Aquatic Mammals 2018, *44*(5), 482-490, DOI 10.1578/AM.44.5.2018.482

Neonatal Critical Care and Hand-Rearing of a Bottlenose Dolphin (*Tursiops truncatus*) Calf

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Abstract

Neonatal mortality is a recognized concern in cetaceans and, although infrequently documented, human intervention to provide neonatal care has been successful. Advancements in cetacean medical care now allow for enhanced neonatal care even with challenging circumstances. Herein, we describe neonatal care and hand-rearing of a male, 13 kg bottlenose dolphin (*Tursiops truncatus*) calf that was immediately rejected and traumatized by the dam following an uncomplicated parturition. Immediate intervention and restraint allowed for examination, medical stabilization, wound care, parenteral treatments, and diagnostics. Colostrum and milk were collected from the dam under manual and voluntary restraint. The calf was fed a combination of the dam's milk and supplemental formula via a gastric tube, initially hourly with gradually decreasing frequency, for three months. Daily intensive care (e.g., blood sampling, topical wound care, and weights) was performed to monitor systemic health. The calf was originally housed alone but later was transitioned to a pool with visual and auditory access to other dolphins. When the calf reached 8 months of age, he was slowly introduced to another dam/calf pair. The calf is presently 4 years old and continues to thrive in a mixed social group of dam and calf pairs and young adult females comprised of two males and six females.

Key Words: neonate, nutrition, hand-rearing, calf, critical care, cetacean, bottlenose dolphin, *Tursiops truncatus*

Introduction

Neonatal mortality is a significant concern in cetaceans, both under professional care and in the wild (Wells et al., 1987; Mann et al., 2000; Sweeney et al., 2010). The critical care of neonatal cetaceans is often challenging due to the aquatic environment coupled with their unique anatomic and physiologic adaptations. The most common problems reported in neonatal cetaceans include trauma, failure to thrive, malnutrition, aspiration pneumonia, and septicemia, often necessitating veterinary intervention (Sweeney et al., 2010). Historically, the intensive management and handling of cetaceans under 1 y of age has been approached with caution. This comes from previous experiences in which neonates and calves have been lost from acute cardio-respiratory failure during restraint (Sweeney et al., 2010). The highest rate of mortality in bottlenose dolphin (*Tursiops truncatus*) calves occurs within the first 30 d following birth; therefore, this time frame represents an opportunity to increase survivorship through targeted veterinary intervention (Sweeney et al., 2010).

There are limited cases of medical intervention in neonatal cetaceans reported in the literature (Bruehler et al., 2001; Sweeney et al., 2010; McKenna & Campbell, 2012; Zaldivar, 2017), and few of these reports involve complete hand-rearing of a cetacean neonate immediately from birth (Ramirez, 2001; Winhall, 2012). Herein, we describe the successful neonatal critical care and hand-rearing of a bottlenose dolphin calf, providing a reference for other cases and emphasizing that early intervention may be paramount to ensure calf survival.

Methods

In October 2013, a male, 13 kg bottlenose dolphin was born to a primiparous dam after an uncomplicated labor (90 min from visible flukes to parturition). The dam had limited or no time being housed with females and calves prior to the birth of her calf. Husbandry training prior to birth focused on blood sampling, ultrasound monitoring, internal body temp, girth measurement, and milk collection. The calf was vibrant upon delivery, swimming to the surface and breathing well, but was quickly traumatized by the dam, including repeated raking and ramming of the calf. Immediately thereafter, the calf's life was deemed to be in immediate danger, and staff intervened. Both dolphins (calf and dam) were shifted to a shallow medical pool (132,489 L, 22.8 m diameter, 12.8 m deep with half of the pool equipped with a non-lifting false bottom) and manually restrained by animal care staff for medical assessment.

Initially, the calf had harsh respirations indicative of turbulent upper airway flow, but this improved over 30 min with repeated blowhole suctioning and supplemental oxygen administration. Physical examination of the calf presented an otherwise normal assessment, aside from superficial lacerations over the calf's body from the dam. Blood was obtained from the periarterial venous retia of the ventral peduncle for blood gas analysis (i-STAT cG4+; Abbott Point of Care Inc., Princeton, NJ, USA), complete blood cell count, and serum biochemical analysis (Tables 1 & 2). No normal reference values were available for a 1-day-old bottlenose dolphin calf; however, normal neonate hematology averages were available for calves less than 30 d of age (Sweeney et al., 2010; Table 1).

Compared to reference values (Table 1), the calf had a mild leukopenia (3.0 × 10^3/L) characterized by a neutropenia (1.92 × 10^3/L) and eosinopenia (0 × 10^3/L) as well as hemoconcentration (PCV 56%). Additional abnormal values included a low blood pH (6.9; reference range: 7.17 to 7.43) (Varela et al., 2006) and an elevated lactate (14.0; in-house reference range: 0.44 to 2.78). Subcutaneous fluids were administered (20 mL of 2.5% dextrose in NaCl) over the right dorsal body wall using ultrasound to confirm placement under the blubber. Due to the recent history of trauma and the calf's neonatal immune status, antibiotics were administered (Convenia®, cefovecin; Pfizer Animal Health, New York, NY, USA; 8 mg/kg i.m.). Topical betadine (Poviderm Medical Scrub; Butler Schein Animal Health, Dublin, OH, USA) and triple antibiotic ointment (Taro Pharmaceuticals USA, Hawthorne, NY, USA) were applied topically to the cutaneous wounds twice daily for 14 d. Initial length, girth, and neck measurements were obtained while the calf was manually restrained in the water, and body weight was obtained by briefly removing the calf from the water and placing it on a poolside scale.

To obtain initial colostrum and milk, the dam was restrained out of the water. Thereafter, collection of milk from the dam occurred under behavioral control once daily for 7 d. After this initial collection, the calf was immediately tube fed 20 mL of milk/colostrum using an 18 Fr orogastric red rubber catheter passed down the esophagus into the forestomach. Shortly after the first feeding, the calf defecated meconium, indicating normal intestinal motility.

After the initial intervention and stabilization of the calf, an additional attempt was made to reunite the calf with its dam by releasing the calf out of the medical pool to join the dam again in a larger pool. Upon this reintroduction, the dam immediately began aggressing on the calf, so the calf was returned to the medical pool by animal care staff. In *Tursiops*, spontaneous return of lactation has been reported, but efforts to place this calf with a surrogate dam that had a young calf die a few months earlier were unsuccessful. The calf was released from the medical pool into a larger pool with this surrogate dam and, although this female did show an initial interest in the calf, she did not display enough maternal care to prevent injuries. Once this introduction was deemed unsuccessful, the calf was moved to a temporary nursery pool (13,248 L system attached to the life support system of the dolphin habitat) to facilitate close monitoring and care. Veterinary staff were present 24 h/d for several weeks, and a member of the animal care staff was continuously in the water with the calf to allow for monitoring and companionship.

To maintain adequate caloric intake, mimic natural nursing, and decrease the risk of aspiration pneumonia, the calf was tube fed small volumes every hour. The calf was initially fed milk collected from the dam and then transitioned to formula within the first 24 h. Formula was made fresh daily and composition was based on previously published recommendations for *Tursiops* neonates (Sweeney et al., 2010), with herring, milk matrix (Zoologic®; PetAg Inc., Hampshire, IL, USA), and water or Pedialyte® (Abbott Laboratories, Abbott Park, IL, USA) as the principle ingredients (Table 4). Other components were adjusted based on the calf's clinical condition and weight gain with a daily caloric goal of 150 to 200 kcal/kg/day. The initial daily target of 200 g/d weight gain was reached 47.6% of the time in the first 3 wks (Table 5). Since previous

Table 1. Neonatal bottlenose dolphin (*Tursiops truncatus*) hematology and biochemistry reference values. Data are representative of average ranges at < 30 d of age (Sweeney et al., 2010) and > 30 d of age (Teare, 2013).

CBC	Parameter	Units	Average range (< 30 d)	Average range (> 30 d)
	WBC	× 10^3/µL	7.4-10.2	2.9-11.5
	RBC	× 10^12/µL	3.4-3.9	2.7-4.2
	HGB	g/dL	12.0-15.4	11.8-17.0
	HCT	%	36.5-45.5	32.9-49.6
	MCV	fL	109.0-116.5	99.9-144.5
	MCH	pg	37.0-39.4	35.8-49.5
	MCHC	g/dL	33.8-34.5	30.7-39.7
	Neutrophil	%	65.0-76.2	--
	Bands	%	0.4-5.4	--
	Lymphocyte	%	13.4-21.6	--
	Monocyte	%	3.5-8.0	--
	Eosinophil	%	1.8-9.2	--
	Platelets	× 10^3/µL	182.0	46.0-215.0
	ESR	mm/h	4.0-12.0	0.0-20.0
CHEM	**Parameter**	**Units**	**Average range (< 30 d)**	**Average range (> 30 d)**
	ALB	g/dL	2.3-4.6	2.4-5.3
	ALP	IU/L	1,899.4-2,716.8	118.0-1,254.0
	ALT	IU/L	10.5-18.8	13.0-116.0
	AST	IU/L	91.6-115.0	113.0-777.0
	Bilirubin	mg/dL	0.1	0.1-0.6
	BUN	mg/dL	46.3-52.0	30.0-62.0
	Calcium	mg/dL	5.5-10.2	8.0-10.7
	Chloride	mEq/L	55.6-113.7	109.0-128.0
	Creatinine	mg/dL	0.7-0.8	0.7-2.1
	Globulin	g/dL	1.3-1.6	1.1-5.0
	Glucose	mg/dL	132.7-143.0	58.0-151.0
	Phosphorus	mg/dL	6.7-7.5	3.2-6.7
	Potassium	mEq/L	2.1-4.4	2.9-4.5
	Sodium	mEq/L	153.6-156.0	147.0-163.0
	Total protein	g/dL	4.0-5.6	5.8-8.2

studies have suggested that oral supplementation with serum products may increase IgG concentrations in other species (Hammer et al., 2004; Wolfe et al., 2015), the neonate was supplemented orally with 5.0 mL of fresh serum from the dam for the first 18 feedings.

Toward the end of the first week of life, the calf's blood results became unremarkable (Tables 2 & 3), and weight gain remained steady (Table 5). Respiratory rate and effort (recorded every 5 min) were normal. Superficial lacerations continued to heal (total healing time 14 d). Hydration status was monitored by assessment of hematocrit trends. Serum blood protein electrophoresis results were within normal range (albumin, 3.14 g/dL; total protein, 5.1 g/dL; alpha-1 globulins, 0.37 g/dL, alpha-2 globulins, 0.78 g dL, beta globulins, 0.47 g/dL, and gamma globulins, 0.07 g/dL; A/G ratio, 2.04; and pre-albumin, 0.29 g/dL).

On Day 8, the calf's weight gain tapered off, and an abnormal blowhole odor was detected with intermittently harsh breaths. Respiratory and heart rates were normal, as were activity and behavior. Blood analysis was unremarkable. Approximately 45 min after handling for blood collection and weight, the calf became lethargic and unresponsive with apnea and bradycardia. The calf was carried around the pool for multiple laps until it regained adequate strength and began attempting to suckle on trainers. Over the next several hours, two similar episodes occurred, accompanied by abdominal bending and flexing as well as multiple "wet" sounding respirations and expulsion of a small amount (approx. 2.0 mL) of a white thick substance from the blowhole that was suspected to be curdled milk/formula. The blowhole was immediately suctioned using a flexible rubber tubing connected to a portable suction unit, and flow-by oxygen was administered. The calf quickly regained strength and swimming ability with more normal behavior that persisted for the remainder of the day. The calf was administered prophylactic antibiotics (enrofloxacin; Putney, Inc., Portland, ME, USA; 7 mg/kg p.o. s.i.d. for 7 d; and cefovecin sodium; 8 mg/kg i.m.) due to concerns of aspiration.

Results

Over the next few weeks (Weeks 2 to 4 after birth), the calf's behavior, activity level, and blood parameters remained stable, and weight gain continued to improve (Table 5). Despite intermittent interest in bottles, the calf was unable to suckle appropriately to consume adequate calories but remained tolerant of feeding via orogastric tube. During a brief period of reduced formula tolerance, the calf received 60 mL of bottled water with 5% dextrose every 8 h for 24 h (in addition to normal formula administration) to ensure adequate hydration and normoglycemia.

Three weeks after birth, the calf's cutaneous wounds had fully healed, and there were no active medical concerns. Blood parameters were within normal range for a *Tursiops* neonate (Tables 2 & 3). During this period, the calf continued to excel in formula consumption and weight gain. The number of feedings in a 24-h period was gradually reduced with a corresponding slow increase in the volume fed per feeding in an effort to encourage the animal to bottle-feed.

Four weeks after birth, recheck bloodwork under manual restraint revealed a mild leukocytosis consisting of neutrophilic left shift (Table 2), hypernatremia, hyperkalemia, and hyperchloremia (Table 3). The electrolyte changes were attributable to mild dehydration or over-supplementation with Pedialyte® in the calf's formula. Elevation in

Table 2. Hematology values during neonatal critical care and hand-rearing of a male bottlenose dolphin calf

CBC	Parameter	Units	Day 1	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 16	6 months
	WBC	× 10^3/µL	3.0	9.79	8.47	7.37	10.36	12.2	12.25	7.54	8.03	10.8
	RBC	× 10^6/µL	4.12	3.84	3.82	3.68	3.4	3.36	3.15	2.6	3.38	3.67
	HGB	g/dL	17.6	15.7	15.3	14.4	13.4	12.7	12.0	9.5	11.7	12.7
	HCT	%	56.0	47.0	44.6	42.8	40.1	40.0	37.2	29.9	37.3	40.5
	MCV	fL	144.9	122.0	117.0	116.0	118.0	119.0	118.0	115.0	110.0	--
	MCH	pg	42.7	40.9	40.1	39.1	39.3	37.8	38.1	36.5	34.6	--
	MCHC	g/dL	29.5	33.4	34.3	33.6	33.4	31.8	32.3	31.8	31.4	--
	Neutrophil	%	64	69	82	73	77	75	69	67	57	63
	Bands	%	0	5	0	0	3	0	0	0	1	2
	Lymphocyte	%	31	18	9	21	13	15	20	22	28	22
	Monocyte	%	5	7	7	4	1	9	6	2	4	0
	Eosinophil	%	0	1	2	2	6	1	5	7	10	13
	Platelets	× 10^3/µL	182.0	188.0	326.0	356.0	343.0	302.0	226.5	260.3	347.0	252.0
	ESR	mm/h	--	7	2	1	4	--	--	--	2	2

Table 3. Chemistry values during neonatal critical care and hand-rearing of a male bottlenose dolphin calf

CHEM	Parameter	Units	Day 1	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 16	6 months
	ALB	g/dL	3.5	2.7	2.9	2.7	2.7	2.7	2.5	3.3	3.6
	ALP	IU/L	1,788	1,465	> 2,000	> 2,000	> 2,000	> 2,000	> 2,000	1,420	1,537
	ALT	IU/L	< 10	27	37	28	22	< 10	< 10	29	< 10
	AST	IU/L	--	199	211	187	190	190	169	192	152
	Bilirubin	mg/dL	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
	BUN	mg/dL	29	44	44	65	98	64	60	43	41
	Calcium	mg/dL	11.1	9.6	9.8	9.5	10.0	9.4	9.3	10.3	10.4
	Chloride	mEq/L	129	122	94	118	133	122	128	118	116
	Creatinine	mg/dL	1.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5
	Globulin	g/dL	2.2	2.9	2.6	2.7	2.8	2.8	2.4	2.6	2.3
	Glucose	mg/dL	65	111	109	128	138	124	113	126	114
	Phosphorus	mg/dL	5.3	6.5	7.4	6.6	6.6	6.4	6.8	7.3	7.9
	Potassium	mEq/L	--	--	4.0	4.5	4.7	4.2	--	4.8	4.5
	Sodium	mEq/L	156	159	156	154	165	160	162	158	159
	Total protein	g/dL	5.7	5.6	5.5	5.4	5.5	5.5	--	6.1	5.9

BUN (Table 3) observed at this time was likely attributable to post-prandial sampling but may have been associated with dehydration. Pedialyte was removed from the formula, but electrolyte and BUN abnormalities persisted. Since sodium concentrations continued to rise despite removal of Pedialyte® from the diet, the salt in the calf's diet was reduced by half.

During this same time period, a sour milk odor developed from the calf's blowhole during exhalation. No discharge was present, and pulmonary auscultation was within normal limits. No abnormalities were noted on cytological evaluation of swabs collected from the blowhole, and the samples contained no inflammatory cells to support occult infection. However, due to the development of the abnormal smell, oral antibiotics (enrofloxacin; 7 mg/kg p.o. s.i.d) were reinstated for 10 d as a precaution.

The leukocytosis and electrolyte abnormalities persisted into the 5th week after birth (Tables 2 & 3). At that time, it was suspected that the calf may have been inadvertently ingesting salt water during orogastric intubation, leading to electrolyte imbalances. Despite the electrolyte imbalances, the calf continued to gain weight and maintained a high level of activity. Based on this positive progress, the calf was moved to a larger round husbandry pool (7.6 m diameter, 0.9 m deep) for 3 h daily to allow for increased space for swimming. In addition, this pool allowed the calf visual and auditory access to the institution's other bottlenose dolphins.

Six weeks after birth the calf continued to have intermittent foul odor from the blowhole and mild leukocytosis. Due to concerns for pulmonary disease, the calf was physically restrained for thoracic ultrasound. Ultrasonography revealed mild alveolar interstitial syndrome (AIS) with no evidence of pulmonary consolidation. The abnormalities included scattered foci of ring-down artifacts bilaterally and one 7 mm lung rocket in the right thorax. AIS is a collection of pulmonary ultrasonographic abnormalities that denote pathology within the alveolar space and/or interstitium causing vertical artifacts perpendicular to the pleura (Louvet, 2008; Stefanidis et al., 2011). AIS is seen with a number of lung abnormalities, including pneumonia. Abdominal ultrasound was within normal limits. Since emerging disease may not yet have been evident, it was decided to restart antibiotic therapy (Clavamox®, amoxicillin trihydrate/clavulante potassium; Pfizer Animal Health; 12 mg/kg p.o. b.i.d. for 14 d) to address the calf's pulmonary changes and clinical signs. Blowhole culture grew presumptively non-pathogenic respiratory flora routinely identified from *Tursiops*, including *Enterococcus* sp., *Escherichia coli*, *Staphylococcus aureus*, and *Candida* (Morris et al., 2011). qPCR of the blowhole sample

Table 4. Formula components utilized during period of neonatal critical care and hand-rearing of a male bottlenose dolphin calf

Formula ingredients	Quantity (grams or mL)	Caloric value (kcal)
Herring	1,135	1.5 kcal/g (1,702 kcals)
Milk matrix 30/52	200	5.78 kcal/g (1,156 kcals)
Milk matrix 33/40	345	5.38 kcal/g (1,856 kcals)
Water	2,426	--
Safflower oil	50 mL	9 kcal/g (450 kcals)
Whipping cream	200 mL	3.4 kcal/g (680 kcals)
Lactobacillus	3 tabs	--
Dicalcium phosphate	5	--
Dextrose	30	--
Salt	18	--
Taurine	500 mg	--
Lecithin	8 g	--

Table 5. Neonate weight gain and caloric intake during neonatal critical care and hand-rearing of a male bottlenose dolphin calf

Age	Formula volume (mL)	Feed frequency	Caloric intake (kcals/kg/day)	Length (cm)	Weight (kg)	Gain/d (kg)
Week 1	20-50	Hourly	100-111	102.5	13.2-14.3	0.15
Week 2	60-80	Hourly	150-180	--	14.2-15.2	0.14
Week 3	80-105	Hourly	197-181	--	15.5-17.0	0.21
Week 4	75-103	Hourly	182-200	109.5	17.0-18.5	0.23
Month 2	108-330	Weaned from hourly to q 2 h	197-188	119.5	19.7-31.9	0.42
Month 3	285-590	Weaned from q 2 to q 3 h	189-174	135.5	32.4-47.0	0.47
Month 4	400-800	q 3 h to 2× daily; herring 4-8×/d	177-108	144.0	48.6-56.0	0.25
Month 5	800-0	Herring 5×/d	117-113	153.0	56.0-64.0	0.27
Month 6	0	Herring 7×/d	117-93	162.0	64.0-72.0	0.27

produced detectable amplification of *S. aureus* DNA, but amplification was below the number of cycles for a definitive positive result and was likely indicative of low levels of target DNA within the submitted swab sample.

Recheck blowhole chuff cytology and swabs were collected a week later and revealed large numbers of epithelial cells, no fungal hyphae, and moderate amounts of mixed bacteria that were determined to be within normal limits. Brief pulmonary ultrasound at the time showed similar mild changes observed on previous lung ultrasound. Despite the calf's normal behavior, intermittent abnormal whistles were heard during exhalation that appeared more pronounced when the animal was excited. The calf continued to display normal activity and weight gain, and concerns were considered resolved by Week 9.

Twelve weeks after birth, blood analysis showed a consistent gradual decline in packed cell volume with marked regeneration (Table 1). Gastric fluid and fecal cytology did not reveal any evidence of blood. A definitive cause for the anemia could not be determined. Due to the propensity of *Tursiops* to develop gastric ulcers (Gulland et al., 2001), the animal was started on cimetidine hydrochloride (Mylan Pharmaceuticals Inc., Morgantown, WV, USA; 4 mg/kg [200 mg] p.o. b.i.d. for 7 d). Due to lack of improvement, the gastrointestinal protection was changed to omeprazole (Dr. Reddy's Laboratories, Inc., Princeton, NJ, USA; 0.42 mg/kg [20 mg] p.o. s.i.d.) and sucralfate (Teva Pharmaceuticals USA, Sellersville, PA, USA; 1 g p.o. b.i.d.) for 7 d. At this age, the calf was also being introduced to very small quantities of fish in the diet via assisted feedings as part of the weaning process.

A gastrointestinal ultrasound confirmed that fish bones were not accumulating due to medication-induced increases in gastric pH (pH 6.0). Since the chronic anemia was suspected to be associated with gastrointestinal blood loss related to the physiologic stress of weaning and repeated mild illnesses, decreases in handling and weighing were implemented. Feedings were reduced to 7 times daily, and weights were obtained only once every 3 d to decrease handling. The calf was started on iron supplementation (ferrous sulfate; Walgreens; 130 mg p.o. b.i.d. for 30 d) as well as coagulation support with Yunnan Baiyao Jiaonang (Yunnan Baiyao Group; 2 capsules p.o. b.i.d. for 7 d).

Over the next several weeks (Weeks 14 to 16 after birth), the calf's anemia began to improve. Gastrointestinal medications and iron supplementation were discontinued. All other hematologic and biochemistry values were within normal limits at that time. Despite a relatively normal clinical appearance, the calf was noted to have intermittent congested breaths that appeared more frequent after tube feedings. Antimicrobial treatment was restarted with enrofloxacin (7 mg kg p.o. s.i.d. for 7 d). Radiographs at this time showed a small area of pulmonary consolidation just caudal to the heart and adjacent to the diaphragm. An *Aspergillus* serology panel, including an electrophoresis panel, and antibody and antigen tests were performed to assess this fungus as a potential cause of respiratory disease, but results were not consistent with an active fungal infection. Endoscopic evaluation of the proximal gastrointestinal tract revealed normal esophageal mucosa, gastric sphincter, and forestomach.

By 5 mo of age, the calf was in good body condition and the decision was made to progress with the weaning process by introducing whole fish to the diet. Initially, this required placing the fish in the oropharynx, but gradually the calf began to swallow the fish voluntarily once placed in its mouth. Given concerns with *Erysipelothrix rhusiopathiae* in a *Tursiops* neonate (Dunn et al., 2001), the weaning period was started with herring only as capelin is believed to be a more significant source of this bacteria (Harris & Boehm, 2001).

By 6 mo of age, the calf was tolerating the weaning process well and was manually restrained for recheck radiographs, ultrasound, and bloodwork. Thoracic ultrasound showed evidence of pulmonary consolidation in the left cranial thorax, while radiographs revealed multi-focal areas of a patchy interstitial pattern in the caudal left lung field, consistent with peribronchial cuffing/consolidation in the left lung. The pleural space appeared within normal limits, and cardiovascular structures remained radiographically normal. Blood analysis demonstrated a recurrent leukocytosis characterized by a monocytosis (Table 2). At that time, it was suspected that hematologic changes were attributable to pulmonary disease. Repeat blood analysis a week later showed improvement in the leukocytosis and monocytosis, auscultation revealed no significant findings, and chuff sample cytology was within normal limits. Since the animal was doing well clinically, and there was no progression of the leukocytosis, antibiotic therapy was not initiated.

At 7 mo of age, radiographs showed no progression of previous pulmonary consolidation, and repeat chuff cytology showed no significant findings. A gastric fluid sample was normal in appearance and pH, while cytology showed normal squamous epithelial cells and no evidence of white blood cells, red blood cells, or fungal elements. The calf was vaccinated at this time with *E. rhusiopathiae* Bacterin (ER Bac Plus; Pfizer Animal Health; 2.0 mL i.m. left epaxial musculature, 2 doses, 2 wks apart). No adverse reactions were observed after vaccination; 2 wks after the second vaccine dose, capelin was introduced to the diet.

By 8 mo, the previous radiographic consolidation in the left lung field was almost completely resolved, and blood analysis continued to be unremarkable. At this time, the calf was slowly introduced to another *Tursiops* dam with a male calf of similar age. The calf was swum around a new pool with guidance from animal care staff, while the dam/calf pair were in visual and auditory contact. This allowed the calf to adjust to the new companions and to the increased size of the new pool (10.6 m diameter, 4.3 m water depth). The acclimation period took approximately 3 wks. Once animal care staff members were confident that all three dolphins were comfortable with each other, the calf was allowed free access to the new pool.

By 15 mo, the calf was fully integrated into the institution's dolphin social group, sharing a habitat with seven other bottlenose dolphins (5 adult females, 1 male calf of similar age, and a 6-mo-old female calf). At publication of this study, the now-juvenile male is 4 y old and consistently displays normal behavior, social interactions, and feeding behaviors. This juvenile male continues to have strong relationships with animal care staff and has a normal repertoire of conditioned behaviors with other animals of a similar age. In addition, the calf has developed a bond to its birth dam, often spending time swimming and socializing with her.

Discussion

There is a paucity of information related to cetacean neonatal care with scant published cases and only a few documented instances of hand-rearing (Bruehler et al., 2001; Ramirez, 2001; Reidarson et al., 2001; Sweeney et al., 2010; Osborn et al., 2012; Winhall, 2012). Neonatal survivability may be greatly improved through prompt emergency care, advanced diagnostic and therapeutic techniques, and a long-term commitment by clinicians and animal care staff to hand-rear compromised animals. This calf was restrained daily from its first day of life for treatments, feeding, and diagnostics with no direct adverse effects and a successful long-term outcome.

Maternal preconditioning is an important aspect of neonatal success and survivability in cetaceans under professional care (Sweeney et al., 2010). Positive operant conditioning of pregnant dams to prepare them for possible perinatal intervention appears vital to ensuring the dam remains calm and, subsequently, reduces stress responses from the neonate (Brando et al., 2017). Previous studies suggested neonates and dams accommodate quickly to handling (three to four behavioral approximations) as long as the process is completed without aversion (Sweeney et al., 2010).

Female dolphin reproductive success is a function of numerous criteria, including, but not limited to, the dam's age, size, and level of maternal experience. A previous study proved a statistically significant linear increase in the quality of maternal care as a function of the dam's experience, with the quality of care increasing with calving experience (Owen, 2001). In this case report, the *Tursiops* neonate was born to a primiparous dam with limited experience around calves. Her limited experience likely resulted in the poor maternal care displayed immediately after parturition as well as her rejection of the calf.

This case provides evidence that early intervention and comprehensive health monitoring of cetacean neonates has the potential to improve survivability. Such an approach should be considered in situations in which a neonate is medically compromised or displays abnormal behavioral or nursing activities after birth. Such intervention differs from some historical approaches that mandated a "hands-off" approach with neonates, which would have resulted in the likely loss of this calf. This case report contributes valuable information for future neonatal critical care and hand-rearing situations in cetacean calves as a method of increasing calf survivability.

Acknowledgments

The authors thank the dedicated animal care and veterinary staff at the Chicago Zoological Society's Brookfield Zoo for their significant contributions to the successful outcome of this case. We further thank numerous colleagues who shared their clinical experiences and knowledge of neonatal cetacean care. This manuscript constitutes Sea Research Foundation #283.

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