



**San Diego Zoo
Wildlife Alliance**

Elephant Endotheliotropic Herpesvirus

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EEHV:
Not *if*, but when.
All elephants
shed EEHV.
It is in your herd.
Right now.



EEHV is not a question of if, but when. If you have elephants at your zoo, you have EEHV at your zoo already. The virus is naturally shed and carried by all elephants tested so far, if they are tested long enough or frequently enough.

EEHV Advisory Group

Your best resource on EEHV

- Website updated regularly
- Background information on EEHV
- Professional content includes
 - sample protocols
 - recommendations on
 - anesthesia/sedation
 - diagnostics and testing labs
 - treatment for EEHV
 - *Must sign up for password to access it*



eehvinfo.org

The EEHV Advisory was formed in the United States in 2014 and includes subject matter experts from North America, and representatives from Europe and Asia. The 28 members of the EEHV Advisory Group help to review and update treatment and monitoring recommendations, give input on research priorities, and keep the website, www.eehvinfo.org, updated.

Please visit www.eehvinfo.org for current information on EEHV, treatment protocols, information on diagnosing EEHV, laboratory locations, etc. Most of the clinically helpful information is present under professional content, and requires a password. You can get this through the website with a day or two turnaround time.



EEHV

Elephant Endotheliotropic Herpesvirus

- Index case: 1995 at National Zoo
- Retrospective cases go back earlier than that

The first elephant diagnosed with EEHV was Kumari, an Asian elephant at the Smithsonian Zoo, who died in 1995. Once the virus was identified, researchers went back and found cases that occurred before 1995, but were not diagnosed at the time of death.

EEHV

Elephant Endotheliotropic Herpesvirus

- Classified as a Proboscivirus
 - Placed in Betaherpesvirus family
 - should have their own virus family (Deltaherpesvirus)
- Host specific: ELEPHANTS ONLY

EEHV impacts elephants and no other species. EEHV has evolved with elephants for millions of years and is a natural part of elephant history and biology. It is different enough from other herpesviruses that experts recommend it be placed in its own family of viruses.

EEHV: Epidemiology

Most herpesviruses do not kill their host

They create a primary infection

Then the host becomes latently infected

Can re-activate later on



Most herpesviruses do not kill their hosts, they create a primary infection, which may or may not be noticed by the host, and then the virus becomes latently infected in the host, which means it hunkers down and just lives with the host. The virus can be re-activated later on and can cause shedding of the virus and possibly clinical illness. In humans, re-activation can be caused by stress (cold-sores) and other immunosuppressive events. In elephants, we do not know what causes re-activation yet.

What is EEHV HD?

EEHV

- Ubiquitous virus
- Virus is found incidentally in trunk secretions, saliva, likely other places
- May be associated with low-level viremia
- Clinically insignificant

EEHV HD

- Hemorrhagic disease
- Associated with high viremia
- Associated with abnormal CBC
- Associated with clinical signs of illness
- Life-threatening

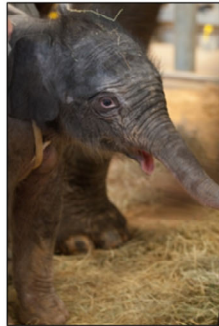
Because EEHV is a virus present in all elephants, it is important to clarify the difference between the EEHV Virus, and illness associated with EEHV, or EEHV-hemorrhagic disease (EEHV-HD).

When we refer to “EEHV Survivors” in our case numbers, we mean elephants that survived illness from EEHV hemorrhagic disease.

EEHV: The Basics

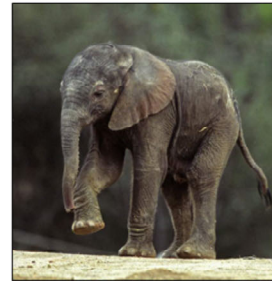
Asian Elephants

- EEHV 1a and 1b
- EEHV 4
- EEHV 5



African Elephants

- EEHV 2
- EEHV 3
- EEHV 6
- EEHV 7



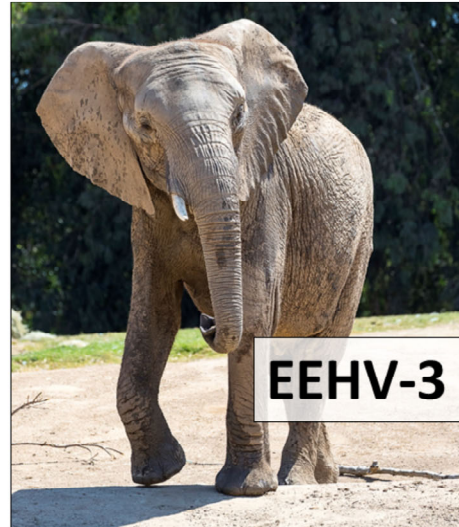
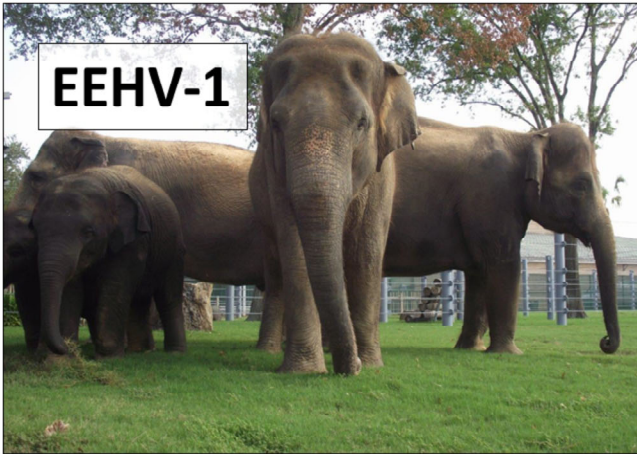
There are 7 species of EEHV, 1-7. 1, 4, and 5 are endemic in Asian elephants, and 2, 3, 6, and 7 are endemic in African elephants.

It's important to note that EEHV3 and EEHV4 are so similar, that most of our front line qPCR testing we do does not discriminate easily between EEHV3 and EEHV4. Thus, you will see qPCR results that say "EEHV3/4" for both Africans and Asians.

We do have a PCR test that can differentiate between the two when necessary, such as when herds are mixed.

Otherwise, we presume an EEHV3/4 result is actually EEHV3 if it is in an African elephant, and EEHV4 if it is in an Asian elephant.

EEHV: The Basics



In Asian elephants EEHV1 is responsible for the majority of EEHV-related elephant deaths and illnesses, and EEHV1A is the most deadly virus. Since 2019, EEHV3 is emerging as the virus to watch for the African elephant communities, though we did lose one African elephant to EEHV2 in 2021

EEHV: the Basics

Shed by asymptomatic elephants

PCR of trunk wash

Epidemiology, no clinical
diagnosis

Natural infection in elephants



PCR of a trunk wash, collected just as it is for a TB test, can detect EEHV in the trunk. This is useful for epidemiologic purposes but is not useful for clinical diagnosis.

Through close evaluation of EEHV viral genetics, from tissues collected from fatal cases and from trunk washes in North America and in range countries, it is evident that EEHV is a very, very old virus that has evolved with elephants for millions of years. It is NOT the product of mixing Asian and African elephants together, and is NOT a product of a captive environment. It appears to be a very natural infection that occurs with every elephant. Every elephant that we have screened for more than three months has been shown to shed EEHV in his or her trunk. It is likely that asymptomatic infections, and shedding of the virus through the trunk, is a common occurrence in adult elephants.

EEHV: the Basics

Hemorrhagic Disease (EEHV HD)

Asian calves

1-8 years of age

African calves

≤15 years of age

qPCR test of whole blood to detect viral DNA



Though EEHV is a natural infection of all elephants, it can also cause acute, hemorrhagic disease (EEHV-HD) in younger elephants, most often in Asian calves between 1 and 8 years of age, and African elephants 15 years and under. Though, for Africans, we have a smaller sample size so take that age range with a grain of salt.

EEHV HD is definitively diagnosed by detecting EEHV DNA in the whole blood via qPCR testing.

Many zoos are establishing their own EEHV qPCR testing labs, with the assistance of the EEHV Advisory Group.

The National Elephant Herpesvirus Laboratory provides EEHV qPCR testing to zoos in the US, contact the laboratory directly for information on testing memberships and fees.

EEHV: The Basics

Hemorrhagic Disease (EEHV HD)

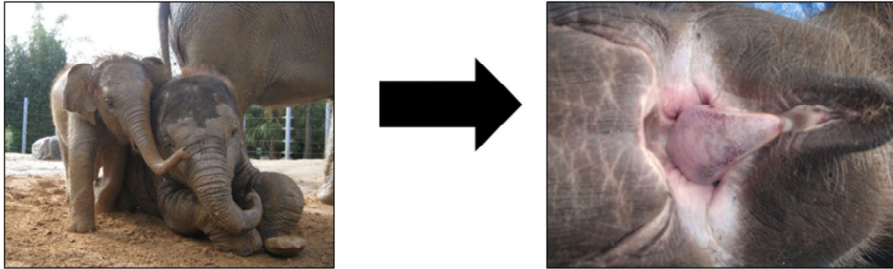


Viremia ⇒ Systemic disease ⇒ Endothelial Damage
⇒ Internal Hemorrhage

In EEHV HD, elephants become viremic, which means the virus enters their bloodstream in high numbers. The virus attacks blood vessels and organs and the elephants become clinically ill, with internal hemorrhage and visible bruising.

EEHV: The Basics

Hemorrhagic Disease (EEHV HD)



Viremia ⇒ Systemic disease ⇒ Endothelial Damage
⇒ Internal Hemorrhage, Shock, DIC, Death

These elephants are unable to handle the presence of the virus in their blood stream, and their system is overwhelmed, leading to internal hemorrhage, and likely cardiovascular shock, and ultimately DIC, often succumbing to fatal disease within a day or two of their first outward sign of illness.

EEHV Epidemiology

We believe EEHV HD in elephants is due to uncontrolled primary EEHV infections that lead to severe systemic infection in calves lacking adequate immune protection.

Why do some young elephants lack adequate immune protection?



The first way to answer this question is to be able to measure immune protection to EEHV in our elephants. Several groups are working on this across the globe. This presentation will focus on the work being done at Baylor College of medicine, to measure EEHV antibodies through their LIPS assay.

It is important to recognize that antibodies represent a portion of the overall body's immune response, and that other processes we have yet to fully identify and measure are also in play.

But, at least we can start with antibodies!

EEHV Serology Testing

Baylor
College of
Medicine

- Detects antibodies against EEHV in Asian and African elephants
- Recent publications with lots more details are available online:
- Asian elephants:
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7000966/pdf/JVI.01528-19.pdf>
- African elephants:
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8528115/pdf/spectrum.00983-21.pdf>

Serology testing for EEHV is a relatively new tool in our tool box so we'll dedicate the next few slides to it. Here are links to two recent publications with a lot more details and graphs for those interested in learning more.

EEHV Serology Testing

The logo for Baylor College of Medicine, featuring the text "Baylor College of Medicine" in white serif font on a dark blue rectangular background.

Serology Tests available:

- Asian elephants:
 - Pan EEHV, EEHV1A, EEHV1B, and EEHV4
- African elephants:
 - Pan EEHV and EEHV3
- Still works in progress: EEHV5, EEH2, and EEHV6

EEHV serology testing is available for these specific EEHV viruses, with some more being developed.

Data so far indicates that exposure to one EEHV strain may not confer significant protection to another EEHV Strain, so knowing which virus strain is which is important.

EEHV Serology Testing

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Why is serology helpful?

- Many elephants who died from EEHV-HD were seronegative to the EEHV virus that killed them
- We believe seronegative elephants are at a higher risk of disease due to EEHV-HD
- Seropositive elephants can still become ill from EEHV-HD, and should still be part of an EEHV monitoring program
- More elephants and more data will continue to validate and confirm our findings

As I mentioned, serology is a new tool in our toolbox, and we are just starting to take it out for a spin.

A positive EEHV Serology result indicates the elephant has antibodies to the EEHV strain and has therefore been previously infected by the specific EEHV strain.

A negative EEHV Serology result indicates the elephant does not have antibodies to the EEHV strain and is considered to be at a higher risk of disease due to EEHV HD from this strain.

The more elephants that are tested, the more we can hone our interpretations and recommendations

EEHV Serology Testing



How frequently to test:

- EEHV antibodies are given to elephant calves through their dam's placenta
- Placentally derived EEHV antibodies wane between 1 to 8 years of age
- More samples from elephants in this age range will help to narrow this down
- Serostatus of elephants <20 may change and should be checked Q 6 months or so

Data on the measurement of placentally derived EEHV Antibodies over time is based on limited numbers of African and Asian elephants at this time, and more data points will help to refine this.

These recommendations are based on Dr. Howard's opinion at this time, based on the data so far.

The EEHV Advisory Group is working with Baylor College of Medicine to provide herd-monitoring recommendations in the near future.

EEHV Serology Testing

When to test:

- Test all elephants once to know serology status – this will help research, too
- Test all elephants <20 every 6 months
- Test Prior to change in herd status (elephant transfers) to better inform degree of risk for disease due to EEHV-HD

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Baylor
College of
Medicine

These recommendations are based on Dr. Howard's opinion at this time, based on the data so far.

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EEHV in African elephants prior to 2019

- Free ranging and under human care
- Multiple EEHVs from lung and skin nodules
- EEHV2: 2 fatalities
 - 11 months, 13 years old
- EEHV6: 1 fatality (10 yo, in Thai Zoo)
- EEHV6, EEHV3
 - 2 cases of clinical disease, survived



This slide sums up all of the knowledge of EEHV in African elephants prior to 2019

Age	Sex	Virus	Outcome	<h1>African Elephant EEHV Cases 2019-2021</h1> <ul style="list-style-type: none"> • 13 cases of EEHV illness; 4-42 years old • 9 survivors; 4-42 years old • 4 deaths; 9-11 years old
11	F	EEHV3	died	
6	F	EEHV3	died	
7	F	EEHV3	died	
11	F	EEHV3	alive	
13	M	EEHV3	alive	
12	F	EEHV3	alive	
36	F	EEHV3	alive	
12	F	EEHV3	alive	
4	M	EEHV3	alive	
9	M	EEHV2	died	
13	M	EEHV6	alive	
17	M	EEHV3	alive	
42	F	EEHV3	alive	

Here is a list of all of the EEHV cases in African elephants that the author is aware of. It is possible there may be others.

North American Elephants and EEHV (Updated 1/3/22)

	Asian Elephants	African Elephants
Elephants born or imported since 1980, with known follow-up	136	261
Elephants still alive	89	158
Elephants that have died	47	103
EEHV HD deaths	31	6
% of elephant deaths that are from EEHV	$31/47 = 66\%$	$6/103 = 6\%$

This table, and the ones that follow, are a best estimate at case numbers and this data is not peer-reviewed.

These numbers are intended to provide an overall impression of the impact of EEHV on Asian and African elephants in North America.

These numbers do not include the recent Omaha African elephant births – congratulations Omaha!

North American Elephants and EEHV (Updated 1/3/22)

	Asian Elephants	African Elephants
Elephants born or imported since 1980, with known follow-up	136	261
EEHV HD Survivors	17	11
EEHV HD Deaths	31	6
Fatality Rate of EEHV HD Cases	65%	35%
% of all elephants in population that have been impacted by EEHV	48/136 = 35%	17/261 = 6.5%

This table, and the ones that follow, are a best estimate at case numbers and this data is not peer-reviewed.

These numbers are intended to provide an overall impression of the impact of EEHV on Asian and African elephants in North America.

North American Elephants and EEHV (Updated 1/3/22)

Asian Elephants	2022	2020
Elephants born or imported since 1980, with known follow-up	136	129
EEHV HD Survivors	17	15
EEHV HD Deaths	31	27
Fatality Rate of EEHV HD Cases	65%	64%
% of all elephants in population that have been impacted by EEHV	48/136 = 35%	42/129 = 32%

This is a look at the changes in EEHV case numbers between 2020 and 2022 in Asian elephants.

North American Elephants and EEHV (Updated 1/3/22)

African Elephants	2022	2020
Elephants born or imported since 1980, with known follow-up	261	258
EEHV HD Survivors	11	5
EEHV HD Deaths	6	5
Fatality Rate of EEHV HD Cases	35%	50%
% of all elephants in population that have been impacted by EEHV	$17/261 = 6.5\%$	$10/258 = 4\%$

This is a look at the changes in EEHV case numbers between 2020 and 2022 in African elephants.



Our current at-risk population of Asian elephants in North America includes 22 elephants that will be between 1 and 9 years of age in 2022.



9 of these elephants (41%) already have survived at least one episode of EEHV-HD.

Asian Elephant EEHV HD in Europe

Asian elephants born 1985-2017:

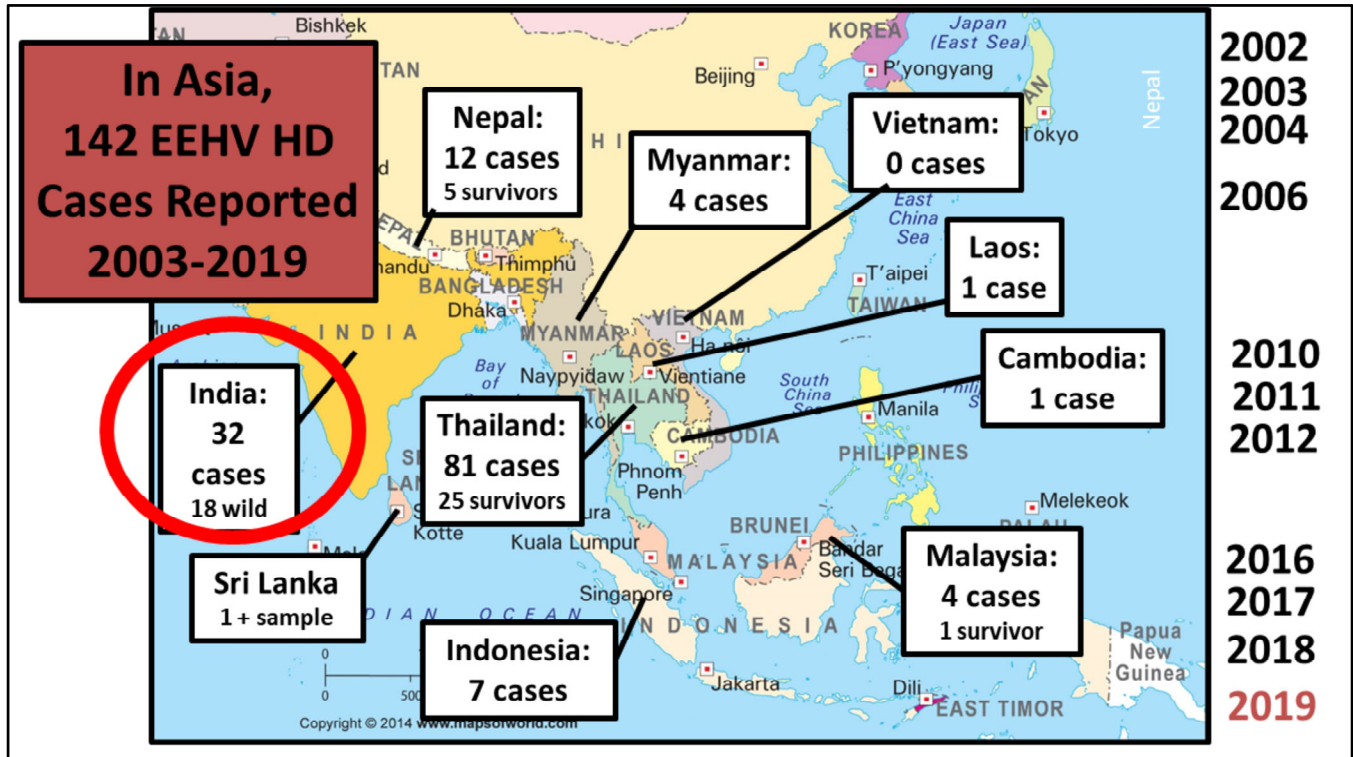
- 35 confirmed deaths
- 42% of breeding facilities have a viremia screening protocol in place

Clinical features of fatal cases:

- Clinical illness 0-6 days
- Both sexes equally affected
- Age: 9 months to 7.6 years old
 - most > 3 years old
- At least 63% developed DIC
 - (disseminated intravascular coagulation – systemic end stage clotting crisis)



This information is based on a work by Dr. Kathryn Perrin, formerly of Copenhagen Zoo and now a clinical veterinarian at the San Diego Zoo Safari Park. Dr. Perrin's research centered around fatal cases and their pathology. There have been some Asian elephant EEHV HD survivors in Europe.



Throughout Asia, in by 2019 we had documented up to 142 EEHV HD cases through confirmation with PCR testing. In India, 18 of these cases of EEHV deaths were detected in free ranging elephants that were never under human care.

It is likely that the number of elephants ill or lost to EEHV is much higher, as PCR testing to confirm cases is not available in all regions.

We have stopped counting individual cases of EEHV throughout Asia at this point, as we have incontrovertible proof that EEHV exists in these range countries. The bigger question now is what is the virus's impact on long term sustainability of elephants under human care and in the wild. Our EEHV partners in Thailand and throughout Asian elephant range countries are working to answer that question.

What does EEHV do?

ENDOTHELIAL CELL DAMAGE



VASCULAR LEAKAGE

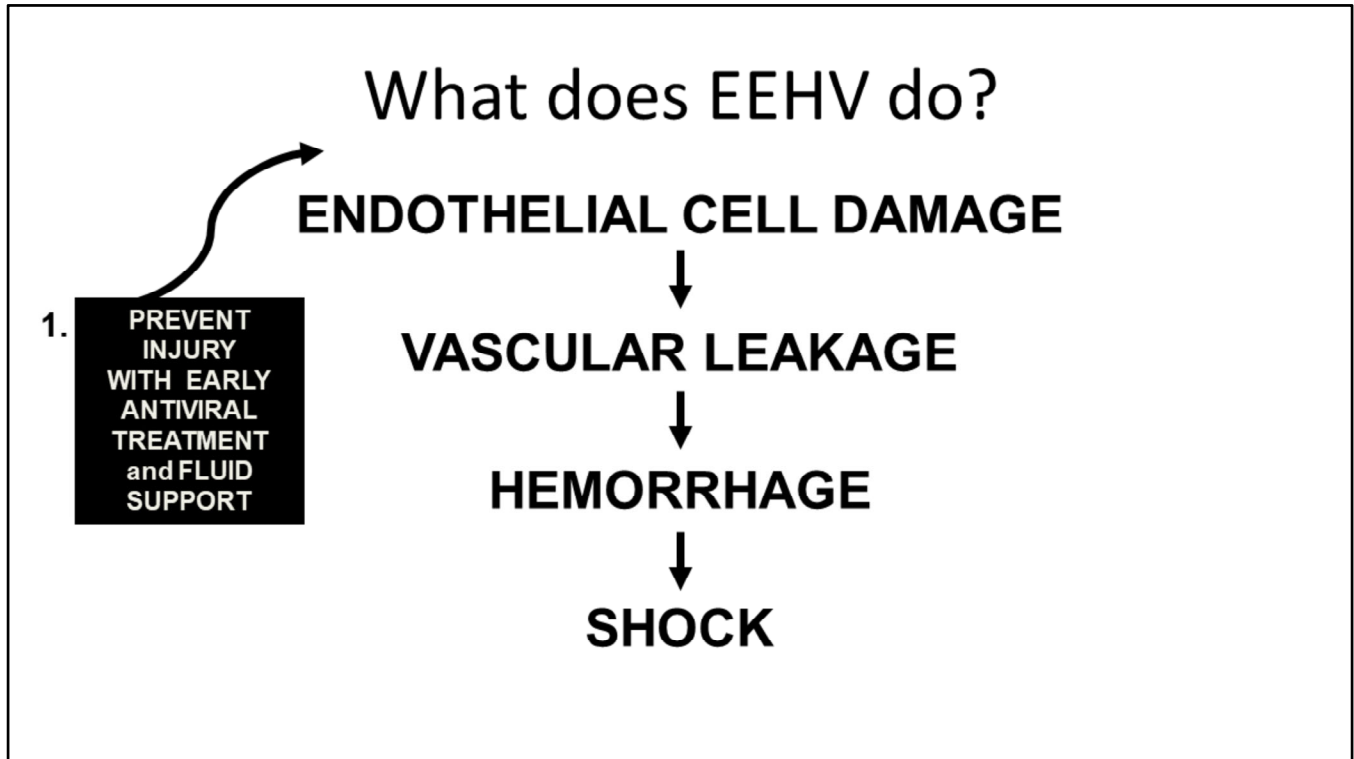


HEMORRHAGE



SHOCK

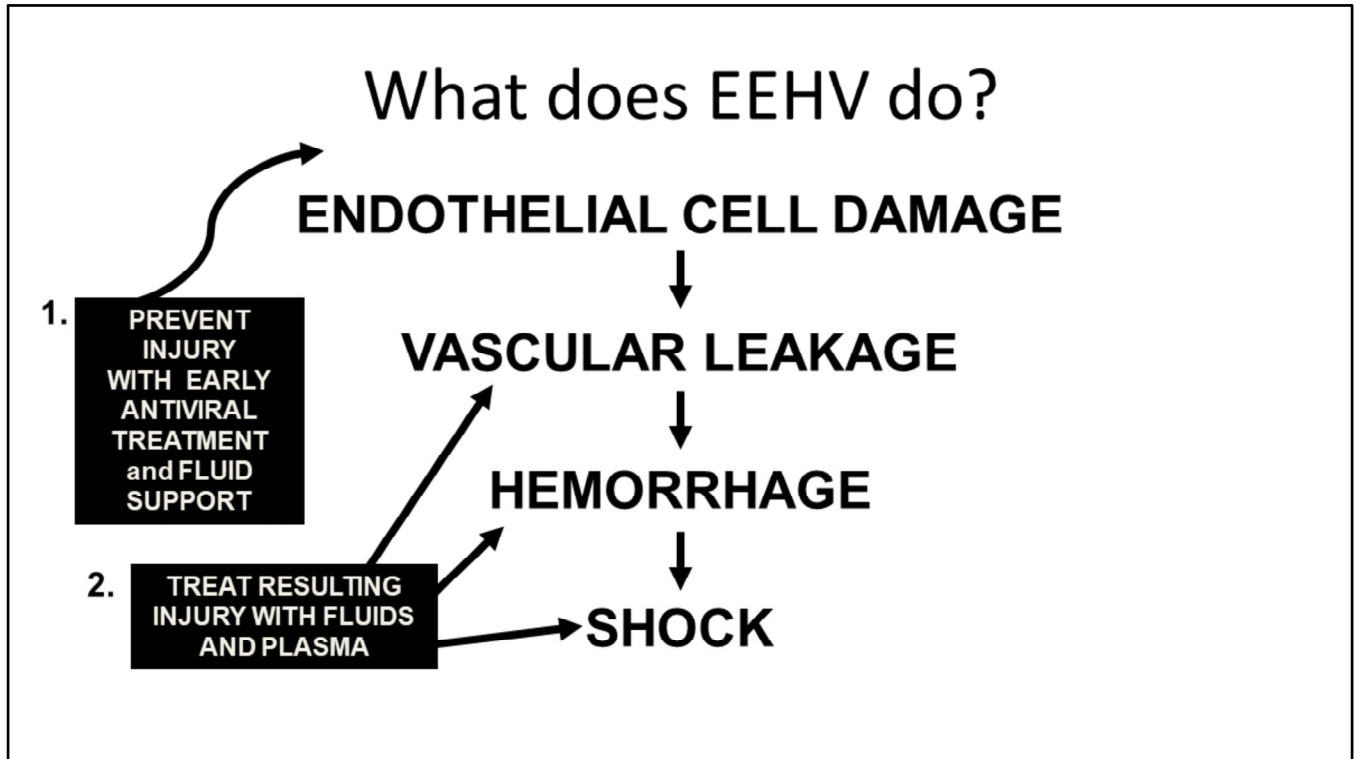
Knowing the progression of EEHV damage is important to understanding the clinical signs and treatment options. EEHV causes endothelial cell damage and leakage of blood vessels, which leads to internal hemorrhages and vascular collapse. This eventually leads to circulatory shock.



Detecting the virus early before it causes clinical signs allows us to treat and to reduce some of the injury before it happens.

Early antiviral treatment, along with fluid support, is the first stage of EEHV treatment.

It is important to note that we have not been able to confirm that any antivirals used to treat EEHV HD are effective against the EEHV virus in the laboratory. Equally, we have not confirmed that they are NOT effective against the EEHV virus. Until more is known, it is recommended to treat with antivirals in an EEHV HD case



Detecting the virus after clinical signs are noted requires more systemic treatment to try to reverse and control organ damage and vascular damage created by the virus.

Starting treatment at this stage is often unsuccessful.

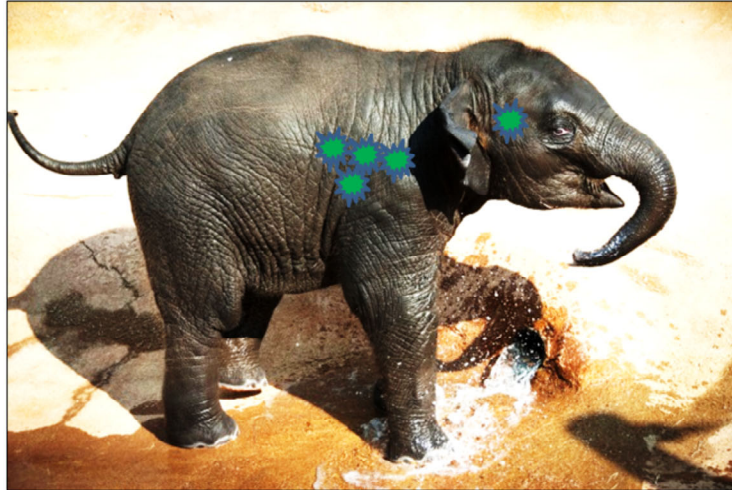
Elephants that were started on treatment early may still hit this stage of illness, and require additional treatments

What do WE see with EEHV?



So, what happens when an elephant is exposed to EEHV....?

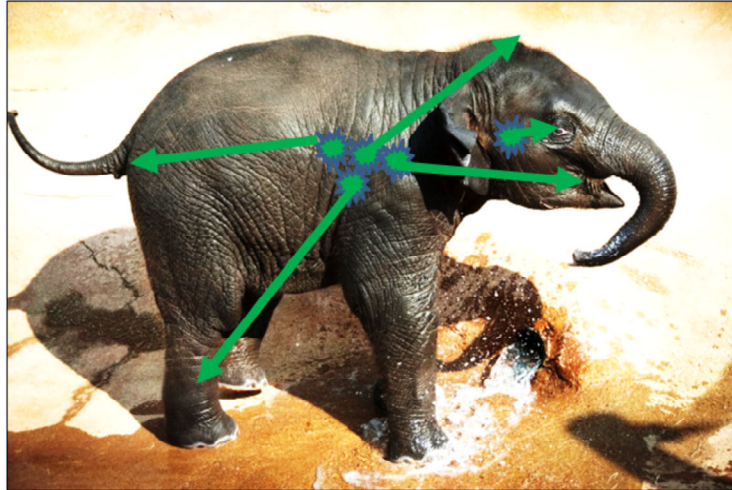
What do WE see with EEHV?



Virus is in blood up to **10 days BEFORE** any clinical signs of illness are observed.

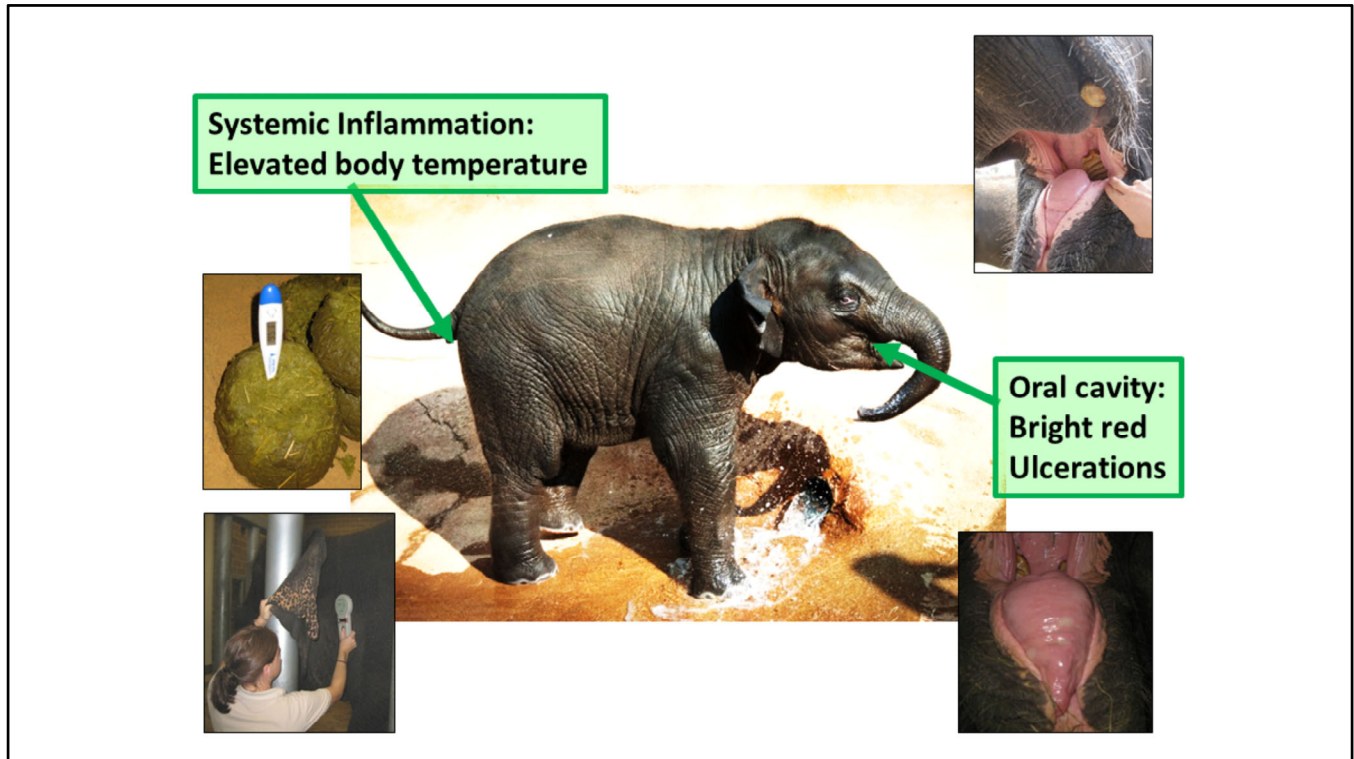
Based on our research so far, an elephant can have virus detectable in blood (viremia) for an average of 5 to 10 days **BEFORE** any clinical signs are observed. Why is this?

What do WE see with EEHV?



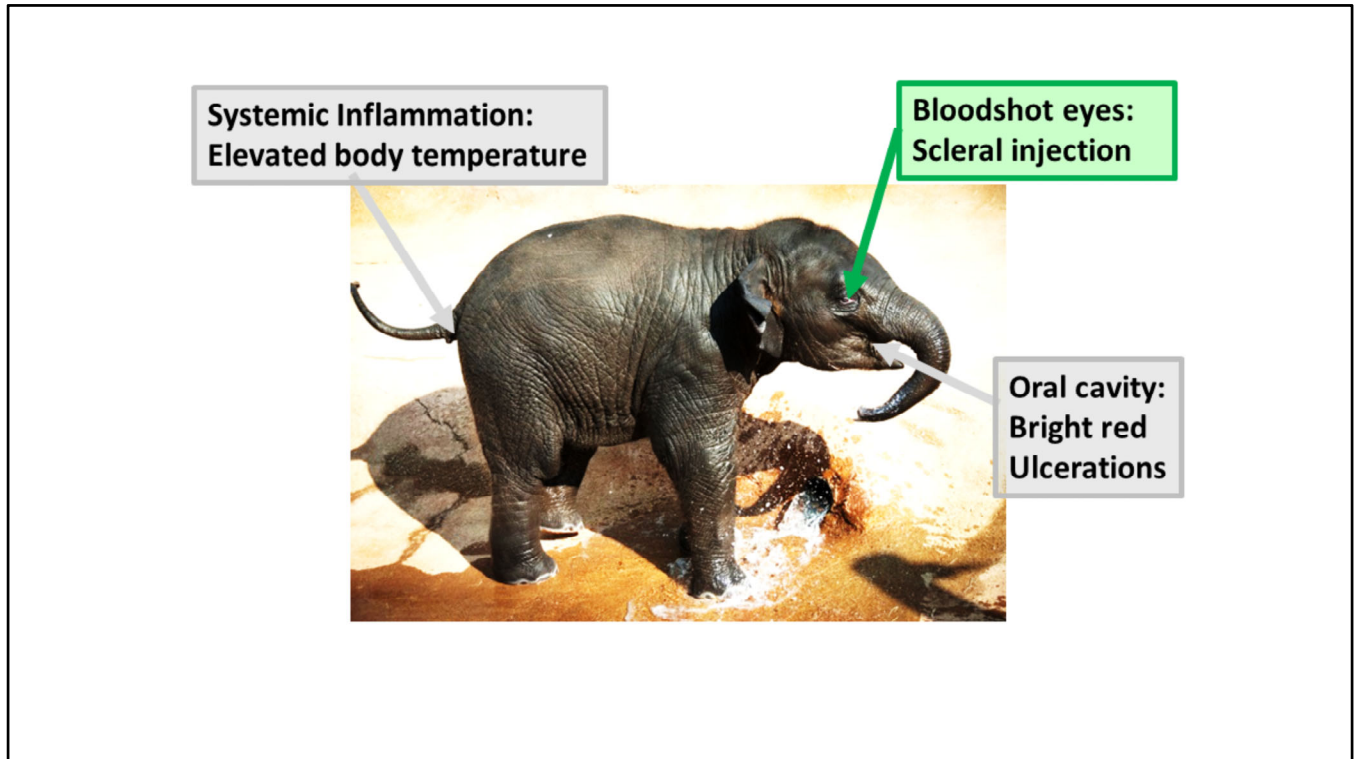
The virus starts to work on endothelial cells soon after it enters the blood. If you think about the physiology of the elephant, it makes sense that it takes THAT long to spread and to cause clinical changes that we can observe externally.

Elephants do not have very elastic skin, so edema is not noted early on
Elephants do not bruise easily so early hemorrhage is not detected easily. E

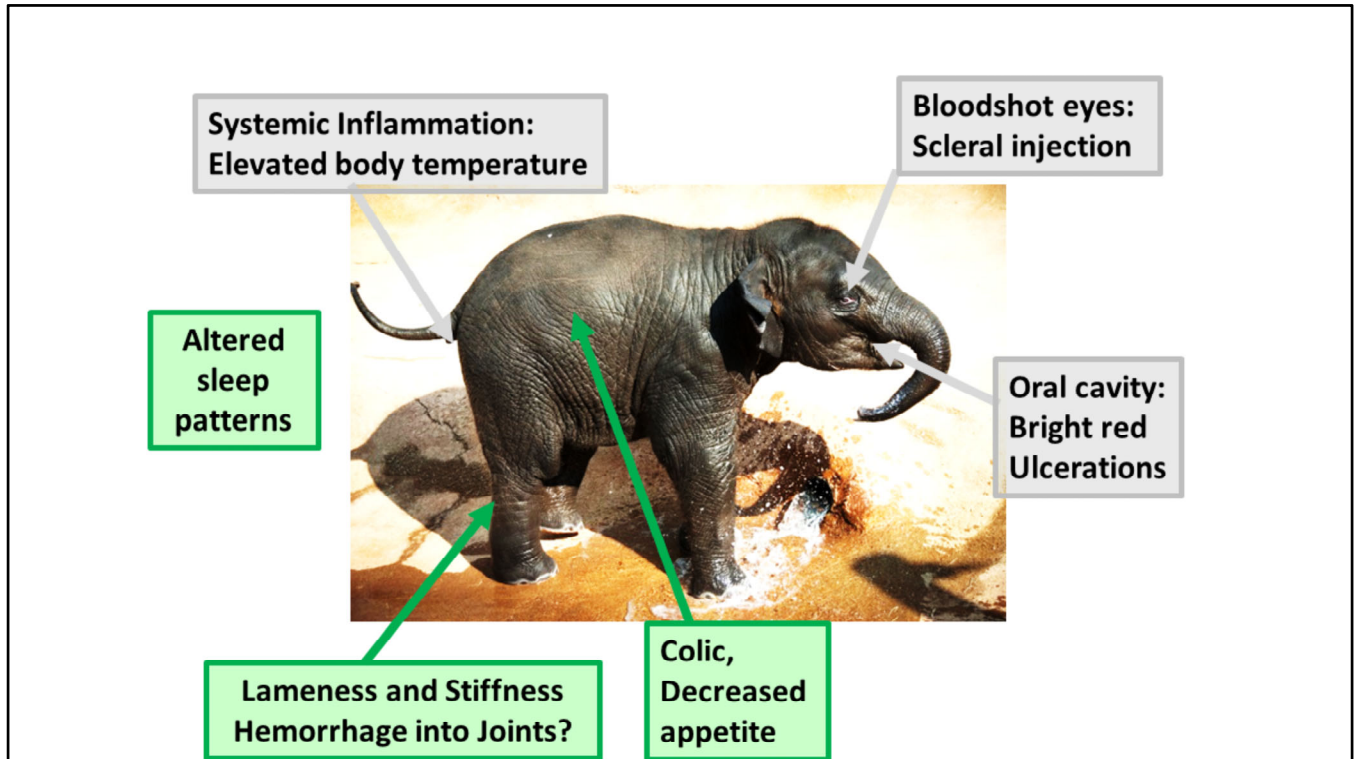


Some earlier changes that we CAN pick up are discoloration of the oral mucosa, which is only really picked up if elephant care takers are familiar with what normal color is. Vesicles and ulcerations are sometimes seen in the mouth as well, though many EEHV fatalities have progressed without ever detecting this finding.

Elevation in body temperature may also be detected. It's important to know the elephant's individual normal range to pick up on subtle changes in this parameter. Fecal boluses can be measured for temperature, or you can use microchips that measure core body temperature with a reader.

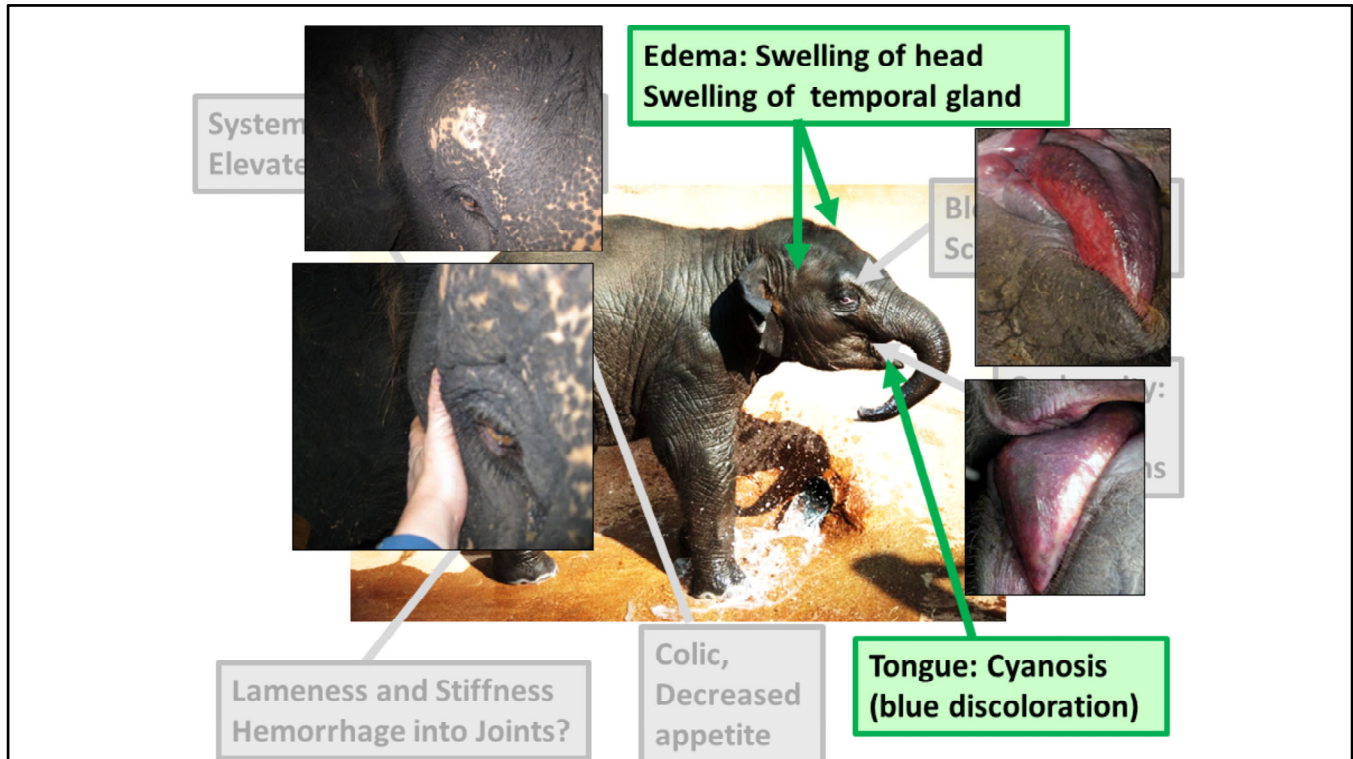


We have noted subtle scleral injection, or the appearance of bloodshot eyes, in our viremic elephants.



More advanced clinical signs, which impact elephant health and function, include the presence of lameness or stiffness in one or more joints. Changes in appetite are also sometimes noted, or signs of colic or abdominal discomfort.

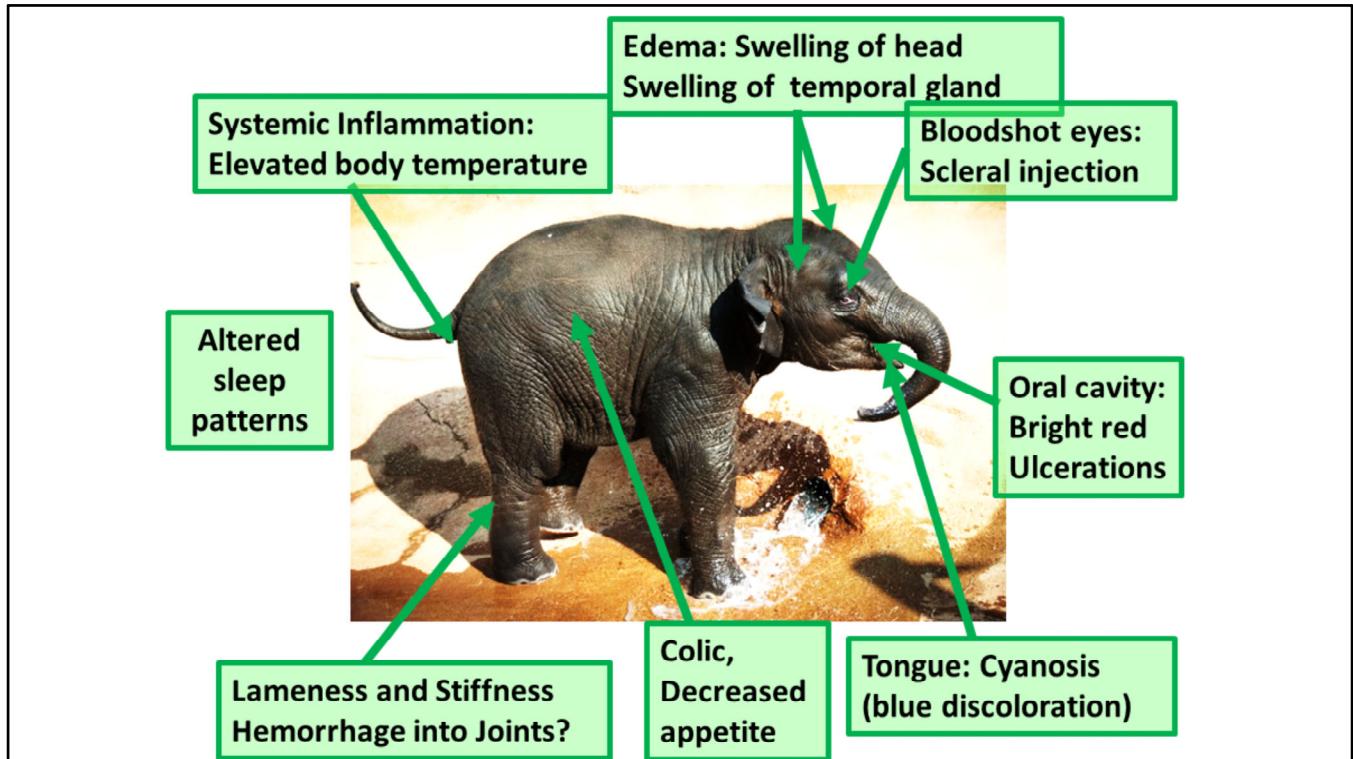
Changes in sleep patterns are also noted, with viremic elephants being more restless and sleeping for shorter bouts of time.



Temporal gland swelling can be noted and is sometimes an earlier, more transient observation.

More end stage observations include generalized edema or swelling of the head, which may be hard to appreciate for someone not familiar with the elephant's normal profile.

Cyanosis of the tongue occurs when internal hemorrhage is pronounced and the ability to carry oxygen in the blood is severely reduced. Likely there are other areas that are cyanotic as well, but due to the nature of the elephant they are not visible.



So, sometime between 1 and 10 days after the elephant becomes viremic, a combination of these signs will be observed.

By the time most of these signs are observed, the physical damage to the elephant has already occurred.

Early detection, BEFORE CLINICAL SIGNS, is key at this point.

Diagnosing EEHV-HD

Clinically Ill Animals or Dead Animals

- Live animals:
 - Identify virus in blood
 - Submit whole blood (EDTA) for qPCR testing
- Post Mortem:
 - Gross lesions (take photos)
 - Formalin fixed tissues: histopathology
 - PCR of tissues : preserve frozen or in DNA preservative
 - PCR of post mortem blood sample: preserve frozen or in DNA preservative

EEHV Hemorrhagic disease is diagnosed by a positive EEHV qPCR of whole blood. Low level EEHV viremia appears to occur occasionally in young elephants, so monitoring a viral load result over time will help the clinician determine if the viremia is clinically significant or is just a low level blip.

Definitively diagnosing EEHV in post mortem cases requires the presence of gross hemorrhagic lesions, and histologic evidence of damaged microvascular endothelial cells with herpesvirus inclusion bodies. Frozen or preserved tissues should be submitted for EEHV PCR to confirm presence of the virus.

It's important to document and verify EEHV-related deaths, as it adds to our knowledge on this deadly virus, both in captive and free ranging animals.

What can we do to protect our elephants and zoos?




First, we have to realize we are protecting not just our elephants, but also our zoos, from an EEHV HD catastrophe.

It's not hopeless, there's actually quite a lot your institution can do.



The three pillars of protecting your elephants from an EEHV HD death are:
Preparedness.
Vigilance.
Early, Aggressive treatment.

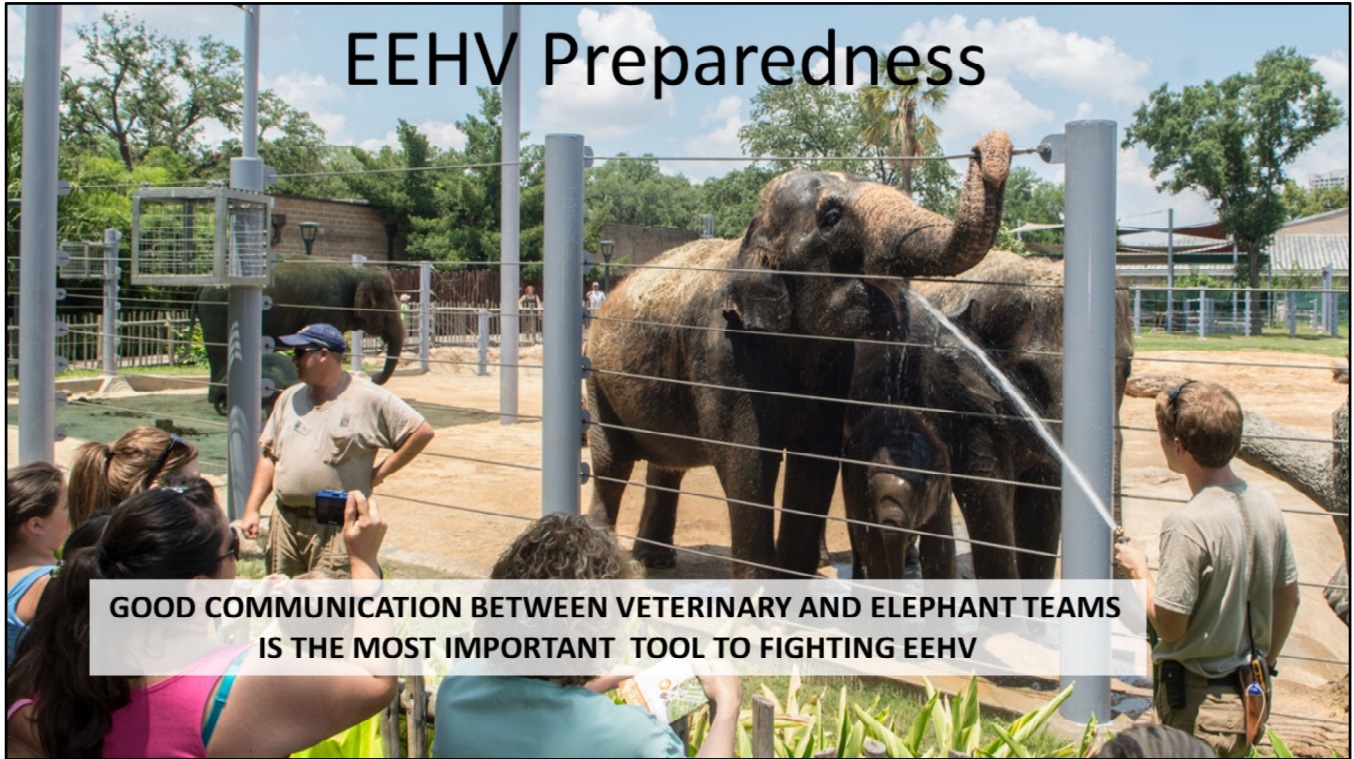


What can we do to protect
our elephants and zoos?

Preparedness
Vigilance
Aggressive Treatment

Preparedness is the first pillar

EEHV Preparedness



**GOOD COMMUNICATION BETWEEN VETERINARY AND ELEPHANT TEAMS
IS THE MOST IMPORTANT TOOL TO FIGHTING EEHV**

Having an open and healthy relationship between the veterinary and elephant team is the MOST IMPORTANT for fighting EEHV.

EEHV Preparedness

HOUSTON ZOO ASIAN ELEPHANT EEHV PROTOCOL

April 2015



EEHV Protocol is Essential

- Monitoring
- Treatment
- Drug procurement
- Communication
- Decision tree
- Necropsy information

Every zoo that houses elephants should have some form of EEHV Plan. A detailed protocol is preferred for any institution with breeding Asian elephants.

A monitoring program should be in place and fully described.

Plans for treatment, including how to get a hold of large amounts of antivirals at short notice, are critical.

Deciding on the communication flow and who will be making decisions is key to being able to act quickly in the face of an ill elephant, and to not waste time posturing or arguing.

It is possible, and even likely, that despite our best efforts we will still lose a calf to EEHV. In that case, the necropsy is essential to advancing our knowledge and keeping research moving forward. Fresh tissues, for viral culture, are in particular critically important. Therefore, an updated and thorough necropsy protocol is essential to any EEHV protocol.



Vigilance is the next pillar of surviving EEHV HD

Vigilance

- EEHV in the blood may lead to EEHV HD illness
- EEHV can be detected in blood **up to 2 weeks before illness.**
- Early changes in the CBC can indicate impending illness.



Amazingly, the EEHV research community has identified two ways to alert zoo staff to a potential illness from EEHV-HD:

- through blood testing.
- EEHV can be detected in an elephants blood up to two weeks before an elephant shows clinical illness from EEHV HD.
- We have also identified early changes in the white blood cells and platelets that may predict an impending illness.

Vigilance

Early changes in the CBC can indicate impending illness:

- Reductions in monocyte absolute numbers or %
- Alteration in monocyte/lymphocyte ratio
- Reduction in platelets



Knowing an elephant's baseline complete blood cell count values is important to be able to detect subtle changes in the CBC that can indicate an early EEHV viremia.

Monocytes are the primary white blood cell of elephants, when they drop in percentage or number compared to that elephant's normal values, even though they may still be within published reference ranges, suspicion of EEHV-HD should increase, and an EEHV qPCR should be performed.

The same is true of platelets. Many laboratories do not measure platelets appropriately, and elephant veterinarians should be sure they are getting accurate laboratory results on their elephants.

Vigilance

- EEHV in at-risk elephants can lead to illness and death.
- EEHV can be detected in the blood **before** symptoms appear.
- Early changes in the CBC can indicate impending illness.

Weekly blood testing
in at-risk elephants
saves lives.



It is for this reason that the EEHV Advisory group recommends weekly blood collection in at-risk elephants for early detection of EEHV virus in the blood. This practice has saved lives.

Vigilance

- EEHV in
- lead to
- EEHV c
- blood u
- before**
- Early c
- can inc
- illness.

On-command blood collection in any at-risk elephant that is even slightly off.



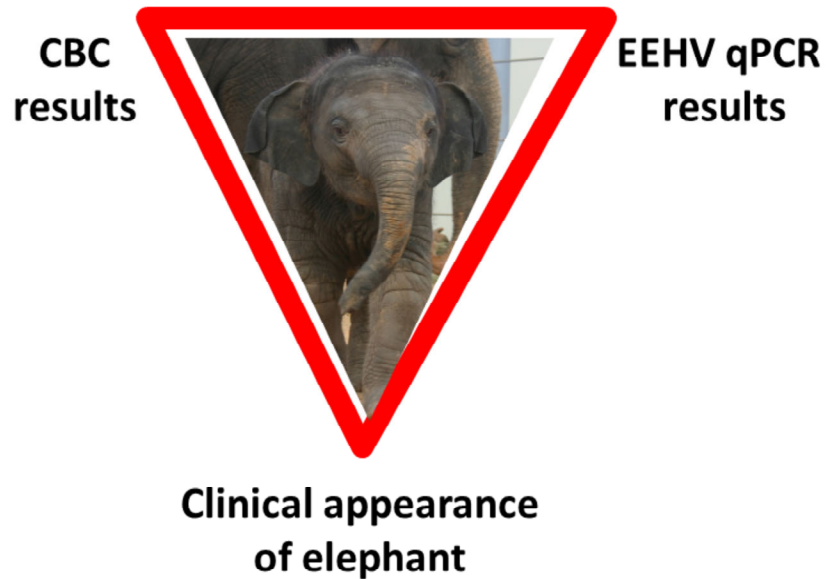
Equally important is the ability to be able to collect blood on any elephant any time....

-Even if the elephant isn't feeling well.

-Training may need to be combined with standing sedation to allow samples to be collected

-the need for standing sedation should not be a deterrent for collecting a life saving blood sample.

EEHV Vigilance



All of the above information is needed to determine if continued monitoring, treatment, or nothing is required.

Use this three pronged approach, looking at the elephant's clinical condition, the EEHV qPCR results, and the CBC, to make these important and potentially life saving decisions.

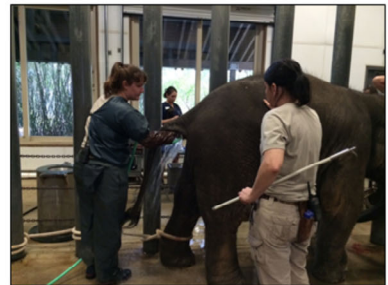


The final pillar of Surviving EEHV HD is to whole-heartedly embrace the philosophy of aggressive treatment.

Early, Aggressive Treatment

Rectal Fluid Therapy

- NEVER UNDERESTIMATE THE ABSORPTIVE CAPACITY OF THE ELEPHANT'S RECTUM
- Excellent method to rehydrate a sick elephant
- Can be given BID to QID
- Low chance of adverse effects if done correctly



Our first line of defense against any elephant with abnormal CBC, EEHV qPCR or signs of being off is rectal fluid therapy.

This is a tremendous tool in our arsenal that is relatively easy and non-invasive, and can have a very positive impact on hydration and overall condition.

There is little chance of fluid overloading b/c what doesn't get absorbed is passed back out.

Early, Aggressive Treatment

Rectal
fluids
given in
a jungle



This technique is possible to accomplish in even the most challenging conditions, as our colleague in Indonesia, Dr. Christopher Stremme, demonstrates here

Early, Aggressive Treatment

Antivirals should be used to treat any elephant with EEHV-HD.

Famciclovir, acyclovir, ganciclovir are all used.

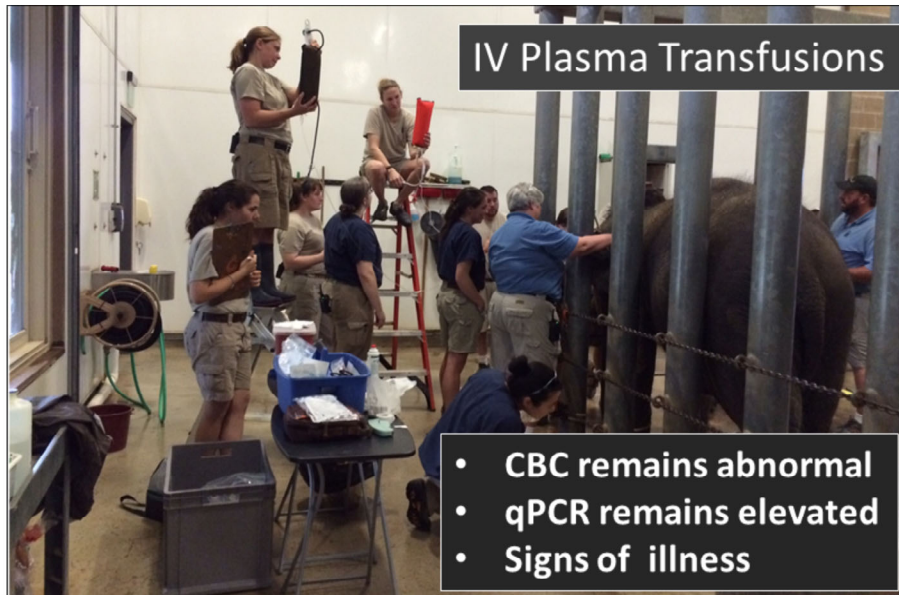
Ganciclovir is given given IV, twice a day, through a 1 hour bolus.



There are no peer reviewed data out there to conclusively say that antivirals do or do not work against EEHV.

Until that happens, we will continue to recommend its use in EEHV HD cases

Early, Aggressive Treatment



The next line of defense after rectal fluids and famciclovir treatment, is IV plasma transfusions.

These can be performed prophylactically, or when the CBC fails to rebound, when the qPCR results remain elevated, or when the elephant shows any sign of illness.

Early, Aggressive Treatment

Intravenous Plasma Transfusions

- Standing sedation
- Butorphanol & Detomidine
- Doses available online



Plasma treatment often requires standing sedation, which can be very intimidating the first time, but has been very safe and effective in the hands of a prepared veterinary and elephant team.

Additional Treatments

Antibiotics for secondary infections
“Fortified” Plasma
Anti-inflammatories at low doses
Opioids (Butorphanol)
Intravenous Vitamin C
Stem Cell Therapy
Aminocaproic Acid
Zelnate – bovine immunostimulant
Steroids



In addition to the treatments already described, other adjunct therapies could also be considered.

Many clinicians start their EEHV HD patients on antibiotics due to the low WBC and potential for secondary infection, as well as anti-inflammatories (once well hydrated)

Fortifying plasma is the practice of giving famciclovir to a plasma donor elephant about 1 hour prior to plasma collection. We believe this results in having levels of the active famciclovir metabolite, penciclovir, present in the plasma, which can be helpful when given to a viremic elephant. A lot of this work needs to be validated, thus far it has not been shown to cause any harm.

Many will use an opioid such as butorphanol for any signs of discomfort or colic.

Our colleagues in Asia use Vitamin C intravenously to treat their cases, and many clinicians in N America have started as well.

Many recent cases of EEHV-HD have been treated with intravenous mesenchymal derived stem cells. As with many EEHV treatments, no adverse effects have been noted, and it is hard to document if it has been helpful. SDZWA can help provide stem cells with relatively quick turn around time, for both African and Asian elephants. There are also other sources of stem cells.

Amino caproic acid is used in emergency and critical care to help stabilize patients with bleeding/clotting crisis, and has been used in some EEHV HD cases.

Zelnate is a bovine immune stimulant that has been used in some EEHV HD cases, without adverse effects noted.

Steroids have been used to treat some EEHV HD cases in Europe and in the US. The use of steroids in EEHV HD cases is supported by the use of steroids in other viral diseases in humans and is under active discussion by EEHV Subject matter experts.

What isn't EEHV?

EEHV is NOT.....

- **A result of mixing Asian and African elephants together.**
- **A result of being under human care.**
- **A reason to prevent elephants from breeding.**

Just as important as what EEHV is, is what this virus is not:

- it is NOT a result of mixing Asian and African elephants together, as we have learned that these viruses have co-evolved with elephants for millions of years
- it is not a product of human care, as wild elephants are also dying of EEHV-HD
- it is not a reason for zoos to stop breeding elephants. It is a reason to support zoos, and their elephant work, so that we work together as a community to find answers.

It starts at home

- EEHV awareness and understanding begins at home
- Resources are needed to be prepared
- Time for vets and elephant staff to meet
- \$\$ and time for staff to attend workshops and stay current
- \$\$ for drug/supply procurement
- Time for elephant training
- Facilities for elephant sedation



We need to work internally and raise the proper awareness in our own institutions about EEHV.

Being prepared and vigilant about EEHV Takes a lot of work, time, and resources. Zoo directors and administrators should be aware of this, and efforts need to be financially supported.

If you have at risk elephants, you simply can't afford NOT to be prepared.

Zoo vets or elephant managers alone can't get an entire zoo prepared for EEHV, it takes an entire team. And it takes support .



Zoos aren't just part of the solution, they are the primary solution so far.

- Research in the last 15 years has been almost completely supported by zoos and grants or donations that zoos have been awarded.

- Everything we know about EEHV has been learned from samples collected from elephants under human care.

- Zoos are going to be critical to the development of an EEHV-1 vaccine

Thank You!

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**San Diego Zoo
Wildlife Alliance**



Thank you for your interest in our work on EEHV, and for joining us in the fight to better understand this virus and to save elephant lives!
Feel free to email with any questions, or if you see something on here that is out of date or inaccurate!
Remember, we are all in this together!

