowledge and techniques can be further improved. It should be noted that high-quality research data can be obtained from healthy common marmosets.

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Notes

(1) Firm stools: Stools that are classified as “Firm Feces” in the marmoset’s 5-step stool visual characterization scale (Fitz et al., 2020) and/or as “Type 1. Rough stools (hard and colonized, like rabbit feces)" and "Type 2. Hard stools (sausage-like but hard) on the Bristol scale for humans.

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