Sidedoor: Season 11, Episode 18 – Zoo's Clues

Lizzie Peabody: Hey there, Sidedoorables. A quick note to say today's episode is an eye-opening dive into veterinary medicine at the Smithsonian's National Zoo, but it could get a little graphic for some people. So if it's not your thing, I'm gonna give you a chance to turn it off while I recite some Shakespeare. And I hope they don't edit it out.

Lizzie: [clears throat] To be ...

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Lizzie: This is Sidedoor, a podcast from the Smithsonian with support from PRX. I'm Lizzie Peabody.

Lizzie: As we now know, COVID-19 didn't just affect humans. There were reports of cats and dogs catching it—even hamsters. And it wasn't only pets.

*[**NEWS CLIP:** Now even zoo animals are coming down with the virus. Six lions and three tigers—that's right—at the National Zoo are being treated right now for COVID-19.]*

*[**NEWS CLIP:** Zoo staff noticed the animals were coughing and sneezing, lethargic with decreased appetites. Right now, they are being treated with various medications.]*

Lizzie: This outbreak happened about a year and a half into the pandemic. And happily, all the lions and tigers recovered. But about six months later, one of the lions started acting funny.

***Kali:** She started to show differences in her chewing. Just the coordination of her jaw was a little bit off, and the coordination of her tongue was a little bit off.*

Lizzie: This is Kali Holder. She's a veterinary pathologist at the Smithsonian's National Zoo and Conservation Biology Institute. She says the lion, Naba, was one of the oldest in the pride—about 19 years old—or 92 in cat years. Dental issues are common in old cats, so everyone thought ...

***Kali:** Oh, she probably just has a sore tooth, or something's going on in her mouth that is dental.*

Lizzie: Kali shows me a video of Naba eating a nice juicy hunk of red meat.

Kali: *So this is her. And she is our sweet old lady, and she's being hand fed.*

Lizzie: *Oh my gosh!*

Kali: *She's got the tongs of meat going in there, and she is chewing, but you can see that her tongue is moving oddly, and her jaw's moving a little oddly. And it looks like she's just having trouble coordinating, moving the piece of meat around in her mouth.*

Lizzie: Naba looks like she's trying to get peanut butter off the roof of her mouth. She had a team of people caring for her, so she wasn't gonna starve. But this was still concerning, especially when it didn't get better, even after months had passed.

Kali: *Then she started losing weight.*

Lizzie: Anyone who's had an older house cat knows that kidney problems are common. Same with lions. That could be the problem. But the vets treated her for kidney and dental disease, and Naba kept losing weight.

Kali: *That's where we go, "Does she just have progression of her renal disease, or does she have a new problem?"*

Lizzie: They suspected she may also have developed cancer. Vets considered all the medical options and weighed that with the fact that Naba was a stately, elderly cat. They didn't want to put her through painful or uncomfortable treatments if there wasn't a chance of recovery.

Kali: *And so that's when the decision was made that she does not have the opportunity to have a good quality of life. This needs to be the end.*

Lizzie: Naba had to be euthanized. And after an animal dies at the National Zoo, that's when it goes to Kali's lab. As a pathologist, it's her job to dissect dead animals and learn what led to their death—a process known as a necropsy. And when Kali examined Naba's internal organs, she discovered a cancerous tumor in the lion's intestines.

Kali: *Most of the intestine, I can put my whole arm down. They're very stretchy. But that section was not letting anything past.*

Lizzie: That explained the weight loss, but it didn't explain why she'd been chewing so oddly. Kali thought, "Okay, if it's a neurological issue, the answer will be in Naba's brain." So when it came time to examine her brain, she was expecting ...

Kali: *We were gonna find a meningioma or something else like that. So maybe an intracranial tumor, a brain tumor. That is not what I found at all.*

Lizzie: Sometimes at the National Zoo, the end of the line for one animal can mean the frontline for saving others. This time on Sidedoor, we're heading through a very special side door of the National Zoo—one only a few people ever go through: the necropsy lab. So put on your rubber gloves and scrubs, and get ready to solve some forensic mysteries—including what happened to Naba's brain.

Lizzie: That's coming up after the break.

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Lizzie: Just up the hill from where visitors stroll the Smithsonian's National Zoo with Dippin' Dots and red slush drinks in hand is the zoo's veterinary hospital.

Lizzie: *Oh, this is like my favorite kind of building smell. It reminds me of, like, every library, and all of my schools.*

Lizzie: Kali Holder is showing me to her office here at the hospital.

Lizzie: *K. Holder.*

Kali: *With the bike and the skulls.*

Lizzie: *D-V-M-D-A-C-V-P.*

Kali: *Yeah.*

Lizzie: *It's a lot of initials.*

Lizzie: Those initials essentially mean Kali is a veterinary pathologist. She studies animal

cells and tissue under a microscope. She also does postmortem exams on dead animals. As she puts it ...

Kali: *I say I do pieces of live things and whole dead things, but no whole live things.*

Lizzie: Let's just say for someone who spends so much time near death, Kali is full of life. Ebullient, if you will. Besides her purple hair and her sense of humor, her office is—well, colorful.

Lizzie: *I see glass jars full of amber-ish liquid. And vaguely ...*

Kali: *Specimens!*

Lizzie: *Yes. Biological-looking things.*

Kali: *Specimens!*

Lizzie: *Also, is this unicorn meat? For real for real?*

Lizzie: There's a little tin on a shelf labeled "Unicorn Meat."

Kali: *And if you open it up, it has little stuffed unicorn bits.*

Lizzie: *Oh my gosh! [laughs]*

Lizzie: To be clear, this is not a real unicorn. It is a stuffed animal cut into bits. And these unicorn bits are sitting right next to an antique microscope, like something you'd see in the 1800s.

Lizzie: *Okay, right next to this antique microscope is an enormous skull.*

Kali: *Oh, they get bigger.*

Lizzie: *What is it?*

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Kali: *So this is a baby elephant.*

Lizzie: *What?*

Kali: *Yes.*

Lizzie: This baby elephant skull is about the size of a human torso. And as I look around the office, I start to notice there are a lot of skulls in here.

Kali: *Yeah.*

Lizzie: *Is that a beaver?*

Kali: *That is a beaver. Well identified!*

Lizzie: *Yes!*

Lizzie: And one skull has horns longer than my legs, even though the skull is maybe only a foot long. It belonged to Jena, a highly-endangered antelope called a scimitar-horned oryx, who died giving birth.

Kali: *She was right at term too, and they lost both the cow and the calf. And it was devastating for the team. It's one of those lessons you have to learn that you can do everything right and still have a bad outcome.*

Lizzie: *And you have her sitting on your desk next to you every day.*

Kali: *Every day. Every day. Don't—don't get too proud. Stay humble. Biology's gonna biology, life is gonna life, and you will—you will never be able to solve for all of the variables. You will never be able to control everything, but you can learn from it. And sometimes that's all you can do, unfortunately.*

Lizzie: Learning from death. Besides the cosmic exercise of it all, it's important on a practical level. Any time an animal dies at the zoo, whether it's a flamingo, an elephant, a snake, a piece of coral or a miscellaneous squirrel passing through that happens to drop on the spot,

that animal comes to the zoo's necropsy lab. And it's the pathologist's job to learn as much as possible about why that animal died. Because that animal could help keep other animals alive.

Lizzie: Now most of the time, Kali says, when an animal dies, it's pretty cut and dry. Like a toad with a kidney problem—which I learned is common. Or a gorilla with heart disease. But sometimes, nobody knows what the heck is going on, and it falls on Kali to search for clues. Like the case of the dizzy kudu.

Lizzie: If you've never seen a kudu, well you're missing out. They're native to Africa, and they look like a huge antelope with a flare for the dramatic: a hump back, big perky-up ears and stripes.

Kali: *And the males have long spiral horns. They're absolutely stunning animals.*

Lizzie: One day in early 2024, a keeper at the National Zoo noticed that one of the kudus named Gal was sort of stumbling around.

Kali: *She just wasn't as coordinated as she might otherwise have been. And we were concerned. And it kept getting worse.*

Lizzie: The zookeepers thought well, maybe Gal hurt one of her legs. But she wasn't exactly limping. She was sort of staggering.

Kali: *Tripping, with multiple issues there. That to us, we're worried about weakness. So muscle problems or neurological problems.*

Lizzie: Vets found no obvious problems with Gal's feet or legs. So they thought, okay. Well, maybe Gal ran into something and bumped her head—which is apparently very common.

Kali: *Antelope are, in general, very prone to trauma.*

Lizzie: *Prone to trauma because they do a lot of leaping and bounding?*

Kali: *They're leaping and muscular and strong and they run into things.*

Lizzie: *Okay.*

Kali: *And they startle. You get a bad storm, and the chance of one of them running into a solid object is non-zero.*

Lizzie: *Okay.*

Kali: *This is true in the wild as well as in human care.*

Lizzie: *Okay.*

Kali: *This is one of the most common causes of mortality in the wild.*

Lizzie: *Is just bumping into things.*

Kali: *They run into stuff. But sometimes what they run into is a lion, but sometimes it's a tree. [laughs]*

Lizzie: Gal obviously did not run into a lion, but she may have run into a tree or a wall. She was definitely stumbling.

Kali: *And it got progressively worse to the point where she was what we would call dog sitting. So the ruminants, they don't sit like dogs do. That's not normal.*

Lizzie: *Oh!*

Kali: *And she was progressing to that dog-sit position.*

Lizzie: *Like up on her haunches with her front legs straight?*

Kali: *Yes. She was on haunches with her front legs straight. And that is not normal.*

Lizzie: *Oh.*

Kali: *And was having trouble getting up. That to us means that she is not improving and her quality of life is poor. So at that point, she was—they'd tried various different treatments, and she was euthanized.*

Lizzie: If you've ever had to euthanize a pet, you know how hard a decision this can be. Zoo vets only choose this option if an animal is suffering and there's no chance it can recover. And so after Gal was euthanized, Kali got to meet her. Hopefully, she could solve the mystery of the dizzy kudu.

Lizzie: If Gal had, in fact, suffered brain damage or some sort of neurological trauma, Kali was going to have to dissect the spinal cord. Not an easy job.

Kali: *It takes a lot of sawing and a lot of cutting away to get to a spinal cord. And you have to look at the whole thing.*

Lizzie: *Every single vertebrae.*

Kali: *I mentioned that they're not small antelope, they're a good size. It was a task!*

Lizzie: Kali got to work, cutting away the bone to get to the spinal cord inside. And when she did ...

Kali: *Didn't see any evidence of trauma—darn! Because trauma's a nice answer.*

Lizzie: Darn. If there was no trauma, what made Gal dizzy? After her gross examination—"gross" meaning anything you can see with the naked eye, not disgusting—Kali sent out pieces of the spinal cord to be put on microscope slides. And when she got the slides back and looked at them ...

Kali: *I see areas of necrosis that are in lines, right? So necrosis means death. So I'm seeing pieces of tissue that have died.*

Lizzie: *In the brain.*

Kali: *In the brain and spinal cord.*

Lizzie: Lines of dead tissue in the spinal cord and brain, like tracks made by something moving.

Kali: *That's all I've got. I've just got dead tracks. And I went, "Dang it!" Because I had a pretty strong suspicion of what it was.*

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Lizzie: Kali's suspicion turned out to be right. The culprit was worms.

Lizzie: *Worms?*

Kali: *Worms. Nematode worms had gotten into her spinal cord, and were tracking through the tissue and causing these dead tracts.*

Lizzie: Nematode worms are tiny—only a millimeter or two long. And the worms were long gone, but the tracks they left behind were as clear as day.

Lizzie: *God. I just got a full body goosebump situation.*

Kali: *Yeah, it's pretty gross. It's pretty gross.*

Lizzie: Kali was hot on the trail of these worms. But before she could get confirmation that she was right, another kudu named Rogue started staggering. Knowing just what to check for this time, vets took a sample of her spinal fluid.

Kali: *And that kudu had evidence on her cerebrospinal fluid tap of—that was also consistent with these worms.*

Lizzie: This was becoming a big problem. There were three kudu at the zoo. Had these worms gotten to all of them? What was even more puzzling is that the kudu had been given deworming medicine just a few months before. And you might be thinking, "Well, why not deworm them again?" Well, they did. But ...

Kali: *Nematodes in the brain are not better when they're dead nematodes in the brain.*

Lizzie: *Oh.*

Kali: *So you can deworm them, but now you have a dead worm in your brain, or you have multiple dead worms in your brain. And dead worms in the brain is actually really bad, because worms—the nematodes themselves have the ability to kind of hide from the immune system. But once they're dead, they lose that ability. And then the immune system goes, "Oh my God, I've got a worm in here!" And there's a lot of inflammation that happens. And now you have not just death from the worm moving, you have inflammation that's causing more*

damage to the brain and spinal cord in this case.

Lizzie: Despite treatment, Rogue got worse. So she was also euthanized. There was now only one kudu left—Jamilah. It wasn't clear if she had worms or not, and nobody knew where these worms came from.

Lizzie: *Is it the kind of thing that can move from one kudu to the next? Is it contagious?*

Kali: *It's not. It's not contagious from kudu to kudu.*

Lizzie: *Okay.*

Kali: *It's not contagious. So that was a big concern, right? Why are both of these animals getting hit?*

Lizzie: Kali and the other vets did a little detective work. The three kudu had recently been moved from their enclosure on the Africa Trail so it could be renovated. And their new enclosure ...

Kali: *While it was still protected from wildlife, it was downhill from an area that did have access to wildlife. And the worm that we very much thought that this was, is called parelaphostrongylus tenuis, which is P-tenuis. So P-tenuis, it's a deer worm.*

Lizzie: The deer worm, P-tenuis, doesn't cause a problem in the white-tailed deer that are native to the DC area. But when these deer poop, the worms pop their little heads out like little hitchhikers and say "I need a ride." And one of the things that is really easy for them to hitch a ride on are slugs. Which is bad for kudu because it's really easy for an herbivore munching grass to accidentally munch a slug on a piece of grass.

Kali: *So we don't know if it was runoff, just straight up water that was washing feces down, or if it was slugs moving into the enclosure. But something from that watershed was allowing the movement of these nematodes into that paddock.*

Lizzie: Kali and the team had figured out that worms were the culprit. And they'd figured out a few ways the worms might have made their way into the enclosure. But there was still Jamilah, the last kudu. Luckily, she hadn't shown any signs of dizziness. But she was all on her own, and kudu are herd animals. They need buddies. So the vets said, "You know, let's get her out of here and find her a new herd at another zoo." And I am happy to report to you that Jamilah is living worm free in St. Louis. Unbothered.

Kali: *She's thriving. [laughs] Moisturized and thriving and unwormed.*

Lizzie: *[laughs] I love that for her. Thank goodness we have a happy ending.*

Kali: *Yeah. It was—it was devastating for us to have that in the herd, but I'm really glad that we were able to solve it fast enough that everybody was able to save that last gal.*

Lizzie: Kali spends most of her time with dead animals. That's her job. But it's all in the service of that happy ending—quickly solving a mystery to save the rest of the herd, or pride, or school. Of course, she still finds plenty of opportunities to visit the living animals at the zoo's hospital.

Kali: *Every once in a while, there'll be an animal up here for a wellness exam, and I get to boop a snoot.*

Lizzie: *Boop a snoot?*

Kali: *Oh, I boop a snoot given the opportunity. I boop a snoot like you wouldn't believe.*

Lizzie: *Oh, is that just to touch an animal's nose?*

Kali: *Touch the nose. Boop the snoot.*

Lizzie: *I didn't—okay, now it makes perfect intuitive sense.*

Kali: *Or I take pictures of toe beans. I love me some toe beans. Yup.*

Lizzie: Kali obviously loves animals, but she didn't start out as a kid dreaming of becoming a vet so she could work with dead ones.

Kali: *No. Nope.*

Lizzie: *Was it love of animals that kind of initially drew you?*

Kali: *It was a hundred percent love of animals. I've always loved animals. I've always been*

really motivated by conservation. And so the opportunity to be a conservation pathologist as a career, I mean, I didn't know that that was a thing. Nobody tells kids that, right?

Lizzie: But when Kali got to college, she investigated her first animal death. It was an osprey—a hawk-like bird that eats fish. And something just clicked.

Kali: *I went, "Oh, that's it. That's—that's the thing!"*

Lizzie: Her professor at the time was a zoo pathologist.

Kali: *And I was a little extra. Like, I went up to him after the class and was like, "How do I get your job? I want your job." And he was like, "Wow! The enthusiasm." I don't know. Some part of him was probably like, "Okay, kiddo." You know?*

Lizzie: He didn't run from this overzealous undergrad, though. He took Kali under his wing, helping her navigate a long educational journey through vet school, postdocs and fellowships that ultimately landed her at the National Zoo.

Lizzie: There are more than 200 animals on display at the Smithsonian's National Zoo. And the circle of life in a zoo has a much longer circumference than in the wild. That's because zoo animals don't have to worry about being eaten at every turn. They're surrounded by keepers and vets to keep them happy, healthy and safe their entire lives. Which means that zoo vets see a lot of ailments you probably wouldn't find in the wild. Things like ...

Kali: *Kidney disease is a thing that we see a ton of in our old amphibians, right? An old amphibian that is not managing its fluids and minerals super well in the wild is going to become a delicious snack.*

Lizzie: *Very soon.*

Kali: *Whereas here we can do some supportive care. They're not at risk of being predated. They will live for decades! Decades!*

Lizzie: Long enough to get things like heart disease, arthritis and cancer. That is, of course, except for one animal ...

Kali: *Naked mole rats, I like to say that cancer doesn't kill naked mole rats. Naked mole rats kill naked mole rats.*

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Lizzie: When we come back, we burrow into the bite-throat world of naked mole rats. It's like a *Game of Thrones*, except everyone is naked and killing each other. Okay, so it's exactly like *Game of Thrones*. We'll also follow Kali to Kenya to investigate a mysterious skin disease affecting an animal with the toughest skin on the planet. Stick around.

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Lizzie: Naked mole rats are an enigma.

Kali: *Not a mole, not a rat. It is a rodent. It is smaller than a typical, like, brown rat. And I would say, like, twice the size of a field mouse to three times the size of a field mouse.*

Lizzie: They look exactly like a naked mole—or rat. Okay, mole rat. They're pink and furless, except for inside their mouths they have some fur.. And they have these gigantic front teeth that they can move independently of each other like chopsticks. And the teeth are just totally disproportionate to the size of the rest of their body. I gotta be honest, the kudu are as epic as the mole rat is horrifying. Don't google images of them alone in the dark, it will haunt your nightmares.

Kali: *They have jaws and teeth that can chew through brick.*

Lizzie: *What?*

Kali: *And they're made of squishy soft tissue. So, if one of them decides ...*

Lizzie: *They're all armed!*

Kali: *Yeah, they're all armed and very dangerous.*

Lizzie: And this is what makes life for a naked mole rat so brutish and potentially short. Because they're armed, and they live in a society where status reigns supreme.

Kali: *They have one queen; she's the one who does the reproducing. And then there are one to three males that are the chosen "men folk." And then everyone else is a worker that does not do any of the reproductive stuff, just does colony stuff.*

Lizzie: *Just, like, digs holes?*

Kali: *Just digs holes and finds food and cuddles. It's a lot of cuddling. That's very important.*

Lizzie: *Oh, that sounds nice.*

Lizzie: It is nice, I suppose. Until the queen dies. Which was the case when I was at the zoo. Kali had recently performed a necropsy on the queen after a fatal coup attempt ended her five-year reign. Remember, cancer doesn't kill naked mole rats. Naked mole rats kill naked mole rats. And her death sparked a game of thrones.

Kali: *So once one queen dies, then the females that were being suppressed are now gonna have to battle for queenhood.*

Lizzie: *So, like, by fighting to the death?*

Kali: *Mm-hmm. Mm-hmm.*

Lizzie: *[gasps]*

Kali: *Most animals, when they fight, it's a dominance display. And when one animal seems like they're the stronger, the other one will be like, "You know what? I'm good. And peace out." These don't.*

Lizzie: The strongest females will fight to fill the vacuum left by Queen Xena. You have the young and ambitious social climber, Gabriella. But you also have the power hungry opportunist, Callisto. Both with eyes on the throne. Side note: Naked mole rats actually don't have names because it is impossible to tell them apart, so I'm giving them these names and character traits for illustrious purposes.

Lizzie: And these females aren't just trying to knock off the competition. They're racing to get pregnant, because the first one to have a healthy litter of naked mole rat pups will wear the crown.

Kali: *That's the thing that kind of makes a successful queen is that she survives through a pregnancy.*

Lizzie: So if Callisto gives birth to a healthy litter and survives, the colony rallies behind her. Long live the queen! Order is restored. Well, okay. Actually, not yet.

Kali: *And then the males start to fight for status to be the favorite of the new queen.*

Lizzie: Just because you were tight with the old queen doesn't mean you'll be in the inner circle of the new queen.

Kali: *She might have her own ideas of who she likes best.*

Lizzie: *Oh my gosh! Okay, I'm tuning in.*

Kali: *Naked mole rats are so metal. And they're tiny, and in that hideous-cute overlap.*

Lizzie: *The jolie laide, as the French say.*

Kali: *Yes. Yes. [laughs]*

Lizzie: By the time you hear this episode, a new queen may have been crowned. But who knows how long her reign will last?

Lizzie: *Oh, thank you. Whoa! Oh, it's the boot zone.*

Kali: *The boot zone.*

Lizzie: *Do we have to take our shoes off?*

Kali: *No.*

Lizzie: I'm entering Kali's lab. It's a large room with stainless steel counters, walk-in refrigerators and freezers, big vents. Kind of like an industrial kitchen, except for all the forceps and scalpels. And the hook on the ceiling.

Lizzie: *Yeah, so I see there is this sort of track going across ...*

Kali: *Mm-hmm.*

Lizzie: *... the ceiling. And on it is ...*

Kali: *A one-ton hoist*

Lizzie: *Wow! For elephants?*

Kali: *Oh, no. Our elephants are far more than a ton. [laughs]*

Lizzie: This is where Kali would dissect Queen Xena, and any of the naked mole rats killed during the regime change—or really, any dead zoo animal bison-sized or smaller. And that track on the ceiling has a chain hanging down with a hook on the bottom. So when, say, a gazelle dies at the zoo and it arrives in the loading dock outside Kali's lab ...

Kali: *I'm gonna roll up the big rolling door.*

Lizzie: *Uh-huh?*

Kali: *And we are gonna bring the hoist out, and we are gonna hook that hoist through the Achilles tendon of the leg.*

Lizzie: *Really?*

Kali: *Yeah. So we'll make a hole just inside the—just interior tendon, and hook through the tendon, pull it off. And then we'll weigh it. This is a scale.*

Lizzie: *Oh, wow!*

Lizzie: I'm standing on a big floor scale and didn't even realize it. And I'm sorry if this is getting a little graphic, but hey, you've made it this far, so you should be okay. The next thing Kali would do with a gazelle is set it on a big stainless steel table and give it a quick rinse. Then she'd look it over for any obvious trauma on the outside of the body.

Kali: *And then we will probably reflect one of the limbs. So that just means we're going to take our knives and we're gonna cut at the joint, and start to move the limbs in a way that they are off behind the animal.*

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Lizzie: *Kind of like butterflying?*

Kali: *Yeah. We're gonna butterfly it open.*

Lizzie: Then Kali will open up the main body cavity to get to the organs.

Kali: *That means we're gonna have to go through the ribs, right? So we're gonna have to take those big loppers and we're gonna have to go through the ribs. Take the ribs off, gotta remove the diaphragm, all of that. And we're gonna look at everything in there.*

Lizzie: Kali then takes out every organ one by one. She slices them in a process known as "breadloafing," taking organ samples to later examine under a microscope. I won't go into the entire process of necropsy, but that's sort of the general idea. Kali says she's like a surgeon, except ...

Kali: *When I take something apart, it doesn't have to work at the end.*

Lizzie: *[laughs]*

Kali: *Surgeons have to put things back together.*

Lizzie: But Kali spends just as much time with a microscope as she does with a knife. And she isn't always working in the lab—or this lab. Kali has helped solve problems half a world away. Back in 2016, veterinarians in Kenya reached out to Kali's supervisor at the National Zoo.

Kali: *They said that they had a problem with big holes in their rhinos. Not little holes, like bullets, but big gaping wounds in the skin.*

Lizzie: *Ooh!*

Kali: *So, like, really zombie looking bad—bad stuff.*

Lizzie: Kali said, "Okay, let's look at some rhino tissue and see what's going on." But Kali's boss said, "Oh, it's not that simple."

Kali: *The problem is that you can't ship pieces of rhinos. That's very much—very difficult, right? Because ...*

Lizzie: *Especially black rhinos.*

Kali: *Even the pieces are very heavily regulated because of poaching.*

Lizzie: *Yeah, that makes sense.*

Kali: *It turns out it is actually easier to send a pathologist to Kenya than it is to send pieces of rhinos out of Kenya.*

Lizzie: Kali was on the next flight to Kenya. And when I heard this, I imagined her riding in the back of an open-top jeep, clutching her canvas hat as they bounced through the grasslands towards a sick rhino. But I'm quickly learning that vet life isn't always as glamorous as I picture it.

Kali: *It's just it's really hard to get diagnostics on rhinos. You can't go up and just swab a live rhino that is awake.*

Lizzie: *Because it will horn you?*

Kali: *They will trample you into red mud, for sure.*

Lizzie: *That was graphic.*

Kali: *[laughs] Yeah.*

Lizzie: *I need a moment.*

Lizzie: Turns out rhinos are a lot like naked mole rats.

Kali: *Most common cause of death for rhinos is also rhinos.*

Lizzie: *Oh, my gosh! Rhinos and naked mole rats.*

Kali: *Rhinos and naked mole rats.*

Lizzie: *We're learning a lot about the metal animal kingdom.*

Kali: *They're so metal.*

Lizzie: Kenyan vets took samples from sleeping rhinos and brought them to the lab where Kali could look at them. They had a suspicion of what was causing these gaping lesions, but the tissue would give them a definitive answer.

Kali: *One of the biggest questions was: are the birds that—the oxpeckers, the things that pick off little ticks and things, they tend to go at wounds as well. And are they making these wounds a lot worse, or is there an initial cause?*

Lizzie: Kali got the hunk of rhino skin from the vets. Now she just had to slice it super thin so she could look at it under a microscope. But rhino skin has a unique trait.

Kali: *It's somewhere between leather and asphalt.*

Lizzie: *Oh, wow!*

Kali: *Yeah, it's really robust, and it's quite thick. It can be more than an inch thick, right? So we're talking very, very thick.*

Lizzie: *Okay. So you're trying to get at asphalt with a deli slicer?*

Kali: *Yeah. And it's—it's challenging. It's challenging.*

Lizzie: But Kali was able to get some usable slides from the skin samples. After examining them, something became clear: it wasn't birds causing all this trouble. It was another much, much smaller culprit.

Kali: *And it turns out there are worms there.*

Lizzie: Nematodes. Again! It's always worms!

Kali: *It's worms! It's always worms!*

Lizzie: Kali told the Kenyan vets what she'd discovered, dusted off her hands and said, "My job here is done."

Kali: *I don't do treatment. I don't fix anything. I give information so that someone else can fix things.*

Lizzie: *You take things apart.*

Kali: *I take things apart and I put together just information. But information is sometimes what allows you to do the thing that needs to be done.*

Lizzie: The vets took that information and dewormed the rhinos. Another happy ending. Kali's job, at the most basic level, is finding information. And there's lots of info that can be gleaned from a dead animal. Just like with Naba, the lion with the eating problem. Remember her? Naba's problem appeared to be neurological, meaning there was likely a problem in her brain. This could be a million different things, so Kali was like, "Okay, let's take a look." She opened up Naba's skull to peek at her brain inside.

Kali: *And looked in, and there were—there was a hole. There was a giant hole in her brain!*

Lizzie: Kali shows me a picture of Naba's brain.

Lizzie: *Oh my gosh!*

Lizzie: And there was a huge chunk gone. Vanished.

Kali: *There's no brain there.*

Lizzie: *That's like a quarter of the brain.*

Kali: *Yeah. So that's—yeah, that's about 20 percent of her cerebrum is gone.*

Lizzie: Inside the brain are four ventricles—big open chambers like the two in our heart. So much of Naba's brain was missing that you could see the ventricles inside with the naked eye.

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Kali: *You should not be able to see those. They should be covered by brain.*

Lizzie: *Whoa!*

Kali: *We are looking straight down into them right here. So the back of her brain, the—most of the occipital lobe, more on the left than the right, has been lost.*

Lizzie: This was a smoking gun for Naba's chewing problems.

Kali: *That part of the brain is actually partially responsible for coordination of the muscles of mastication. So chewing.*

Lizzie: *Hmm.*

Kali: *So the fact that she was having trouble chewing is attributable to ...*

Lizzie: *The giant hole in her brain?*

Kali: *The giant hole in her brain. I'm just shocked that there weren't more obvious signs.*

Lizzie: *Yeah.*

Kali: *But brains are amazing, and biology's phenomenal.*

Lizzie: To be ultra clear, a gigantic hole in the brain is not normal. This isn't something Naba was born with. So the cause is most likely worms. Just kidding! It's not always worms. This time, it was a restriction of blood flow. But why did blood stop flowing to this part of Naba's brain? Well, Kali suspects ...

Kali: *That that obstruction of blood flow to the area was due to a post-COVID stroke. And the reason why I'm concerned about that is because we know from human medicine that COVID caused an increased risk of vascular events in the brain for humans. And we have no reason to think that that was not also true for cats.*

Lizzie: Kali can't say for sure that a post-COVID stroke led to the hole in Naba's brain. But like a good scientist or doctor, she's working off the best information available, consulting the latest medical journals for both humans and zoo animals, and then making an educated conclusion. After she learned about Naba's brain, she shared her findings with other zoos.

Kali: *Hey, if your cats also had a COVID outbreak, be on the lookout. Like, be aware that this is a potential complication. We don't necessarily know that it is 100 percent a thing, but it's a thing to keep an eye out for.*

Lizzie: What happened to Naba's brain could be something entirely unique that nobody will ever see again. But Kali's findings could also help other zoo vets if they ever see this problem, potentially giving a lion a few extra good years—or even saving its life.

Lizzie: I think I would find it hard to work with death day in and day out, like Kali does. Especially when you're dealing with some of the world's most majestic animals, like Naba the lion or Jena the scimitar-horned oryx. Even the mole rats are—no, they're not cute. I'm sorry. But I don't think I've ever met anyone who loves their job as much as Kali loves hers. And she helped me understand why she's so comfortable with death. When I talked to her, her grandmother had recently died.

Lizzie: *Oh, I'm so sorry!*

Kali: *I loved her dearly, and still do. So for me, the important thing there was that her passing was peaceful.*

Lizzie: Kali says she takes comfort knowing her grandmother had a good quality of life, that she didn't spend her final years in pain. This is similar to the comfort she feels with animals that have died at the zoo. They lived good lives, and they died peacefully.

Kali: *Good time is more important than long time. And that is something that veterinary medicine has really started and ended with, that good time is really what we're here for.*

Lizzie: Kali says one of the most important parts of her job is to confirm that it was the right time to euthanize an animal, that no other medical interventions would have saved that animal. Just like with Naba, death was the best option.

Lizzie: Most zoos don't have a dedicated veterinary pathologist on staff. But the Smithsonian's National Zoo is also part of a conservation biology institute. By examining death, Kali can gather information that helps protect and treat endangered animals like rhinos or the scimitar-horned oryx.

Kali: *These are animals that were, I mean, so endangered they were practically imaginary, right? They were extinct in the wild.*

Lizzie: But the National Zoo's conservation efforts, including Kali's work, helped bring the oryx back from the brink of extinction. There's also another reason this pathology is important, and it hits a lot closer to home—your home. And that's because we're all connected—a concept called one health.

Kali: *The idea that ecosystem health, human health and animal health are all connected, and you cannot address or understand any one of those without understanding the context in all three.*

Lizzie: Think of how the nematodes moved from a white-tailed deer to a slug to a kudu. This is how disease and parasites move to humans, too. We're not separate from our environment, we're a piece of it. It's a reminder Kali sees everyday when she looks at Jena's skull in her office. We can ignore death or fool ourselves into thinking that we have control over biology, but at the end of the day ...

Kali: *Biology's gonna biology, life is gonna life, and you will never be able to solve for all of the variables. You will never be able to control everything, but you can learn from it.*

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Lizzie: You've been listening to Sidedoor, a podcast from the Smithsonian with support from PRX.

Lizzie: To learn more about Kali Holder and the work she does at the Smithsonian's National Zoo and Conservation Biology Institute, check out our newsletter. You can subscribe at SI.EDU/Sidedoor. We'll also share some pics of my visit to the zoo with Kali on our social media channels. Follow us @SidedoorPod.

Lizzie: To learn more about the scimitar-horned oryx, and how the Smithsonian helped bring them back from extinction, we did a whole episode about it called "Don't Call me Extinct." To find it, look way way way back to season two of Sidedoor. And if you want more about the naked mole rats—you know you do—the Smithsonian Zoo has a dedicated naked mole rat live cam, so you can just hang out with them all day long. I won't judge. We'll share it on our socials.

Lizzie: For help with this episode, we want to thank Kali Holder, Ellie Tahmaseb and Ben

Marcus. We also want to acknowledge that Kali is just one of a much larger veterinarian team at the National Zoo, including other amazing pathologists: doctors Lauren Pieffer and Neel Aziz are pathologists who also worked on the case of the dizzy kudu. Dr. Natalie Tocco assisted with the kudu spinal dissection. Consulting pathologists in that case were doctors Jey Koehler from Auburn University and Brigid Troan from North Carolina State University. And none of the work in the pathology lab would be possible without the amazing technician Pattie Walsh.

Lizzie: Our podcast is produced by James Morrison, and me, Lizzie Peabody. Executive producer is Ann Conanan. Our editorial team is Jess Sadeq and Sharon Bryant. Fact-checking by Nathalie Boyd. Episode artwork is by Dave Leonard. Transcripts are done by Russell Gragg, and extra support comes from PRX. Our show is mixed by Tarek Fouda. Our theme song and episode music are by Breakmaster Cylinder.

Lizzie: If you like our show, please leave us a review on Apple Podcasts. That will help other people find us. If you want to sponsor our show, please email sponsorship [at] prx [dot] org. I'm your host, Lizzie Peabody. Thanks for listening.

Kali: *Cats are phenomenal with visual deficits. So if they—if they can't see well, but it's a place that they know, a lot of times with domestic cats, owners don't know that their cat has gone blind until they move furniture.*

Lizzie: *Wow!*

Kali: *Because the cat knows where everything is, and can even jump on things.*

Lizzie: *Wow!*

Kali: *Without being able to see it. They just know. They just have a mental mapping that is so good.*

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