

Hand Raising and Diet Supplementation of Calves

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Introduction

Most of the information in this chapter was taken from the "Elephant Hand Raising Notebook", a compilation of hand raising experiences in survey form. The cases reported in this 1997 survey include calves hand raised from birth on, calves hand raised until they were successfully reintroduced to the dam, mother-raised calves that were supplemented, and calves raised at wildlife rehabilitation facilities. The David Sheldrick Wildlife Trust in Nairobi National Park, Kenya is one of the three reported "elephant orphanages". The "Elephant Hand Raising Notebook" includes several articles written by Wildlife Trust Director Daphne Sheldrick detailing her experience in raising more than thirty calves. For more detailed information on individual cases refer to the "Elephant Hand Raising Notebook".

Cases included in the "Elephant Hand Raising Notebook"

Facility and Location	Period of Hand Raising	Facility and Location	Period of Hand Raising
Tel Aviv-Ramat ban Safari, Israel (TARS)	Several days	Cabarceno Wildlife Park, Spain (CWP)	32 hours
Monterrey Zoo, Mexico (MZ)	9 days	African Lion Safari & Game Farm Canada (ALS)	Approx. 10 days
Chester Zoo, UK (CZ)	29 months	Dickerson Park Zoo USA (DPZ)	7 days
Oakland Zoo, USA (OZ)	11 months	Burnet Park Zoo USA (BPZ)	7 days
Kaliningrad Zoo, Russia (KZ)	7 months	St. Louis Zoo USA (SLZ)	4 days
Daphne Sheldrick, Kenya (Sheldrick)	Until weaned	Assam State Zoo Guwahati (ASZ)	Until weaned
Tel Aviv Zoo, Jerusalem Zoo, Tisch Family Zoo Israel (TAZ)	Until weaned	Pinnawela Elephant Orphanage, Sri Lanka (Pinnawela)	Until weaned
Noorder Zoo Netherlands (NZ)	Until weaned	Zurich Zoo Switzerland (ZZ)	Supplemented from 37 th day until weaned
Hawthorn Corp. USA (Hawthorn)	Until weaned	Berlin Zoo, Germany (Born in Thailand) (BZ)	Until weaned
S.D.W.A.P. USA (SDWAP)	Until weaned	Busch Gardens USA (BG)	Until weaned

Although over the years many very young elephants have been imported and subsequently bottle fed for some period of time, very few elephants have been hand raised from birth. In the eleven reported cases of calves entirely hand raised from birth only five survived past infancy. Apart from these eleven cases, five others reported successful reintroduction to the dam after a period of up to ten days of bottle feeding the calf. Partially due to the large numbers of females lacking calf experience in captivity we can expect that with increased reproductive success will come an increased need for hand raising. However, preconditioning of the dam and planning for a gradual, but persistent reintroduction of a rejected calf may result in more mother-raised calves.

Planning for Hand Raising

Planning for any elephant birth should include plans for the possible need to hand raise or supplement the calf's diet. There are many possible scenarios (i.e. aggression from the dam, death or illness of the dam, poor milk production, and a weak or under sized calf etc.) that would necessitate hand raising or supplementing a calf.

Preconditioning for calf acceptance and milking

Planning might include training to desensitize the pregnant female to the presence of a calf and milking. Several facilities have attempted to minimize the fear and aggression a new, inexperienced mother might have towards her calf by exposing her to calf-like stimulus prior to the birth. Artificial elephant calves and other animals (ie. goats, dogs, bovine calves) have been used to desensitize the pregnant female to having smaller, unfamiliar and moving beings around her. Others have played audiotape and videotape recordings of calves to get the female accustomed to the sight and sound of a calf. Desensitizing her to gentle mammary gland and nipple manipulation, as well as, the feel of a warm damp compress may increase her comfort with both the calf's initial attempts to nurse and if necessary milking. However, exercise caution when handling the mammary glands prior to parturition. Excessive handling may reduce the amount of colostrum available to the calf if milk is expressed and may increase the possibility of both mastitis and mammary gland edema.

Supplies

Planning should include the acquisition of supplies at least several months in advance of the anticipated birth date in case the calf is premature or the conception date is wrong. Some supplies like the elephant milk replacer have to be special ordered and may take weeks for the company to mix a batch and ship it to your facility.

Supplies For Hand Raising

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|------------------------------|----------------------|---------------------------------|
| • Bovine bottles and nipples | • Cloth tape measure | • Caretakers for 24hr. coverage |
| • Milk replacer | • Walk on scale | • Nursery in elephant barn |
| • Human breast pump | • Video camera | • Shavings |
| • Microwave | • Camera | • Straw |
| • Refrigerator | • Record sheets | • Blankets |
| • Cooking thermometer | • Notebooks | • Towels |
| • Containers and utensils | • File folder box | • Baby wipes |
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Caretakers

A plan for 24hr. care of the calf should be worked out in advance. Three eight-hour shifts work well. Initially two people should be scheduled per shift. The calf will bond very quickly and closely with its caretakers. Every effort should be made to establish a stable group of people responsible for the calf's care. This group should be large enough to allow for ease of scheduling over a long period of time but small enough that each caretaker is with the calf for most of their workweek. Because of their highly social nature, being able to bond with a human "family group" may help to reduce stress and thereby the likelihood of illness. A small group of caretakers will also increase consistency in care and calf behavior.

Nursery Location

Planning should also include the development of a nursery. It will need to be safe from the adult elephants but allow for visual, auditory, and olfactory contact. Chain link works well as a barrier for the calf but the smaller (1"x1") links are necessary to prevent the calf from putting its trunk through the fence. Generally, the nursery area should be kept at about 18° C (65° F) but a very young or ill calf may require a warmer ambient temperature. Blankets and heavy bedding may help to offset cold temperatures. The space should

also be hoseable; calves will produce large volumes of urine and feces. A layer of shavings covered by a deep straw bedding works well to insulate the calf and to absorb urine and feces between clean outs. A service area with electricity, water and storage space should be near by.

Record sheet

In addition to standard medical records an infant care sheet should be decided upon. For the purposes of tabulation the sheets should be designed to record a 24hr. period. Basic information includes intake (formula, solids, water) and output (defecation, urination). Other information that could be included are the times the calf lays down and gets up to record sleep time, vital signs, development and behavior.

Reintroduction

As part of the planning process the Elephant Management Committee should develop a plan for a possible attempt at reintroducing the calf to the dam. In five reported cases calves were successfully reintroduced to the dam after a period of up to ten days of bottle feeding the calf. In each of these cases the staff worked around the clock to encourage and facilitate the maternal relationship. The committee should consider their management program, facility, the use of outside consultation and assistance, the temperament of the dam, the potential risks to staff and the calf and the impact of hand raising on the calf and the staff.

Feeding

In the reported cases a wide range of time (2-19 hours) passed before the calves received their first bottle-feeding. Those that went for longer period were trying to get the calf to nurse from the dam. Most often a bovine calf nurser was used with the nipple openings slightly enlarged to allow a steady drip when tipped. A rubber band was placed between the nipple and the bottle rim to allow air to escape. Two facilities (DPZ, SLZ) used an IV line attached to a fluid bag, the end of the IV line was attached to the keepers fingers so the calf could be more easily led to the dams teat.

Milking the Dam

In the majority of reported cases (10 of 16) the dam was milked for some period of time enabling the calf to receive some colostrum and milk. In at least two cases (DPZ, SLZ) the majority of the calves' diet during the short period that they were hand raised was mother's milk. Milking methods varied and included; by hand (similar in technique to that used to milk goats; squeeze the teat at the top with the thumb and fore finger then squeeze with the other three fingers in succession.), manual human breast pump and electric human breast pump. In two cases (SLZ, OZ) human lactation consultants have assisted in facilitating the loan of breast pump equipment as well as providing instruction on its use. In at least two cases (DPZ, SLZ) Oxytocin was used to aid in milk let down and production. Dickerson Park Zoo (DPZ) administered 3ml of Oxytocin intramuscularly approximately 5 minutes before pumping then pumped for between 5-10 minutes. Oxytocin was also administered when the calf began to nurse and it appeared that the milk let down was poor. The amount collected in the first 24hrs. varied widely (300-3,880 ml) partly because in some cases the dam was only milked one time in an attempt to collect colostrum. Of those that continued milking, frequent milking and the use of Oxytocin dramatically increased the amount collected. In one case (DPZ) where the dam was milked every three hours and Oxytocin was given each time the average amount collected per milking was 1080 ml during the first week. Milking has also been used to collect samples from a nursing mother over the course of lactation for the development and modification of formula for a bottle-fed calf.

Milking Procedure with Human Breast Pump and Oxytocin (SLZ)

- 1) Wash the breasts with warm water.
- 2) Massage the breasts.
- 3) Pump the breast 8-10 min. after administering Oxytocin.
- 4) Rest (stroke, massage + shake breasts).
- 5) Pump for another 5-7 minutes after 2nd Oxytocin.

- 6) Rest (stroke, massage, and shake breasts).
- 7) Pump another 3-5 minutes and finish up.

Milk replacer and supplements

An elephant milk replacer formulated by analyzing the milk of lactating females was used in a number of cases (ALS, OZ, TAZ, NZ, and Hawthorne). In at least two cases (NZ, OZ) additional milk samples were analyzed over time and changes were made to the formula composition accordingly. Several human infant formulas have also been used to bottle feed calves. In North America Grober Company located in Cambridge, Ontario produces the most commonly used elephant milk replacer. Grober produces a replacer for both African and Asian elephants that has been formulated from the analysis of milk collected from lactating females. The Asian formula has 1215 Kcal digestible energy per liter. The African formula has 750 Kcal digestible energy per liter. Enfamil is the most commonly used human infant formula and has 666 Kcal per liter (note not in digestible energy). In most reported cases some kind of dietary supplementation was provided. Bovine colostrum, Colostrix (a colostrum replacer), and lactobacillus were given to protect the gastrointestinal tract. Desiccated coconut and butter fat were added to increase the fat in the diet. Vitamin and mineral supplements were commonly used; mentioned specifically were Vit. E, Vit. B, and calcium. In many cases rice water (cook rice and pour the water off) and glutinous rice broth were used when mixing the formula to help alleviate diarrhea. Rice cereal, milled whole barley or oatmeal, desiccated coconut, and other ground solid foods were added to the bottles of older calves to facilitate the transition to solid foods.

Feeding Schedules

In each of the reported cases the calves were fed "on demand" initially. The keepers began by encouraging/offering the bottle, but the calf soon developed recognizable behavior indicating a desire to nurse, this usually meant placing the trunk in the nursing position. Sheldrick recommends feeding on demand for at least the first three months, then gradually shifting to an every three hour feeding schedule. In at least one case (OZ) the calf was fed on demand for eleven months. On average the calf nursed every 1-2 hours, although at times he would solicit nursing for comfort and consume little or no formula. When feeding schedules were used the feeding interval for very young calves was 1-3 hours. After three months the nighttime feedings were gradually eliminated and by nine months the calf was offered as few as four feedings per day.

Feeding Amounts

Calves weighing 100 kg (220 lbs.) should receive between 6,000 and 8,000 Kcal per day and calves weighing 200 kg (440 lbs.) should receive between 16,000 and 20,000 Kcal per day¹. The Grober Asian formula should be fed at a rate of 5-6.6 liters and 13.2-16.5 liters, respectively to meet this requirement. It is necessary to feed 8-10.7 liters and 21.3-26.7 liters of the African formula per day. At these weights a calf would require 9-12 liter and 24-30 liters of the Enfamil formula per day. Sheldrick recommends that newborns receive at least 8 liters (2gal.) per 24hrs. but states that they can go to as low as 5 liters for a couple of days. Sheldrick states that "over feeding is not possible in elephants calves" and that when allowed to feed at will, as they would if mother raised, they will consume an appropriate amount. Ultimately, the calf should gain between 0.5 kg (1 lbs.) and 1.4 kg (3 lbs.) per day, averaging 0.9 kg (2 lbs.).

RANGE OF REPORTED AMOUNTS BOTTLE FED *

week	liters/day	liters/hour	ml/kg/day
1	5.0-10.7	.208-.446	55.6-87.2
2	8.75-11.6	.364-.483	70.0-91.0
3	11.0-13.2	.458-.550	75.9-128.5
4	11.8-12.0	.490-.500	85.0-98.0

month	liters/day	liters/hour	ml/kg/day
1	5.0-13.2	.208-550	55.6-128.5
2	12.0-18.0	.500-.750	75.9-128.5
3	10.9-20.0	.456-.833	62.9-119.1
4	12.1-24.0	.504-1.00	63.0-130.7
5	14.5-29.0	.606-1.21	70.0-134.0
6	13.7-31.0	.573-1.29	52.9-138.2
7	10.9-24.6	.456-1.02	44.9-118.3
8	12.7-25.8	.531-1.08	56.2-110.8
9	15.0-28.5	.625-1.19	36.8-107.2
10	10.6-28.3	.441-1.18	36.8-107.2
11	12.7-30.6	.531-1.26	43.8-104.1

*(CZ, DPZ, SLZ, KZ, OZ, SDWAP, and Sheldrick)

Solid Foods

Although, hand raised calves experiment with solid foods at an early age they develop normal feeding habits much more slowly than mother raised calves. What is desirable to eat seems to be one more thing calves learn from either their elephant or human families. Hand raised calves often are very interested in tasting foods being eaten by their caretakers. And just like mother-raised calves they use their trunk to smell and try to take food from the mouth of their surrogate mothers. Caretakers might be able generate more interest in appropriate foods by eating or pretending to eat them with the calf. As with mother raised calves weaning and consequently hunger may increase the calf's appetite for solid foods.

Weaning

Very little information has been reported on weaning of the calf. Sheldrick has described generally their process for weaning elephant calves as follows: At 4-6 months they begin to add milled whole barley or oatmeal and desiccated coconut to the formula. They start with 1 TBS. of each and gradually increase the amount until the formula becomes the consistency of porridge. Sheldrick states "the desiccated coconut is a vital ingredient, for this contains the fat that they need. Without it, a calf will begin to show signs of malnutrition during weaning, evident in the development of a pot belly." At nine months Sheldrick believes the calves should be receiving their largest volume of formula at about 28liters/ 24hrs. After this point she begins to decrease, very gradually, the amount of formula. At one year bottles are mixed with half formula and half skim milk, the cereal and coconut continue to be added. At two years Sheldrick gradually replaces the formula and skim milk with water but continues to bottle feed until the calf is five years old. Sheldrick states " that mother raised calves usually nurse until the age of five and that suckling is psychologically important to the calf ". Fowler indicated an age of 15-18 months for weaning to occur.¹

Behavior

Hand raised calves very quickly become imprinted on their human caretakers. If there is any possibility that the calf might be reintroduced to the dam or introduced to a foster mother in the first couple of weeks, it should spend as much time with them as possible and interaction with people should be minimized. Calves have been successfully returned to their dams after up to ten days of bottle-feeding but in each of these cases the calf was either kept right with the dam or visited frequently including all feedings. Feeding was used as a way to lure the calf to the dam and ultimately transfer the calf to the teat. In one case (NZ) the calf was introduced to a foster mother on day two so the staff continued to bottle-feed the calf but it didn't require round the clock care. In most cases calves that are hand reared require twenty-four hour care and companionship. Being highly social and tactile animals companionship is thought to be very important to

their overall health and well being. Sheldrick states "hand raised calves should never be left alone", someone from their "keeper family" should be with them at all times.

Newborns

Initially, some calves may struggle with finding a comfortable nursing position, and not nurse well until they do. They seem to need to have their trunks up against something. Sheldrick has had success with hanging a piece of canvas, which the calf then pushes up against to nurse. But Sheldrick cautions that " some calves need more intimate contact with the keeper and will come to rest their trunk at the underarm, face, neck, etc." Once the calf finds a comfortable position it will be reluctant to nurse until it is in that position. Very young calves are also comforted by covering them with a blanket, allowing it to cover their ears so just the front of their face is visible. They may have some instinct to be shadowed or covered by the dam that this fulfills. This will also help to keep them warm. Lighter blankets or sheets can be used in warmer weather.

Newborn elephants often have difficulty lying down, they shuffle around the enclosure until they stop and begin falling asleep standing. At some point they just collapse or tip over. They also may need help getting up. Sheldrick provides large canvas sleeping cushions, others have used deep straw bedding and whole bales for the calves to lean against and slide down.

Companion Animals

A variety of animals have been used as companions to elephant calves, in hand raising situations this is most often in addition to human companionship. Grazing species (goats, sheep, cows) may encourage interest in hay, grass and browse. Animal companions may also encourage play and exercise. Care should be taken that the companion animal is appropriately tested and found to be disease free.

Socializing w/ other elephants and reintroduction

As with many hand raised animals elephants that are hand raised prefer human companionship to that of other elephants. In at least one case (NZ) a calf was introduced to a foster mother on day two. This allowed the calf to socialize normally while still being bottle-fed. It is critical that the calf gets every opportunity to socialize with other elephants. The nursery should be in close proximity to the elephant stalls so the calf can hear, smell and see the other elephants. If possible regular periods of interaction with the other elephants should be planned. The Elephant Management Committee should develop a plan and timetable for integrating the calf into the herd as soon as possible.

Interaction with People/Manners/Training

It can be very difficult to control the movement of very young calves. They may not follow well, a bout of exuberance will send them running off in any direction, and they can be very resistant to attempts to direct or stop them. The environment that they are kept in should be "baby proof" so that they are not in danger if their caretaker "loses control of them". Although pushing and herding the calf can be effective, grabbing and pulling on the calf seems to trigger an escape instinct and the calf will fight to get away. As they get older they become more reliable followers and respond to their name and simple directional commands. A firm "no" seems to be effective in teaching them what they cannot do. But avoiding problem situations is most practical in calf interactions. Calves exhibit normal butting and charging play behavior at a very early age. Calves should not be allowed to interact with humans in any way that would be unacceptable for an adult elephant. Having many toys available like plastic garbage cans, boat buoys, and hanging objects will make it easy to divert the calf to a toy when a play bout begins. The calf will learn to direct play behavior towards inanimate objects. Although young calves can learn some basic manners, like all infants they are very willful and probably don't have the maturity for concentrated training until they are at least two years old. In many cases keepers have been able to "capture" simple behaviors like "lie down", "trunk up", "move up", "back up", etc. by naming and reinforcing the behaviors when they occur.

Play/ Exercise

It is important for normal and healthy development that the calf receives regular exercise. Calves in the wild would be walking miles each day. Even in a captive situation a mother-raised calf would spend more time walking as it followed its mother than a calf raised in a nursery situation. If possible the calf should be allowed to follow the keepers through their cleaning routine. A regular walking routine should be established, possibly before and after business hours. Exercise should also come in the form of play bouts. Healthy calves should regularly have energetic play bouts, which can be solicited with favorite and novel toys.

Physical and Behavioral Development

Physical development of hand raised calves should follow very closely that of mother-raised calves. Monthly body measurements, photographs and videotape of the calf will allow close monitoring of the calf's growth and development. If a hand raised calf is not able to spend an adequate amount of time with other elephants normal behaviors may be absent or slow to develop. The caretakers can encourage some behaviors like dusting, eating solid foods, mud wallowing, swimming, and play behaviors. Further study is needed to determine the effect of hand raising on the calf's communication and social skill once it is integrated into a herd.

Record Keeping and Documentation

Detailed nursery and medical records are essential in monitoring the health and development of the calf. Daily records that allow for the twenty-four hour tabulation of input /output will translate easily into weekly and monthly summaries that make it easier to monitor trends in feeding and stool production. Hand raising also offers a unique opportunity to closely observe and document the behavioral and physical development of an elephant calf. Written, photographic and video documentation of body measurements, vital signs, eruption of molars and tusks, and learning stages of the calf would be a valuable addition to our knowledge of elephants.

Medical Issues in Hand Rearing Elephants

The medical issues involved in the process of hand-rearing elephants are multiple, and the methods for dealing with these issues can be varied. There is little published information available on the subject. Most of the information in this section is derived from our personal experience in raising an elephant calf at the Oakland Zoo from birth to 11 months age, discussions with other zoo veterinarians and staff regarding medical events in hand-reared elephants, and the "Elephant Hand Raising Notebook", including the references cited within the notebook. It is important to plan ahead for the medical aspects of hand-rearing as long as a year ahead of an impending birth. Here is a list of suggested supplies to collect:

Suggested Medical Supplies

- Elephant plasma- 4 to 8 liters minimum for IV use, plus an additional 4 to 8 liters for possible oral use. Can begin collecting 6 months prior to calving date and store at -20°C (-4°F); it can be stored for 12 months if a -70°C (-94°F) freezer is available. Do not use plasma from the dam due to potential for isoantibodies. Donor elephant should be healthy, on-site, and a whole blood PCR test for Herpesvirus should be negative.
- Elephant colostrum- 2 to 10 liters, if available. Bovine colostrum can be substituted in emergencies, same volume.
- Stethoscope
- Large animal thermometer
- Flashlight, penlight, ophthalmoscope
- Intravenous (IV) catheters- 18 gauge, 20 gauge intracaths (eg. Sureflo), 1" to 3" in length. Other catheterization supplies including heparinized saline, bandage tape, surgical adhesive, suture kit, 2% lidocaine

- IV fluid solutions- Lactated Ringers solution preferred, also NaCl, KCL, 50% dextrose
- Large animal fluid administration sets, standard administration sets, IV fluid bag pump, possibly IVAC unit
- Antibiotics- Ceftiofur (Naxcel), Penicillin GK, Penicillin G Procaine, Amikacin, Gentamycin, Ampicillin, Amoxicillin, Trimethoprim sulfas. Do not advise use of fluoroquinolones.
- Therapeutics for shock- Dexamethasone NaP, Dopram, Epinephrine, Atropine
- Surgical kit- surgical instrument packs, suture material,(2-0 to 0; absorbable, slowly absorbable, and non-absorbable)
- Radiology- portable unit ok for distal extremities, 300 MA or greater for thorax, abdomen, pelvis. On-site preferred, or plan for potential transport to other facility
- Bandaging and casting material
- Antiseptics- Betadyne, Nolvasan, hydrogen peroxide, tincture of iodine
- Vitamin injections- B, C, E and Bo-Se
- Banamine injectable
- Stanolozol (Winstrol), prednisone
- Blood collection kit- vacutainer system, and standard syringes, serum (clot) tubes and EDTA tubes, access to STAT lab, on-site preferred
- Blood culture bottles
- Calf formula and bottles (see above section)
- Heat sources- heating blanket, heat lamps, floor heaters
- Tetanus toxoid, tetanus antitoxin
- Oxygen administration system- portable to elephant location. Anesthesia machine or oxygen demand valve with tank
- Anesthetics- Isoflurane vaporizer system, ketamine, xylazine, reversal agent for xylazine
- Endotracheal tubes up to size 18 with stylets, mask to fit over trunk
- Anesthesia monitoring equipment- pulse oximeter, EKG, Doppler unit
- Medical records

Medical Protocol for Rejected/Orphaned Elephant less than 24 hours of Age

1. *Assess immediate needs.* Evaluate respiration, heart rate, mucus membrane perfusion. Perform resuscitation procedures or begin oxygen therapy before proceeding with further steps if needed.
2. *If temperature is less than 36° C (97.5° F),* apply heat lamps and/or heating blankets (36.4° C to 37.2° C is normal)
3. *Draw EDTA and Clot blood tubes for:*
 - a. Whole blood glucose. If less than 40 mg/dl infuse 5% to 10% glucose solution, 10 to 20 ml/kg IV bolus. Recheck blood glucose.
 - b. CBC (STAT)
 - c. Chemistry panel (STAT) including electrolytes, P, Creatinine, T.P., Globulins, Ca, CPK
 - d. Zinc sulfate turbidity or glutaraldehyde precipitation test (qualitative IgG test)
 - e. SAVE extra serum and freeze
 - f. Serum electrophoresis
4. *Consider blood culture* if calf is weak and/or placentitis is present.
5. *Administer elephant colostrum* if available, 2 to 10 liters orally. Give by stomach tube if necessary (may need to complete further assessments or treatments if tubing is necessary as this is stressful). Colostrum should be given when the calf is less than 12 hours old if possible, and no more than 24 hours old. Bovine colostrum can be substituted if necessary.
6. *Weigh*
7. *Assess fluid balance.* Insert IV catheter if fluid therapy or plasma therapy is indicated. If calf has not received colostrum – plasma is preferred fluid. If calf has received colostrum, use LRS and/or plasma.
8. *Perform thorough physical examination.* Assess maturity. Rule out congenital defects.
9. *Save placenta* for examination (culture and sensitivity, histopathology)
10. *Evaluate lab data and PE,* decide upon appropriate antibiotic, plasma, fluid therapy, tetanus prophylaxis, umbilical care, and vitamin E or Bo-Se injection.

This table is adapted from Smith, Large Animal Internal Med 1990

Failure of Passive Transfer (FPT) of Immunoglobulins

There have been no recent definitive studies of the immune development of the elephant neonate. Some guidelines, such as volume of plasma to administer in cases of FPT, have been extrapolated from equine recommendations. Some guidelines to consider are as follows:

- Elephant neonates consume 2 to 10 liters of colostrum, with nursing beginning as early as 30 minutes after birth¹. Therefore it is recommended to give this amount, and assumed that the window of time for absorption is from birth to 6 to 12 hours of age, possibly up to 24 hours of age, as in the foal. Colostrum can be stored frozen for a period of up to one year at -20° C.
- Elephants have long been thought to have no placental transfer of immunoglobulins, only passive transfer through colostrum after birth. Recent findings suggest that further work is needed in this area.²
- More information is needed on testing the immune status of neonatal elephants. Tests that should be performed are: total protein and globulins, serum electrophoresis, and a qualitative immunoglobulin test such as zinc turbidity test. A threshold of 400 mg/dl of IgG is an adequate level for foals but this may not be adequate for elephants. Note that the two African elephant calves born at Oakland Zoo that had not nursed prior to blood draw had IgG levels of greater than 400 mg/dl as determined by the glutaraldehyde precipitation test (a qualitative IgG test). It has been suggested that a neonate should be considered hypogammaglobulinemic if serum concentrations are less than 25% of the adult average for the species. Electrophoresis does not require species-specific reagents and can measure gammaglobulins.³ Total protein and globulins may not be a reliable indicator of passive transfer, even in foals. Generally, a serum globulin level of less than 4.5 g/dl suggests FPT, and 4.5 to 5.0 suggests partial FPT, but these values are only guidelines, and again in the Oakland calves had values greater than 4.5 even though no nursing had taken place. Quantification of IgG requires radial immunodiffusion (RID), which requires species-specific antiserum. This would have to be developed by a research laboratory at present, but in future perhaps would be available. Finally, although not definitive, these tests should be performed to help attempt assessment of the calf, but also to gather information for future calves.
- Elephant plasma should be collected up to 6 to 12 months prior to expected calving date. The sterile plasma can be stored at -20° C (-4° F) for 6 months, and at -70° C (-94° F) for 12 months. The donor elephant should not be the dam due to potential for isoantibodies should be healthy, and Herpesvirus negative by whole blood PCR tests. The elephant should be tested at each plasma collection. It is preferable to collect from elephants on-site, as resistance to local infectious agents is more likely.
- The volume of elephant plasma to administer IV to the calf is not known, but it is likely that amounts similar to that required for the foal are necessary. Foals are given 40 to 80 ml/kg IV over a 2 to 4 day period. For a 100 kg (220 lbs.) elephant calf, this would total 4 to 8 liters. This amount is too large a bolus for one administration, especially in a calf with normal hydration status. Ten to twenty ml/kg is a reasonable amount to give as one IV bolus over 30 to 60 minutes. The volumes of plasma administered to neonatal calves reported in the "Elephant Hand Raising Notebook" have been lower than recommended amounts, 1.5 liters or less. Elephant plasma can also be given orally during the first 24 hours after birth (first 6 to 12 hours preferred), but the antibody content is lower than colostrum, therefore a larger volume must be given to approach a similar absorption. Colostrum or plasma may have a local protective effect on the gut even if GI absorption is closed.

Diseases and Problems of the Hand-Reared Neonate

Selected conditions that appear to be specific to, or occur more frequently in, hand-reared neonates are discussed here.

1. Diarrhea- Defined as an increase in liquidity or frequency of stool production. Loose stool in a variety of colors may be "normal" for formula-fed infants. Severely odorous stool may be abnormal. The frequency of stool production that is normal for one particular calf is helpful in determining the extent of diarrhea when it occurs.
- In cases of mild diarrhea without any additional clinical signs: either dilute formula 25% to 50% for 1 to 3 days; or discontinue formula and substitute water, electrolyte solution such as pedialyte, rice water or

rice milk; or alternate each formula feed with a feed of electrolyte solution; or change to a different formula.

- In cases of diarrhea accompanied by other clinical signs such as lethargy, weakness, reduced appetite, colic or dehydration, diagnostic evaluation as well as treatment is necessary. Diagnostics include- CBC, Chemistry panel (note that blood collection is stressful for elephant calves, so the necessity for this action should be based on history, and severity of clinical signs); Fecal culture for Salmonella, +/- other potential pathogens such as E Coli, Pseudomonas, Clostridium perfringens, and Campylobacter; fecal cytology smear; fecal flotation for parasites, +/- exam for giardia; TPR, and body weight SID to BID; +/- Herpes serology test; and +/- blood culture. Treatment options include diet changes as above, with emphasis on electrolyte oral fluids; IV fluid therapy; antibiotic therapy; Kaopectate orally; anthelmintic when appropriate.
2. Constipation
 - Has been reported in mother reared and hand reared calves.⁴
 - Can occur in particular following a stressful event or abrupt diet change.
 - Signs include listlessness, anorexia, abdominal contractions with no defecation (straining), absence of defecation, and rubbing hindquarters against walls.
 - Treatments: enema (may be necessary to be given daily); consider antibiotics, corticosteroids, and vitamin B12 if the calf is weak; consider use of oral cathartics such as mineral oil, but these should be used with caution in very young animals, as they could cause further abdominal discomfort and/or diarrhea.
 3. Metabolic Bone Disease/Rickets- Rickets has occurred in young growing elephants fed a diet with (what appears to be) an imbalanced calcium:phosphorus ratio.¹ Unfortunately there may not be enough information on the calcium:phosphorus content of normal maternal elephant milk to know what the recommended amount should be. Readers should see the analyses in the "Elephant Hand Raising Notebook", and any new information, prior to evaluating a particular formula for a calf. Access to sunlight may also be important in the prevention of this disease, as a source of vitamin D necessary for calcium absorption from the gut. Chronic intestinal malabsorption was suspected as a causative factor in one case of metabolic bone disease in a hand-reared calf at the San Diego Wild Animal Park (Oosterhuis, personal communication 1996).⁴ Diagnostic evaluation may include evaluating serum calcium and phosphorus levels, radiology, and formula (repeat) analysis. Treatment would involve correcting the dietary imbalance, possibly injection(s) of vitamin D, access to sunlight, and care with regard to body weight and type of exercise (or any activity that could lead to pathologic fracture). It is recommended that the calf be exposed to 30-60min. of sunlight per day depending on the weather. It is also recommended that x-rays of the distal limbs be taken to evaluate bone density at approximately 6 and 8 months of age.
 4. Herpesvirus Infection - Approximately twenty cases of the disease have occurred; eighteen of these cases have been in young Asian elephants. Of the cases that have occurred it is not known how many were hand raised calves with the exception of the Oakland Zoo African calf no.1. The disease is acute to peracute, and often rapidly fatal. Recently four young elephants have been treated with the oral antiherpes medication Famcyclovir, and of these cases three have survived. (Montali, R., personal communication 1999). A whole blood PCR test is available upon special request from Dr. Richmond or Dr. Montali. (National Zoo, Washington D.C.) Results from this test may not be received for a number of days. Treatment may therefore need to be initiated based only on history and clinical signs. Symptoms include lethargy, weakness, reduction in appetite, diarrhea or lack of stool production, cyanosis of the tongue tip, swelling around the face, trunk and front limbs, elevated heart rate, collapse, and sudden death. Not all of these symptoms have been seen in each case of herpesvirus infection, and in older animals the symptoms have appeared to be less specific. It is advised that Famcyclovir be kept on hand at the zoo when hand-rearing an elephant calf. Acyclovir (Zovirex) does come in an injectable as well as an oral form, but this has not yet been used in an elephant, and also the cost may be prohibitive. It is recommended that hand reared calves be trained to allow a physical examination especially of the oral cavity. This is particularly important in situations where herpesvirus has been known to occur on the premises or where there has been cross species contact in the herd.

5. Sunburn- Elephants are susceptible to sunburn, especially on the head. Ensure that adequate shade is available during outdoor time. Sunscreen has been used on calves, however effectiveness is uncertain and there could be some potential for allergy, so covering the calf with sheets, and keeping in the shade are better options. Treat sunburn with a soothing cream such as Vitamin E cream and restricted access to sunlight until healed.
6. Skin Dryness- This has been noted in hand-raised calves. Cause is unknown. The dryness can cause a marked pruritis resulting in the calf rubbing itself raw on doors, walls, etc. Treat with a mixture of lanolin and mineral oil (1-lb lanolin added to 1-gallon mineral oil). Apply to the entire calf's skin once to three times weekly after gently bathing the calf with warm water. It may be advisable to test the calf for allergy to the mixture by applying a small amount to the skin the first time it is used.
7. Umbilical infection- The umbilicus can be very open at birth, and umbilical infections have been reported in elephants, including one fatality.⁶ Serious infection may be more likely in a calf that is immune-compromised by FPT, stress, etc. Diagnostic evaluation: Aerobic and anaerobic culture and sensitivity. Treatment: Cleansing and antiseptic flush with dilute Betadyne or Nolvasan q 12 to 24 hours; gentle curettage if necessary; +/- topical antibiotic flush, eg. Penicillin GK or dilute Gentocin q 12 to 24 hours; +/- systemic antibiotics (may be critical in cases of FPT). Broad-spectrum therapy is advised, for example ampicillin + amikacin (with adequate hydration), or Ceftiofur (Naxcel) IM.
8. Trauma- An infant that has been rejected may have received traumatic wounds from the dam or other elephants. The wounds can be external, such as abrasions, lacerations, bruising, puncture wounds, etc.; or internal, such as fractures, trauma to internal organs. Diagnostic evaluations include physical examination (repeat frequently), aerobic and anaerobic culture and sensitivity of any infected wounds, radiology. An x-ray generator of 300 MA or greater will be necessary for all but the distal extremities. Anesthesia may be required to x-ray a calf that is not depressed or weak. Treatment may include minor surgery, major surgery, wound care +/- bandaging q 12 to 24 hours, antibiotic therapy, and analgesics depending upon the location and extent of the trauma.

Fluid Therapy

- Can be a critical therapy in the treatment of many different conditions.
- Adult elephant fluid requirement is approximately 30 to 50 ml/kg/day.¹ The infant requirement is likely to be higher. For example the Oakland zoo calf had an average milk consumption of 108 to 138 ml/kg/day (up to 11 months of age). Active disease and fluid losses can increase fluid requirement to 2 to 4 times maintenance.
- Subcutaneous fluid administration is not a good option for therapy due to limited SQ space. Fluid is of course well absorbed by the oral route, and this should be used whenever possible, although clear fluids such as electrolyte solutions should not completely replace milk for too long due to caloric reduction.
- Intravenous fluid therapy: a good tool when dehydration is present, especially if the calf is anorexic. It is difficult to maintain an IV catheter in an infant for continuous infusion. One option is to give fluid by intermittent IV bolus. No IV bolus should exceed 40 to 90 ml/kg, 20 ml/kg being preferred; and the fluids should be given as slow as possible (over 30 to 60 minutes). Anesthesia should be considered if the calf is extremely stressed by restraint for IV fluid administration.
- IV catheters: 18 gauge or 20-gauge intracath, placed in medial saphenous vein or ear veins. It may be difficult to thread an over-the-needle catheter through the skin on the hindlimb. Butterfly catheters can also be used but are difficult to keep in place, even for short periods. Use 2% lidocaine for catheter placement. Suture or apply surgical adhesive to help keep the catheter in place.
- Fluid type: Lactated Ringers is suitable for most cases. Do not add KCl if fluid is given as a rapid IV bolus. May add glucose to make a 2.5% or 5% solution if blood glucose is reduced.

Vaccinations

1. Tetanus toxoid- vaccination for *Clostridium tetani*. Has been given to adults, sub-adults and neonates at multiple institutions. Give 1 ml IM. First dose at 3 months age, second at 4 months. Consider an initial dose as early as the first day if calf has not received colostrum.
2. Tetanus antitoxin has been administered in adults, and could be considered particularly for use in a neonate with lesions likely to become contaminated with clostridium. However note that fatal serum hepatitis has occurred following administration of tetanus antitoxin to horses.
3. Discuss vaccination for other clostridial diseases with veterinarian. Deaths of elephants have been reported due to *C. septicum*, *C. botulinum* and *C. perfringens* (enterotoxemia), however vaccination has not yet been routinely recommended.
4. Discuss rabies vaccination with veterinarian. One death has been reported⁵. Vaccination of elephants for rabies is rare in zoos, and has not yet been routinely recommended. Calf should be greater than 3 months of age if vaccinated.
5. Discuss encephalomyocarditis virus vaccination in endemic areas with veterinarian. An experimental vaccine has been tested in zoos, however with varying results.
6. Any vaccination could result in anaphylaxis, an acute and potentially fatal systemic reaction. Elephants should be observed for one hour following vaccine administration. Treatment for anaphylaxis would be approximately 0.1 to 0.2 ml of 1:1,000 epinephrine per 100 lbs. body weight IM or SQ, or 0.25 to 0.5 mls of 1:10,000 dilution of epinephrine per 100 lbs. IV. These doses are extrapolated from equine recommendations.

Normal Vitals

No published normal values for neonates. See "Elephant Hand-Raising Notebook" for some examples.

- Temperature: Adults- 36 to 37° C (97.5 to 99° F) is normal. 38° C (100° F) or higher is elevated. Notebook: Oakland Zoo (OZ) calf no.1 temp. was between 36° C and 37° C taken over several months. Kaliningrad Zoo calf temp. was between 36.8° C and 37° C.
- Heart Rate: Adult average (unexcited) is 25 to 35 BPM. Notebook: OZ calf no.1 HR was 100 to 128 BPM during the first week.
- Respiratory rate: Adult, calm is 4 to 6 breaths/min. Adult, excited is 15 or more breaths/min. Notebook: OZ calf no. 1 rate was 22 breaths/min during the first week.

Normal Hematologic and Serum Chemistry Values

Refer to: *Normal hematologic values for young African Elephants with variations for sex and age*, Allen JL et al. Journal of Zoo Animal Medicine Vol. 16(3), p.98-101, 1985.

Blood gas values in juvenile Elephants, Heard DJ et al. Journal of the American Veterinary Medical Association, vol. 189 (9), p.1071-1074, 1986.

"Elephant Hand Raising Notebook", Kinzley, C., Oakland Zoo.

ISIS normals are available, however only for adults, separated by males, females, Africans, Asians.

Antibiotic Therapy

- Can be critical in neonates, especially in cases of FPT.
- No pharmacokinetic studies have been done comparing juvenile to adult elephants.
- Few studies have included captive African elephants, and the doses could vary.
- The number of elephants in the studies have been limited in number.
- Generally, however, the dosage ranges have correlated well with equine dose ranges, with the exception of Amikacin.
- The author prefers the use of ceftiofur, ampicillin, amoxicillin, or penicillin G; Amikacin or Gentocin in more severe infections, when hydration is maintained and if possible serum levels are measured. Do not use fluoroquinolones in growing animals. Avoid LA tetracycline due to the potential for muscle irritation or perivascular sloughing.

- Intramuscular or intravenous routes of administration are preferred to oral, due to the potential for iatrogenic diarrhea. Repeated IV doses in a calf would be difficult due to stress however, unless the calf was moribund.
- Table one offers approximate antibiotic doses. These should be used only as guidelines for use in infant elephants. See reference for further details.

Table 1. Antibiotic Therapy in Elephants (adults). Adapted from "Antibiotic Therapy in Elephants" in *Zoo and Wild Animal Medicine CT 4* by Fowler/Miller.³

A. Based on pharmacokinetic studies		B. Based on doses reported only	
Drug	Dose	Drug	Dose
Penicillin G	4545 IU/kg q 24 to 96 hrs IM; or 2272 IU/kg q 48 hrs IM	Ceftiofur (Naxcel)	2.2 to 4.4 mg/kg IM q 24 hrs IM; or 1.1 mg/kg q 24 hrs IM; or 1-2 mg/kg q 12 to 24 hrs IM. Do not use IV.
Amoxicillin	11 mg/kg IM q 24 hrs	Trimethoprim-sulfamethoxazole (TMZ-SMZ)	18.1 to 21.1 mg/kg q 12 to 24 hrs. Could cause diarrhea.
Ampicillin	8 mg/kg PO q8 to 12 hrs. Dose may be low for some organisms.**		
TMZ-SMZ	22 mg/kg IV or PO q12 hrs, for Asians. Do not use metabolic scaling. Safety of IV use in horses questioned.	Sulfadimethoxine/ormeto prim (Primor)	16.2 to 18.5 mg/kg q 12 h for one day, then 9.25 mg/kg q12 h; or 23.1 to 26.4 mg/kg q 12 h for one day, then 13.2 mg/kg q 12 hr.
Amikacin *	6 to 8 mg/kg IM q24 hrs. Potentially toxic.*	Amikacin*	4.4 to 4.7 mg/kg IV q 18 to 24 hrs.***
Gentamycin*	4.4 mg/kg IV or IM q 24 hrs. Potentially toxic.*		
Metronidazole	15 mg/kg/day as a rectal suppository		

* Aminoglycosides: potential for nephrotoxicity and ototoxicity. Use only when hydration is adequate. When possible, peak and trough serum levels should be measured. Note that this published gentamycin dose appears high and may result in high peak concentrations.

** Refer to the chapter Antibiotic Therapy in Elephants, *Zoo and Wild Animal Medicine, CT4*, by Fowler/Miller

*** The intravenous amikacin dose is based on the authors' experience.

¹ Fowler, ME: Zoo and Wild Animal Medicine. Philadelphia: W.B. Saunders, 1986.

² “Analysis of African Elephant Mature Milk in Early Lactation and Formulation of an Elephant Calf Milk Replacer”, by J. Parrott, presented at the AAZV Conference, 1996.

³ Fowler ME and Miller RE: Zoo and Wild Animal Medicine CT 4, Antibiotic Therapy in Elephants p.533. Philadelphia: W.B. Saunders, 1999.

⁴ “The Elephant Hand Raising Notebook”, compiled by Colleen Kinzley, Curator, Oakland Zoo, California USA, 1997.

⁵ Mikota, MK: Medical Management of the Elephant. Michigan: Indira Publishing House, 1994.