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Saving Lissa: How Training Aided in the Cancer Treatment of a Southern White Rhinoceros

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Meet Lissa

Lissa is a 37-year-old female Southern White Rhinoceros (*Ceratotherium simum simum*), one of twelve at Lion Country Safari (LCS), a drive-through safari just outside of West Palm Beach, Florida. The white rhinoceros has two horns; a larger primary, and a smaller secondary. These horns are composed of keratin, a protein also found in our hair and fingernails. Rhinoceros horn is so valuable in certain cultures, that all five species are threatened and face the possibility of extinction in the wild due to poaching. Three of the five rhinoceros species—Black (*Diceros bicornis*), Sumatran (*Dicerorhinus sumatrensis*) and Javan (*Rhinoceros sondaicus*)—are classified by the IUCN Red List as critically endangered with only 5055, 100 and 58 individuals remaining in the wild respectively. Rhinos are poached for their horns, which are then sold illegally in the wildlife trade as a purported cure for cancer and other ailments (IRF, 2015). However, in Lissa's case, it's her horn which was killing her.

Image 1: Lissa prior to having her horn removed.

In October of 2013, Lissa presented with an abscess and inflammation on the left side of her primary horn base. In addition, keepers noticed her horn started to develop an abnormal wear pattern (Image 2). After several weeks of antibiotic and regimented cleaning treatments, the abscess worsened, and a second abscess appeared. Because of this lack of progress, our veterinarians determined that Lissa needed to be anesthetized to further assess her condition.

Injection Training and Immobilizations

Like all rhinos at LCS, Lissa is trained to enter a chute and receive voluntary injections into her hump for annual vaccinations. Because this injection behavior was already established, adapting it into an immobilization behavior was relatively easy in the short time frame we were given to accomplish it. Typically, during a vaccination, our rhinoceros are continually reinforced for standing calmly in the chute throughout the procedure. Since Lissa was going to be under anesthesia, she would not be able to consume food the day of the immobilization, so we had to fade out reinforcement until only reinforcing after the mock hand-injection. In addition, we had to desensitize her to an item not typically used during a vaccination- a protective face shield which would be used as a safety measure while handling potent anesthetics. Finally, we had to take into consideration that our chute does not have a breakaway door, therefore it was important that after receiving the injection, she was trained to back out of the chute and into a

night pen. Once she was consistent with the above criteria, reinforcement was again faded out until she only received her jackpot after she had entered the chute, received the injection and then backed out of the chute.

Lissa's first procedure was in December of 2013. During this procedure, radiographs revealed an abnormality (a gas pocket) inside her horn. In order to assess this abnormality, the distal 2/3rds of the horn was removed just above what was discovered to be a large, necrotic mass extending up from the base of the horn (Image 3). Superficial biopsy samples were collected but unfortunately the results were inconclusive and additional samples collected from deeper within the mass were needed. Her next anesthetic procedure occurred twelve days later, and additional samples were collected. These samples confirmed that she had a very rare type of cancer- Fibromyxosarcoma. Neoplasia, or an abnormal growth of cells, is known as a tumor when formed and is uncommon in rhinoceros (AVMA, 2018; Miller, 2014). Additionally, there have only been two other documented cases of a rhinoceros developing cancer of the horn in captivity (Greer, 2010; Nandi, 1972).

In between Lissa's procedures, keepers and vet staff were tasked with keeping the site clean. Lissa was brought into the chute several times a day to flush and debride the dying tissue and apply topical ointments to prevent infection and promote healthy tissue growth. After several procedures and intense daily wound care, we faced another obstacle: Lissa would willingly enter the chute to train but would occasionally stand just out of reach. As treatment and training occurred in the same location (the chute), albeit at different times, we concluded Lissa was anticipating an uncomfortable cleaning treatment causing her to stand further away. By using a target, we were clearly able to convey to Lissa which session was to occur, increasing her willingness and cooperation.

Target

Training Lissa to come into the chute and touch her nose to a target allowed us to position her closer so that we could safely administer the injections for each of her subsequent immobilizations. Lissa would go on to have five additional procedures; seven total in a span of six months. Her primary horn was completely removed to give access to, and eventual removal of, the basketball-sized tumor growing beneath and within it and allow for several rounds of chemotherapy (Image 4). While this behavior was initially trained to meet a current need, it ended up having much broader applications and helped us to monitor her health post-operatively.

Radiographs

Following Lissa's anesthetic procedures, we needed a way to monitor her healing process and bone health. We elected to train her to voluntarily allow radiographs of her head. Inspired by a timely published article (Keeley, 2014) in the *Animal Keepers' Forum's* September Training Tales section on voluntary head radiographs on an Eastern Black Rhino, we put our plan into motion. First, we modified a door

Image 2: The first clinical signs: an abscess at the base and irregular wear to the primary horn.

Image 3: A large, cancerous mass was discovered extending up within the horn.

Image 4: Lissa during recovery after her final procedure with her horn completely removed.

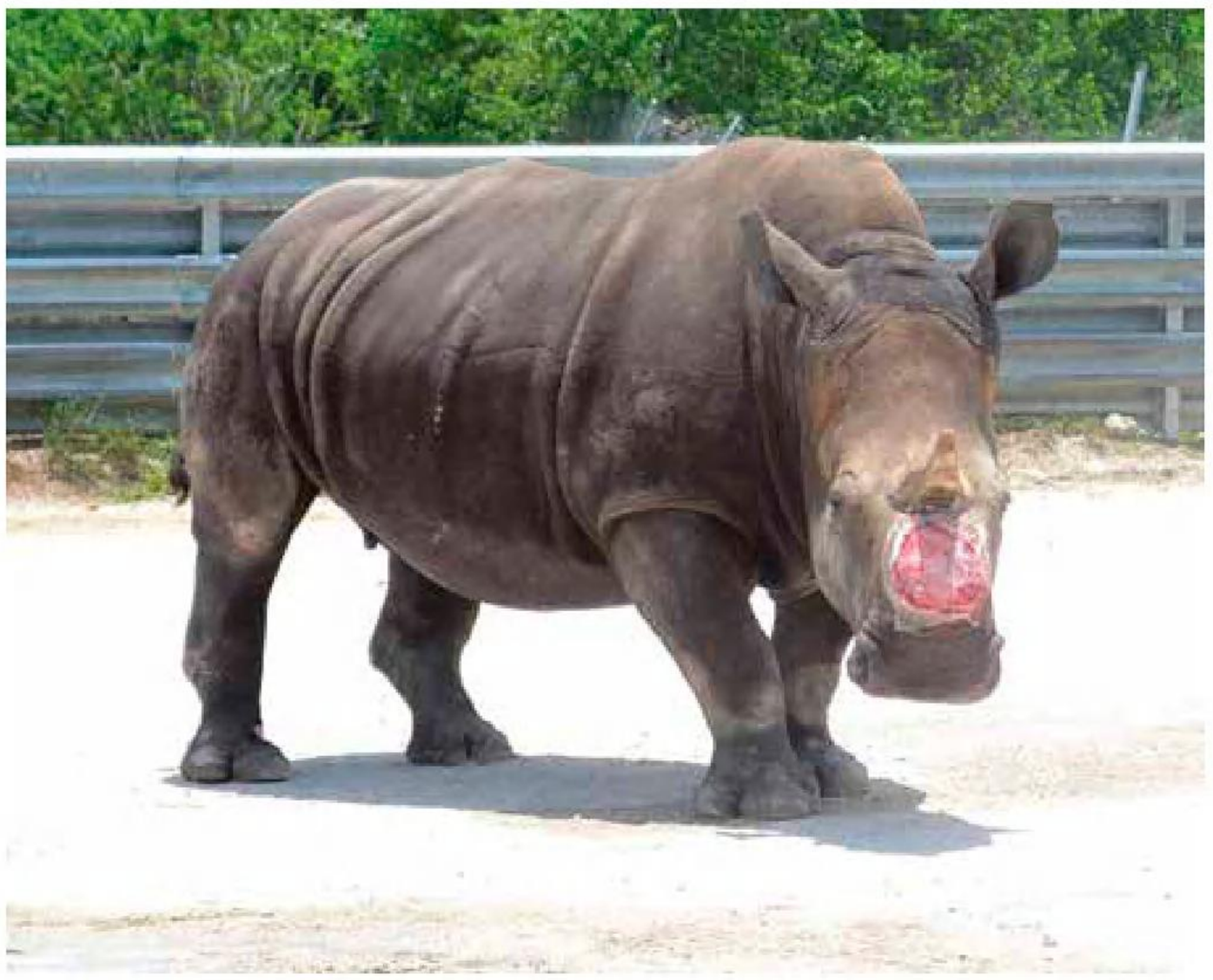

Image 5: Lissa during a radiograph training session with mock equipment- a painted cardboard box and artist's canvas.

Image 6: Lissa receiving her first post-operative radiographs.

in our chute that would allow Lissa to stick her head out of a window into the keeper area. Using her established target behavior, this was easily accomplished and allowed us to position her head and hold still long enough for a radiograph to be taken. Using a creatively made mock x-ray generator and imaging plate, smock aprons in the place of lead vests and oven mitts serving as gloves, we were able to desensitize her to all the equipment that would be needed to take x-rays (Image 5). It was also important to not only train her to hold her head completely still in order to obtain a clear image, targeting also aimed to keep Lissa from rubbing on or playing with the equipment as to avoid damaging it. After three weeks of training, we were able to successfully take our first post-operative radiographs in October of 2014 (Image 6). These radiographs showed an irregularity to the bony surface under her horn that would need to be monitored closely. Images were then taken every 4-6 weeks for the next two years while her horn was healing to monitor for osteomyelitis, an infection of the bone. Radiographs were also taken on several other members of our herd for comparative purposes. With time, radiographs became less concerning and today images are taken every three months.

Recently keepers noted that Lissa has started eating more slowly and that she has not been maintaining her weight. With a few simple modifications to the radiograph training plan for her horn, we were able to successfully take images of her teeth to see if there was an underlying dental issue (Image 7). When taking images of her horn, the plate and generator are aligned horizontally so that a lateral view may be obtained. In this case we needed to alter our positioning so the image isn't distorted by the overlapping of her teeth from one side to the other to allow each side to be evaluated separately. This was accomplished by having the person holding the generator stand on an elevated surface so that the machine could be angled downward at a 45-degree angle while the plate was aligned lower along her jawline, so an oblique radiograph could be obtained. The bed of a pickup truck parked in front of the chute window provided a steady, elevated platform to achieve the height needed to capture the images (Image 8). Living in a drive-through safari, Lissa is used to standing amongst vehicles so this desensitization did not pose much of a challenge. However, one very important criterion had to be changed- Lissa was previously taught never to touch the equipment. Rhinos have thick skin and a very dense skull. While prior imaging of her horn and sinus cavity were easily taken, to get a clear radiograph of her teeth, the power, or kVp (kilovolt peak) and mAs (milliamperage-seconds), on the generator had to be increased and the imaging plate had to be pressed firmly against the bottom of her jaw.

Image 6B: Lissa receiving her first post-operative radiographs.

Image 7: A radiographic image of her teeth

Once her head was properly in position, she was trained to hold still and allow vet staff to bring the plate to her rather than her move towards the plate. This allowed us to be in control, minimizing the risk of her damaging the plate. Also, it helped us maintain the 'head hold' criterion for future horn radiograph sessions.

Fly mask

During the day, the rhinoceros herd at LCS is released onto a 35 acre mixed-species habitat along with 60 plains zebra, 12 wildebeest and a hartebeest. At night, or while under medical care, the rhinos are housed in a smaller area where there is a marked increase in the concentration of flies. Efforts were made to reduce or eliminate fly populations including installing fans for air circulation, weekly removal of midden piles, installation of purple martin nest boxes, the use of fly traps and other repellents. Despite use of these deterrents, flies remain a concern as they have been known to cause eye ailments within our rhino herd including Habronemiasis. Habronema is a parasite which can cause severe inflammation of the conjunctiva surrounding the eye, spread through larvae on feeding flies, which over time can possibly lead to vision impairment and ocular ulceration (Horowitz, 2015). In December 2016 while being housed off-exhibit for treatment, Lissa started showing clinical signs of Habronemiasis including ocular discharge and inflammation, therefore it became crucial to keep flies away from her eyes. A simple solution was formed, Lissa needed a fly mask. Our plan had one main problem though, rhinoceros fly masks are not commercially available, and so we decided to modify an equine mask (Professional's Choice Wrangler Fly Mask. 2025 Gillespie Way Suite 106 El Cajon, CA 92020. profchoice.com).


Image 8: Jen standing on an elevated platform while Dr. Anne brings the mock imaging plate towards Lissa's jaw for radiographs of her teeth.

First, we elongated the chin and ear straps. Pieces of Velcro® strap sewn on the ends gave us the length we needed as well as the breakaway factor we desired. The next issue we faced was her secondary horn. We needed to modify the mask so it would fit flush around it. As horses do not have horns, the fabric would bunch up rather than lay flat against her face allowing access points for flies to get underneath. By cutting around her horn and attaching a buckle strap as well as an additional face strap we were able to accomplish this (Image 9). Cutting down the center of the mask to give it more length to completely cover her eyes was our final step. Left with two halves we elected to reattach them with string, corset style, rather than simply sew a piece of fabric in between. This would allow us to adjust the sides as needed (Image 10,11). By modifying the mask in stages, it allowed us to get the proper fit and allowed Lissa to get used to each new element, one strap at a time, in approximations--rather than us simply putting the finished product on her all at once.

Once the mask was constructed, and we had desensitized her to wearing it in the chute, two final factors had to be met. First, a vision test. Rhinos already have poor vision and we were not sure how much the fabric covering her eyes would further affect it (Image 12). However, as Lissa is target trained we had an easy way to check. By asking Lissa to target to various target positions, we were confident that the mask did not impede her vision. Second, her daughter Eliza, who was being held back from the herd as a companion would need to tolerate the mask on her mother. With Lissa in one section of the chute, Eliza was given access to the opposite compartment so they could howdy face to face to check for any negative reaction to the foreign object on her mother's face. Once those were accomplished, we were able to release her into the pen wearing the mask. Day by day, we gradually


Image 9: Her secondary horn prevented the fly mask from lying flush with her face.


Image 10 and 11 (varying angles): Our final modified equine fly mask

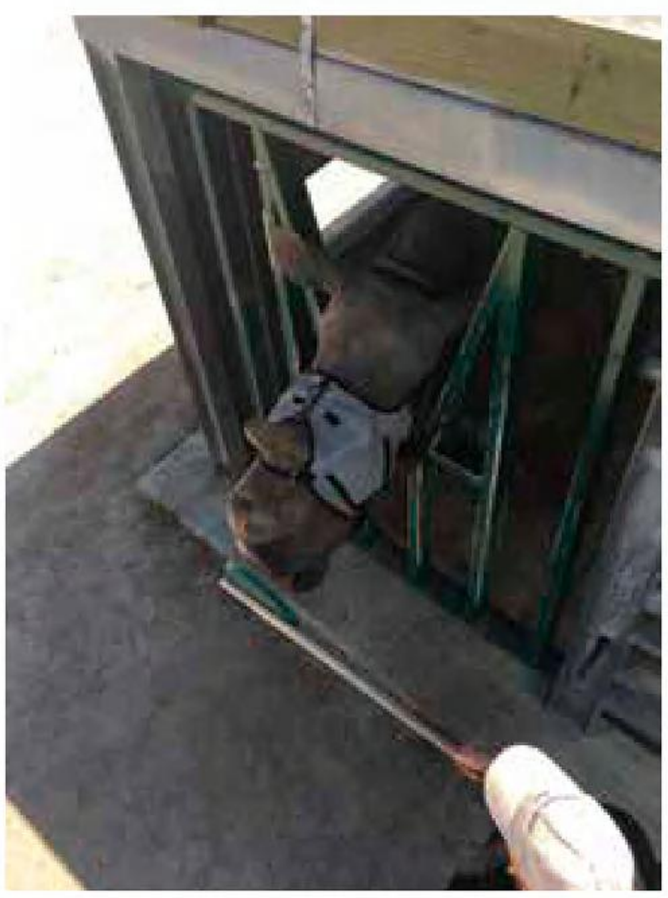

Image 10 and 11 (varying angles): Our final modified equine fly mask

Image 12: Lissa targeting to a frisbee during a vision check

Image 13: A treatment window, which gave the ability to administer eye meds without removing the mask.

increased the length of time Lissa wore the mask. On days she seemed uncomfortable (i.e. rubbing her face on items in the exhibit, hanging around the chute), we listened to her cues by removing it. Soon Lissa would willingly wear the mask all day. Not only did the mask successfully keep flies away from her eyes, it had additional unanticipated benefits. Lissa appeared to squint less and had less eye discharge- the mask was acting as a visor, shielding some of the sunlight from her irritated eyes.

At the same time, the mask did present some obstacles. We learned that if Lissa was wearing the mask, she could not have access to a mud wallow as the mud would cake on the screen of the mask, which impaired her vision. Aside from enjoyment, wallowing has numerous health benefits for rhinos, it provides a way for them to thermoregulate or cool themselves off, provides UV protection from the sun protecting their skin from burning as well as acts as a deterrent to biting insects (Higgins, 2013). To make up for the lack of a wallow on sunny days keepers would give her mud baths, smearing mud on her back by hand. Another drawback to the face mask was her mid-day eye treatment. In order to medicate, the mask had to be removed, and then put back on after administering her eye drops. We quickly realized the mask needed a treatment window: a flap that could be raised and lowered to give access to her eye without having to remove the mask entirely.

With our design and sewing capabilities capped, we reached out to a fly mask vendor, Equine Sun Visor, about designing a custom mask. After giving them a list of our needs as well as pictures and measurements of our current mask and Lissa's face, they were able to construct a prototype. Once in hand, we were able to mark any areas of fabric that needed altering, the location of Lissa's eye for window placement as well as proper strap location. We also requested a piece of Velcro® be attached above the window so the flap could be held open during treatment (Image 13). Wanting the mask to be universal in sizing and able to fit other rhinos in our herd should the need arise, we also trained our largest male to wear the prototype so that his measurements could be notated as well (Image 14). Today we have a custom mask that is able to meet all of Lissa's medical needs. (Image 15).

In our training and designing process for the fly mask, safety remained a top priority. All straps on the mask had to be breakaway should she get caught on something. Additionally, the mask is only to be worn during hours that a keeper is present for monitoring. Placement and removal of the mask requires two trained staff and only takes place in a chute, where both sides of her face can be accessed and to eliminate the risk of her walking away with the mask partially on. When putting the mask on, an extension strap (a removable piece of Velcro® with a ring on the end) is temporarily attached to the end of the mask chin and face straps so the strap can be safely passed under her head from one person to the other with a snake hook used to hook the ring. Once in hand, the extension can be removed, and the strap snuggly attached.

Conclusion

Throughout Lissa's case, one common theme emerged: We were ready! Each new behavior trained not only achieved the current goal, but was vital to the success of the next. Injection training made way for an 'immobilization' behavior, which then evolved into a targeting behavior. Targeting then allowed for radiograph training and the ability to test her vision while wearing a fly mask - a behavior achieved in part from the desensitization of her face being touched and manipulated during treatments. They all circled back, interdependent on one another.

Training played a fundamental role in Lissa's recovery. It reduced stress and allowed her to be a willing participant in her own medical care. Without her cooperation, successful treatment may not have been possible. Today Lissa is in remission and her horn is slowly starting to regrow… something we were

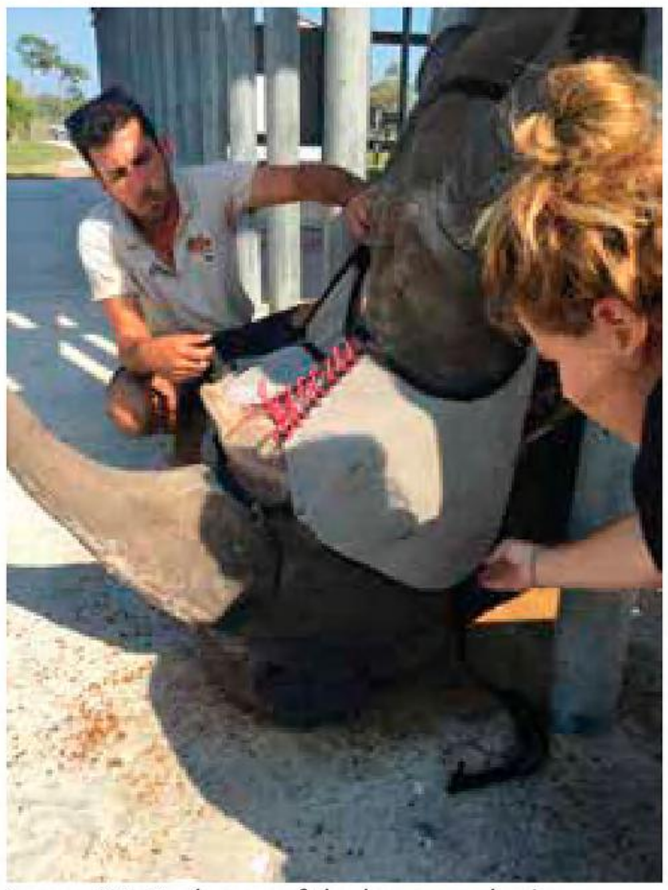

Image 14: Buck, one of the larger males in our herd, being fitted in the prototype with denotations for eye location and strap placement.

Image 15: Lissa wearing the finished Fly mask (Equine Sun Visor by EquiTek. 6628 Bell Court San Diego, CA 92111. equinesunvisor.com)

unsure would happen. While the horn may never look the same as it once did, it's distinctly jagged, stunted appearance serves as a constant reminder of all that she has overcome.

Acknowledgements

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Image 16: Lissa today