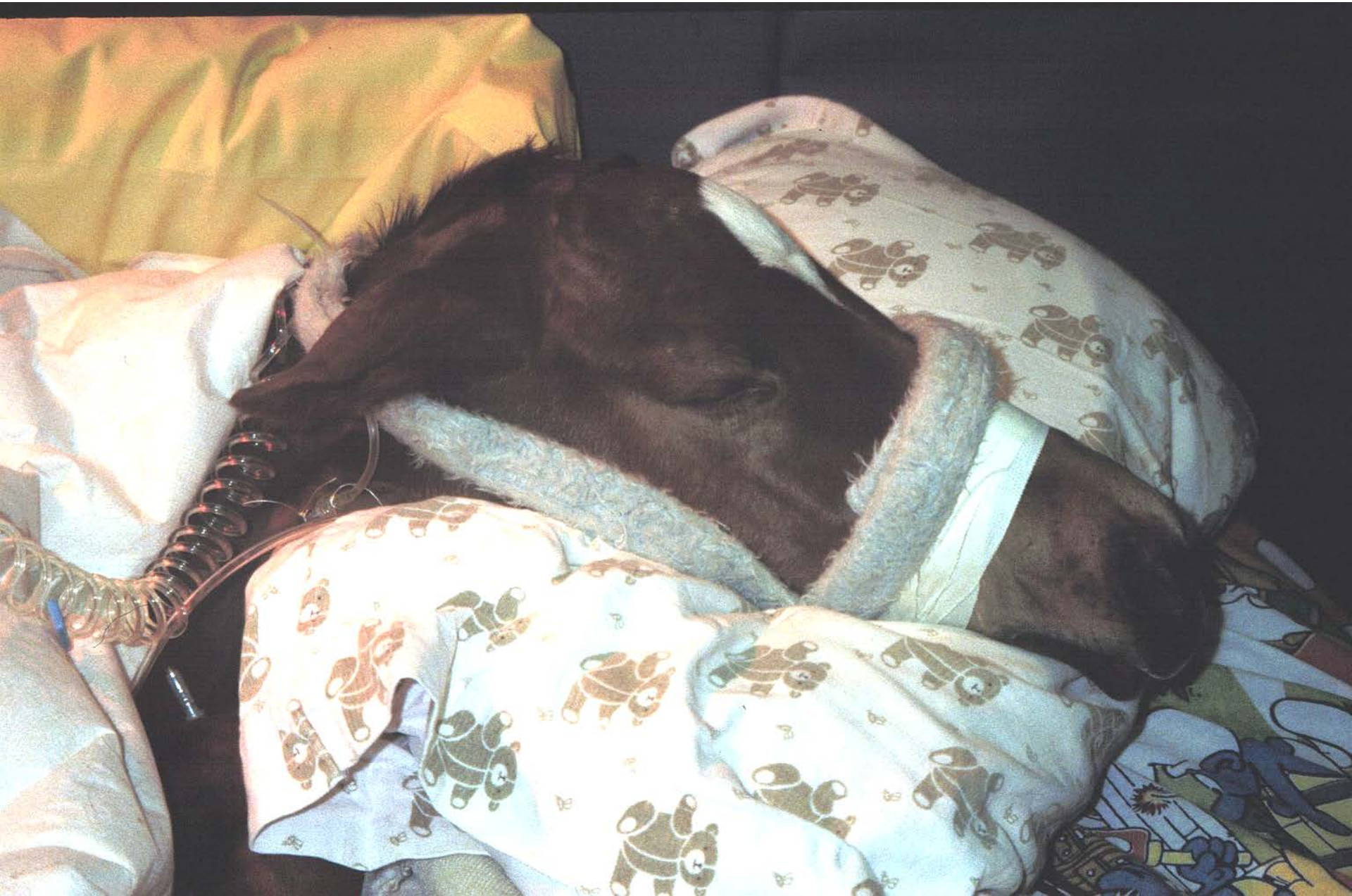
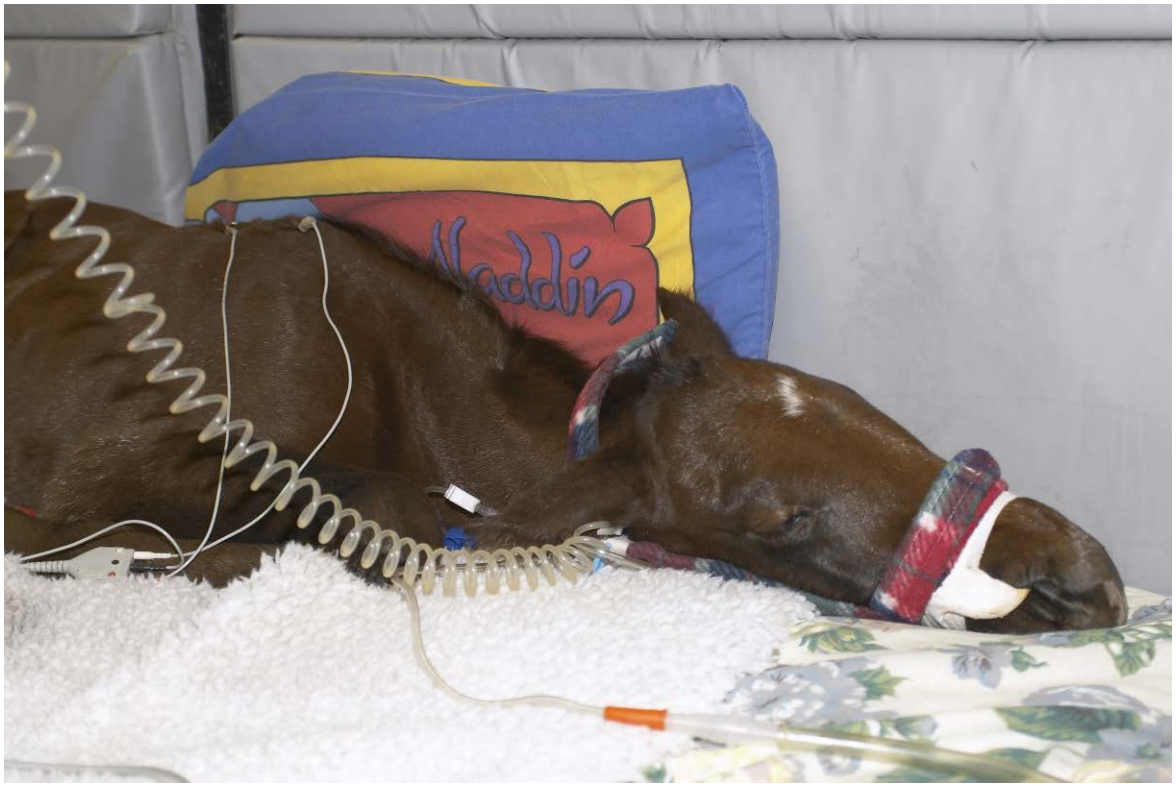
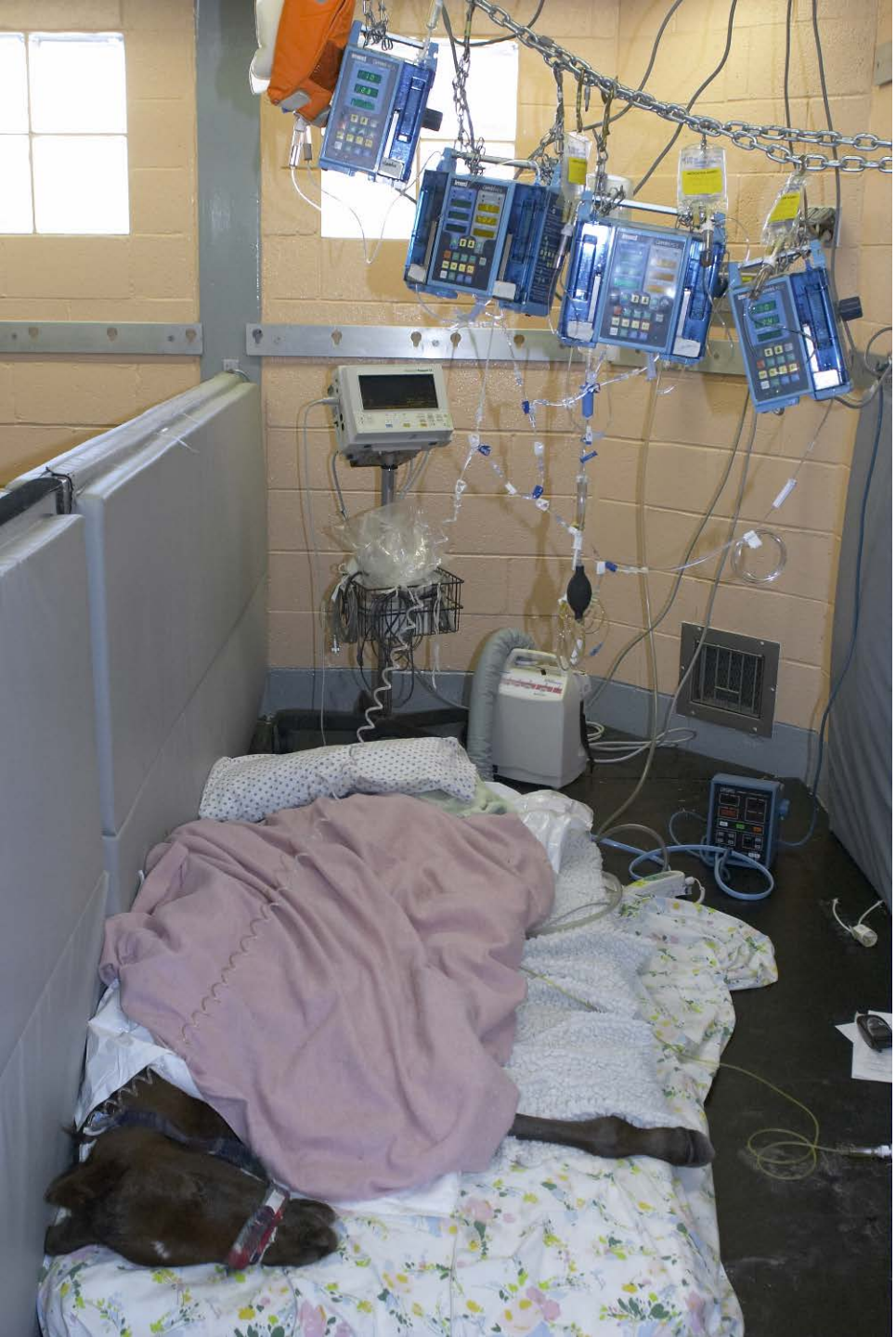
Sepsis and Septic Shock



Sepsis and Septic Shock Definitions

- Sepsis
- Septicemia
- SIRS
- Severe Sepsis
- Septic Shock
- MODS
- ARDS
- CARS





Most common cause of death

- Human SMICU
- Large animal NICU

Fatality rate

- Human medicine 20-80%
- NBC NICU - 137 cases
  - Sepsis without shock - 17%
  - Septic Shock - 90%

Fatalities

- Refractory hypotension
- ARDS
- MODS

Sepsis and Septic Shock
Etiology

Infectious causes
- Bacterial infections
  - Gram negative pathogens – 60%
  - Gram positive pathogens – 40%
- Viral pathogens
- Fungal pathogens

Bacteremia detected in neonate
- Sepsis < 30%
- Septic Shock > 70%

Localized infections

May never isolate causative agent

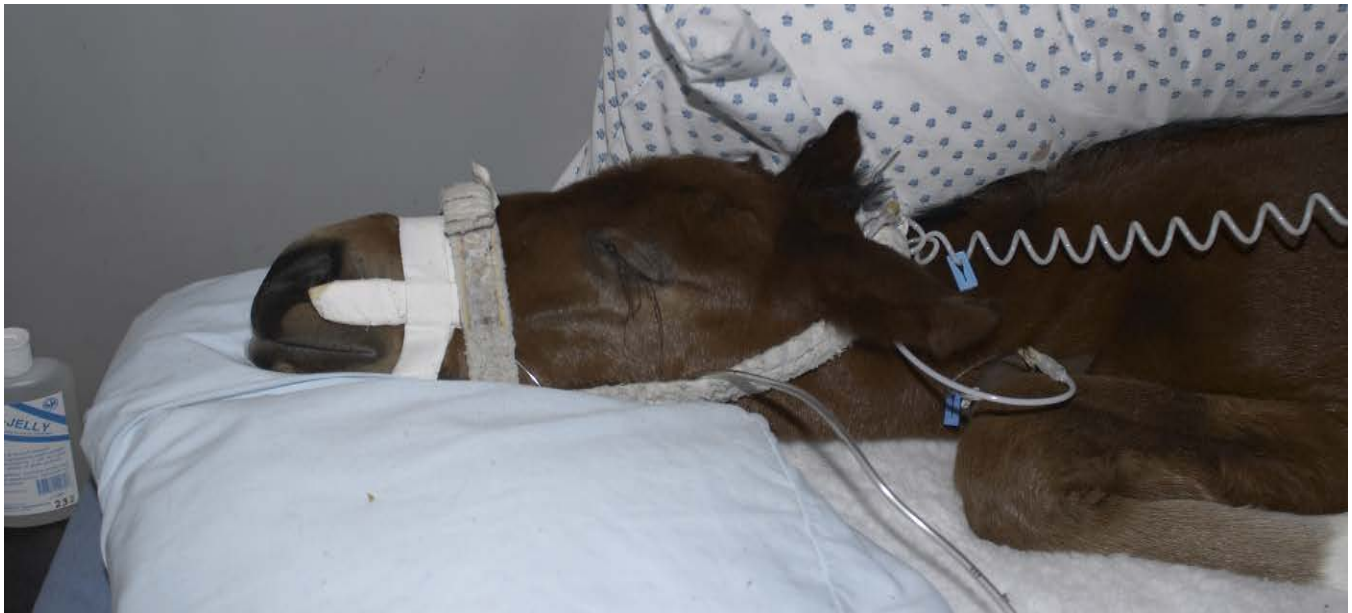
Noninfectious causes

Septic Shock
Pathogenesis

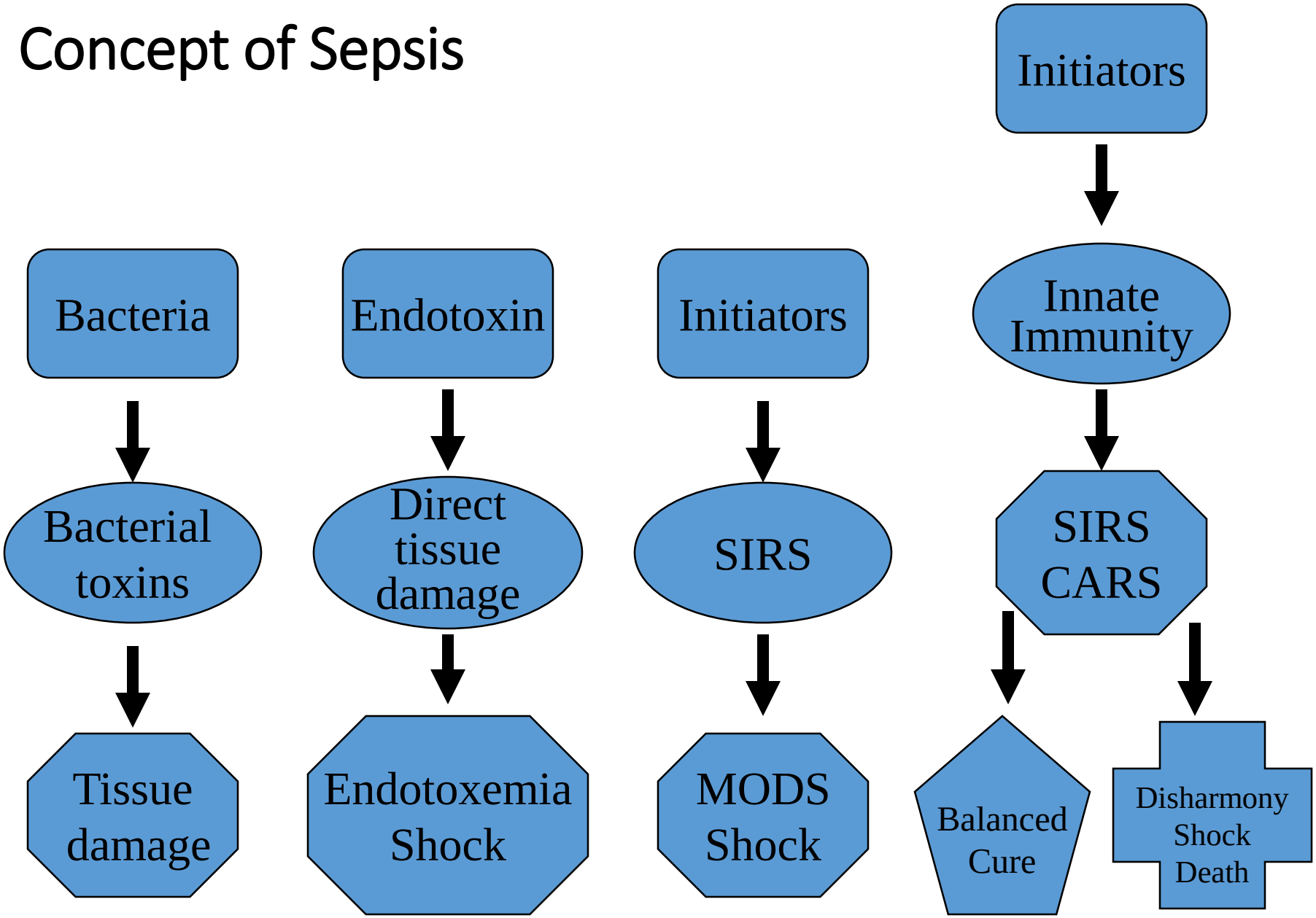
Septic shock

Inflammatory response (SIRS)

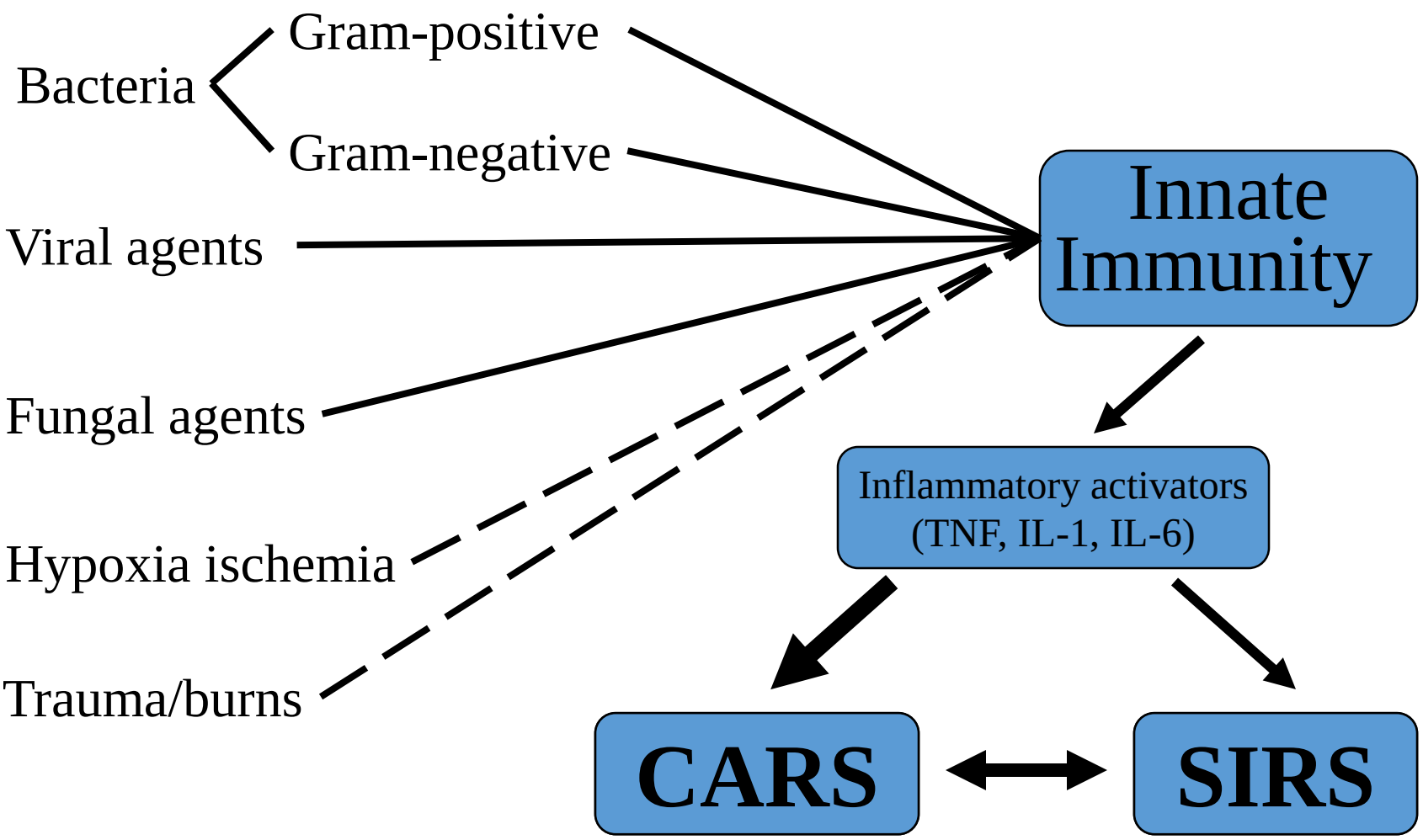
Immunosuppression (CARS)



Concept of Sepsis



Initiation of Inflammatory Reactions

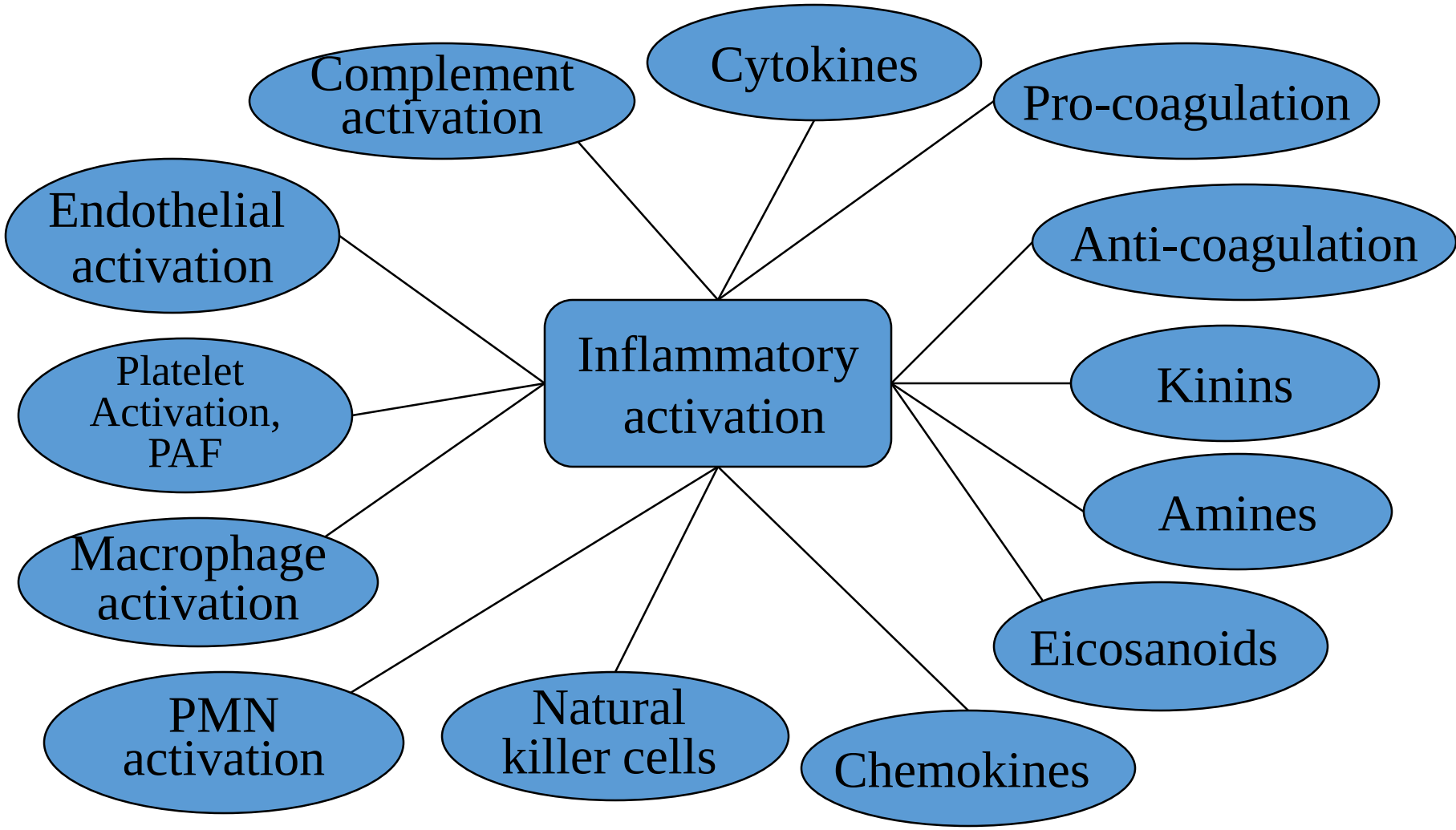


Septic Shock
Initiators of mediator response

Gram negative pathogens
- Endotoxin
- Formyl peptides
- Exotoxins
- Proteases

Gram positive pathogens
- Exotoxins
- Enterotoxins
- Hemolysins
- Peptidoglycans
- Lipoteichoic acid

Inflammatory Cascade



Septic Shock
Pathogenesis - Cardiovascular effects

- Heart rate increases
- Cardiac output increases
- Systemic vascular resistance low
  - Arteriolar tone is decreases - hypotension
  - Venus tone decreased - venous pooling
- Pulmonary vascular resistance is high
  - Right-to-left shunt
- Despite increase cardiac output
  - Tissue hypoperfusion - malperfusion
  - Increased lactate
  - Decreased oxygen utilization

Septic Shock

Pathogenesis - Cardiovascular effects

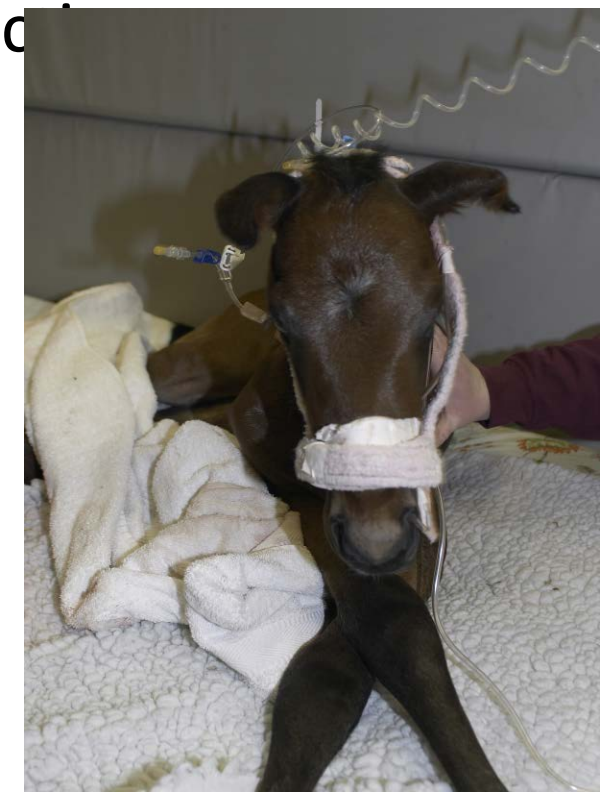
- Decreased sensitivity to catecholamines
  - Circulating vasodilator substances
  - Adrenergic receptor down-regulation
- Loss of microvascular autoregulatory mechanisms
  - Microvascular damage
- Distributive shock
  - Maldistribution of blood flow
  - Dilation of most vascular beds
  - Constriction of some

Sepsis and Septic Shock
Portals of Entry

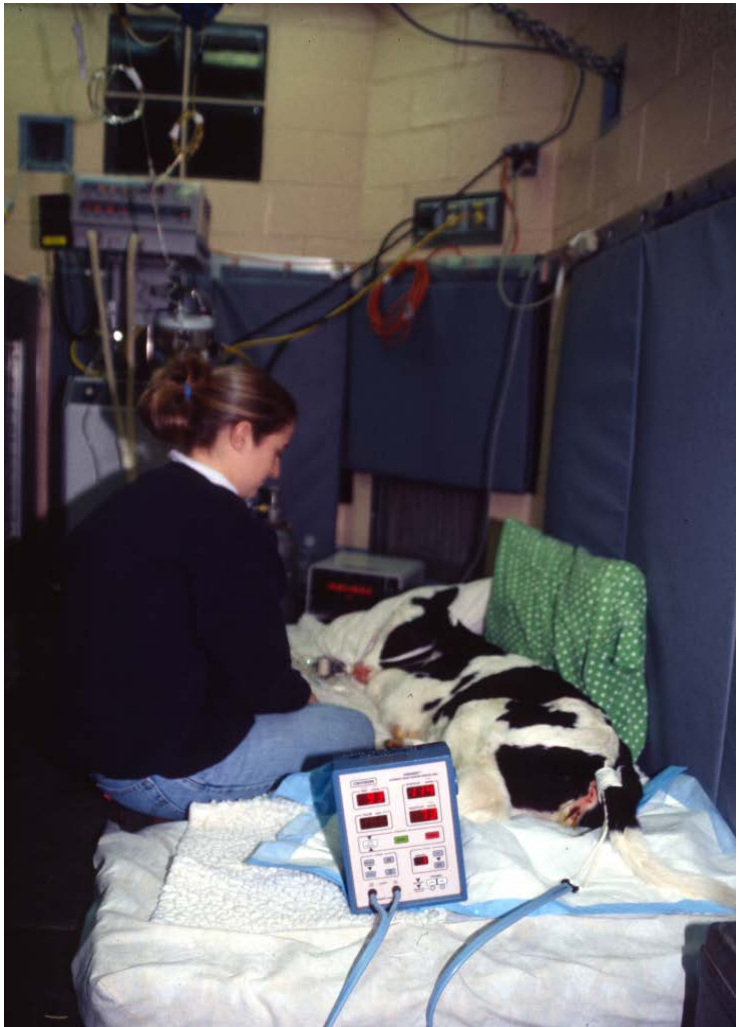
- GIt - Translocation
- Respiratory tract - Aspirat
- Placenta - *in utero*
- Umbilicus

Sepsis and Septic Shock
Predisposing factors

- Placentitis – may be protec
- Prematurity
- Hypoxic-Ischemic disease
- Hypothermia
- FPT
- Stress
- Poor nutrition
- Poor husbandry



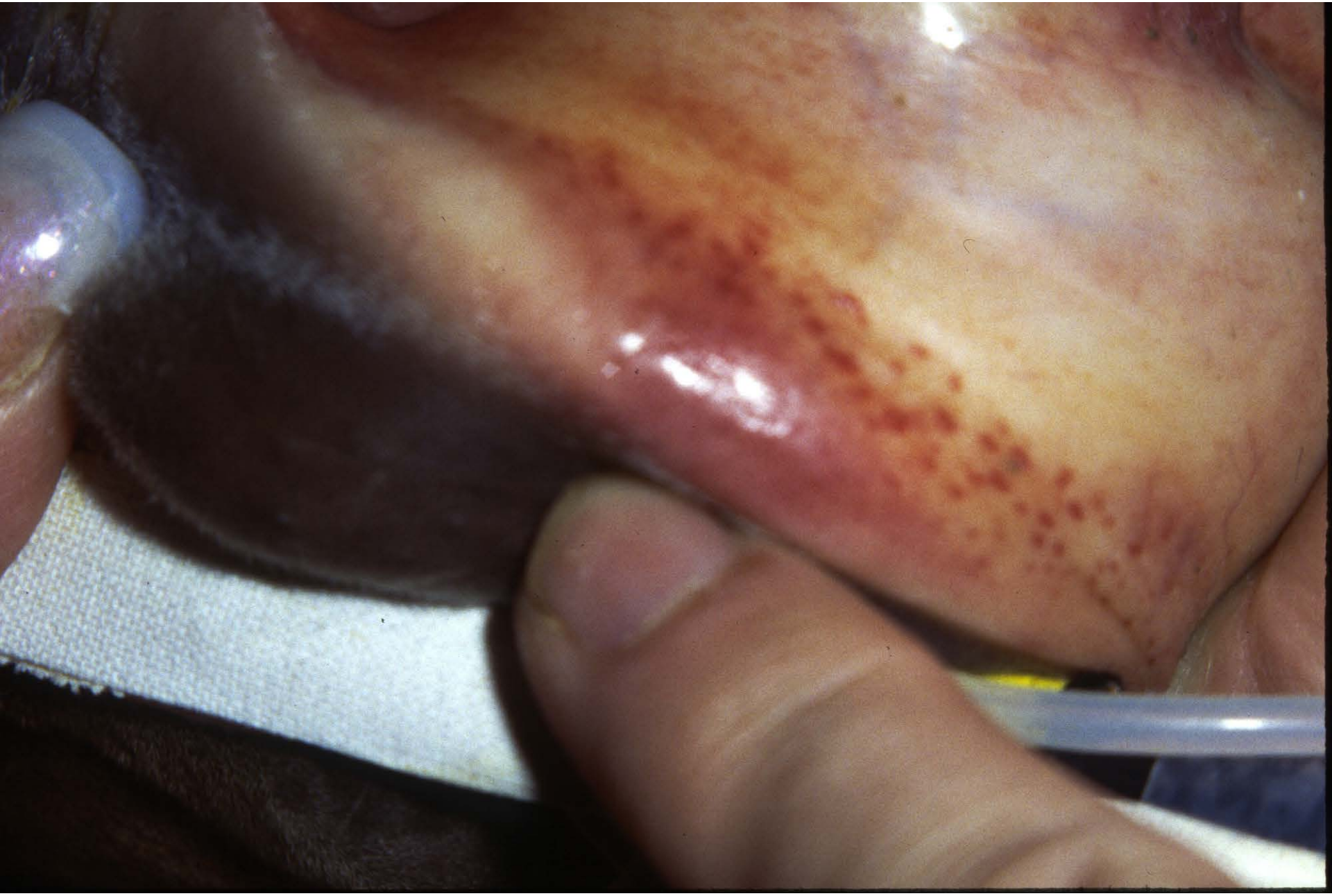
Sepsis and Septic Shock
Localized Infections

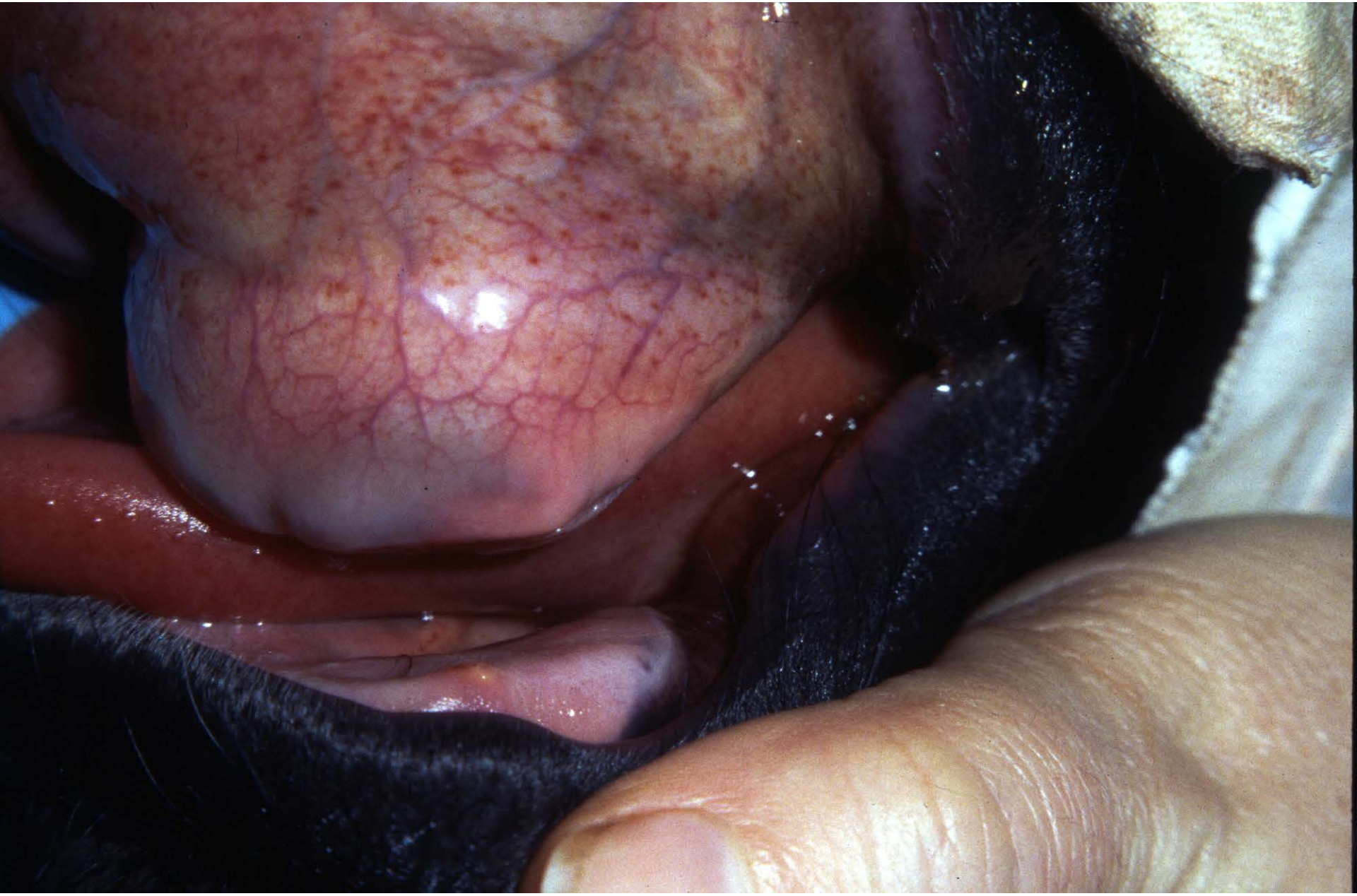


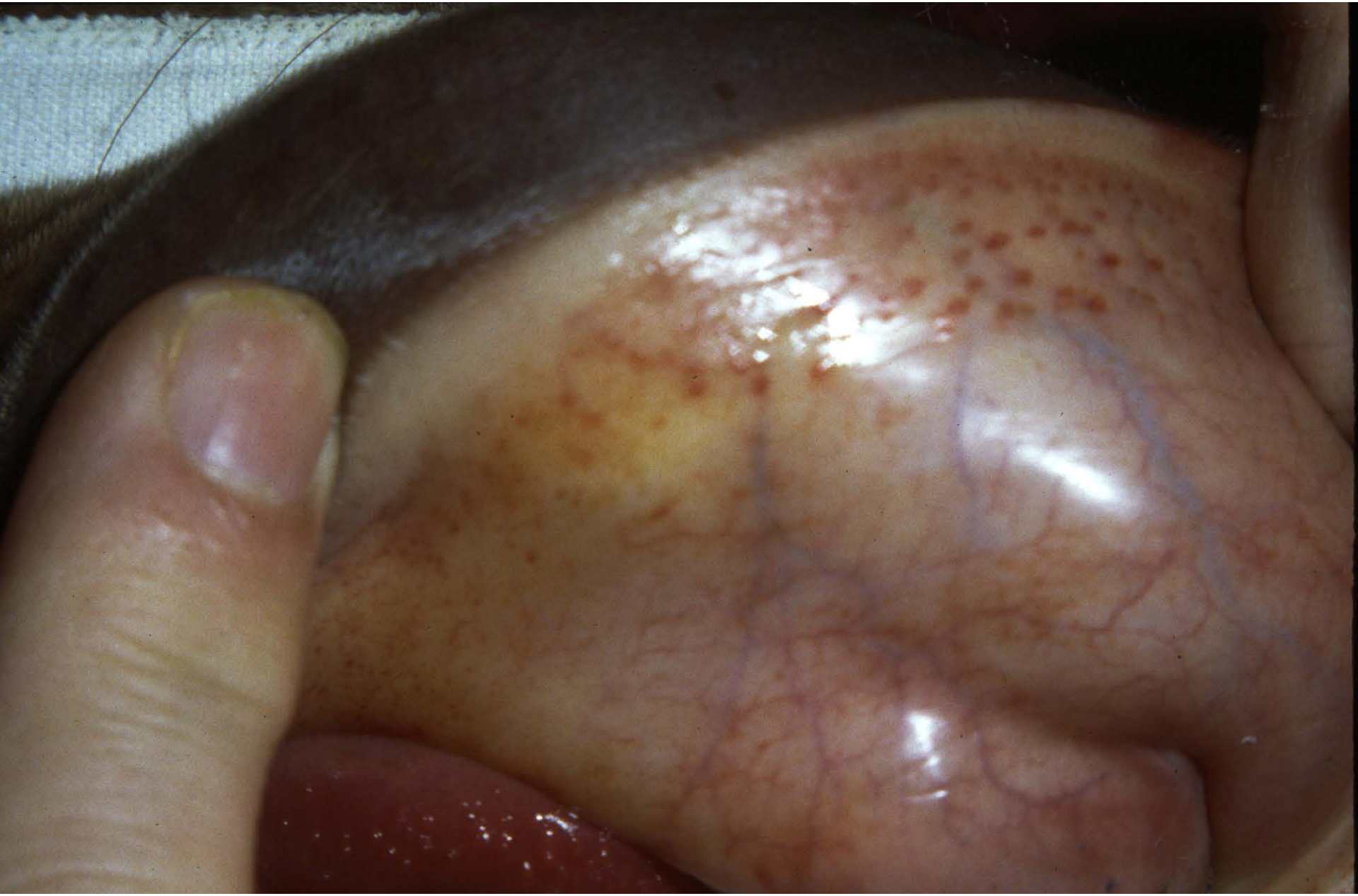
- Pneumonia
- Enteritis
- Arthritis
- Osteomyelitis
- Meningitis
- Omphalitis
- Uveitis

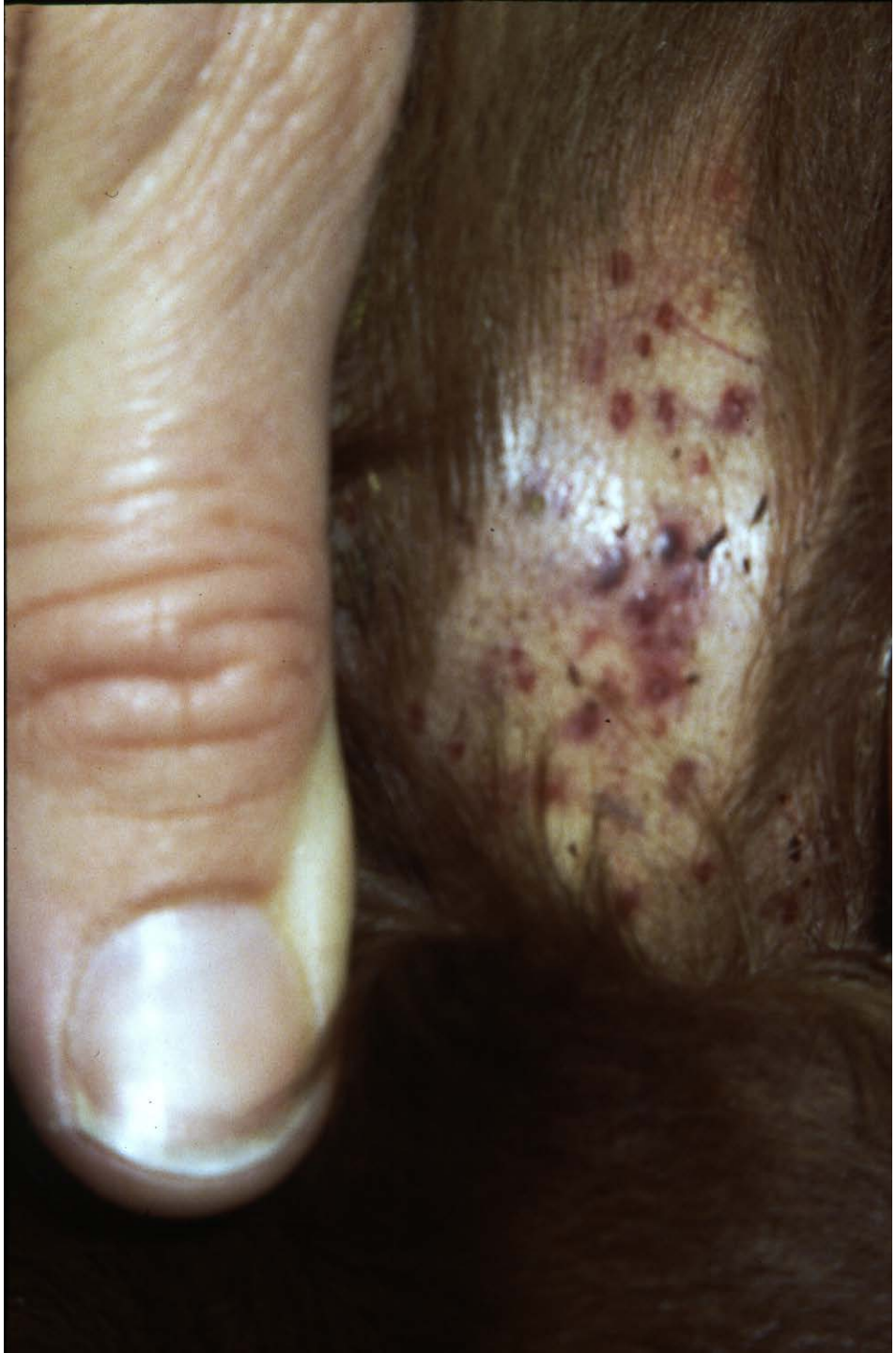
Sepsis and Septic Shock
Signs of Sepsis

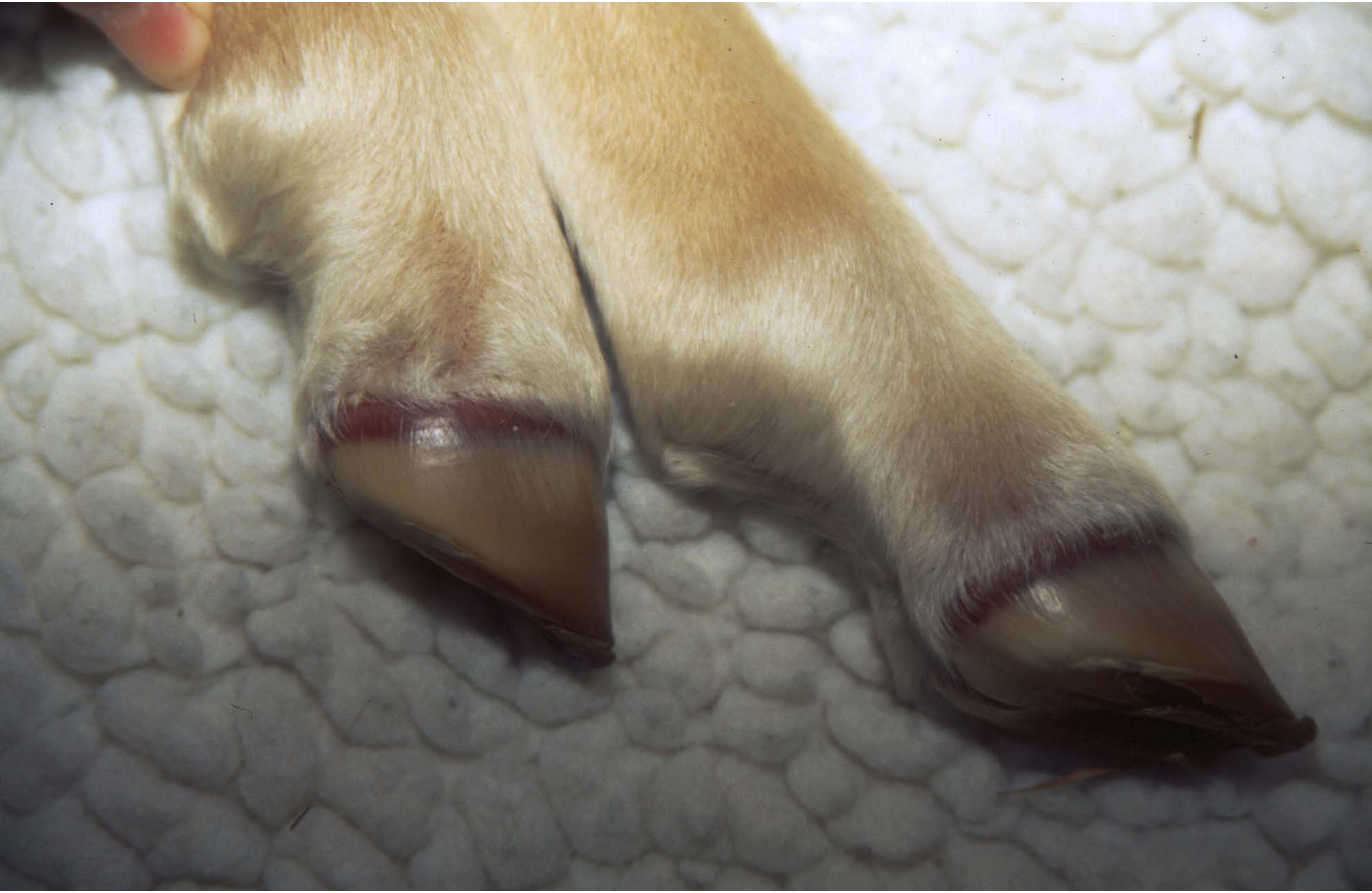
- Fever/hypothermia
- Loss of suckle, lethargy, weakness
- Tachycardia, tachypnea
- Injection, Icterus – oral, scleral
- Petechia - oral, scleral, aural
- Hyperemic coronary bands
- Linear dermal necrosis
- Increased/decreased CRT
- Shock

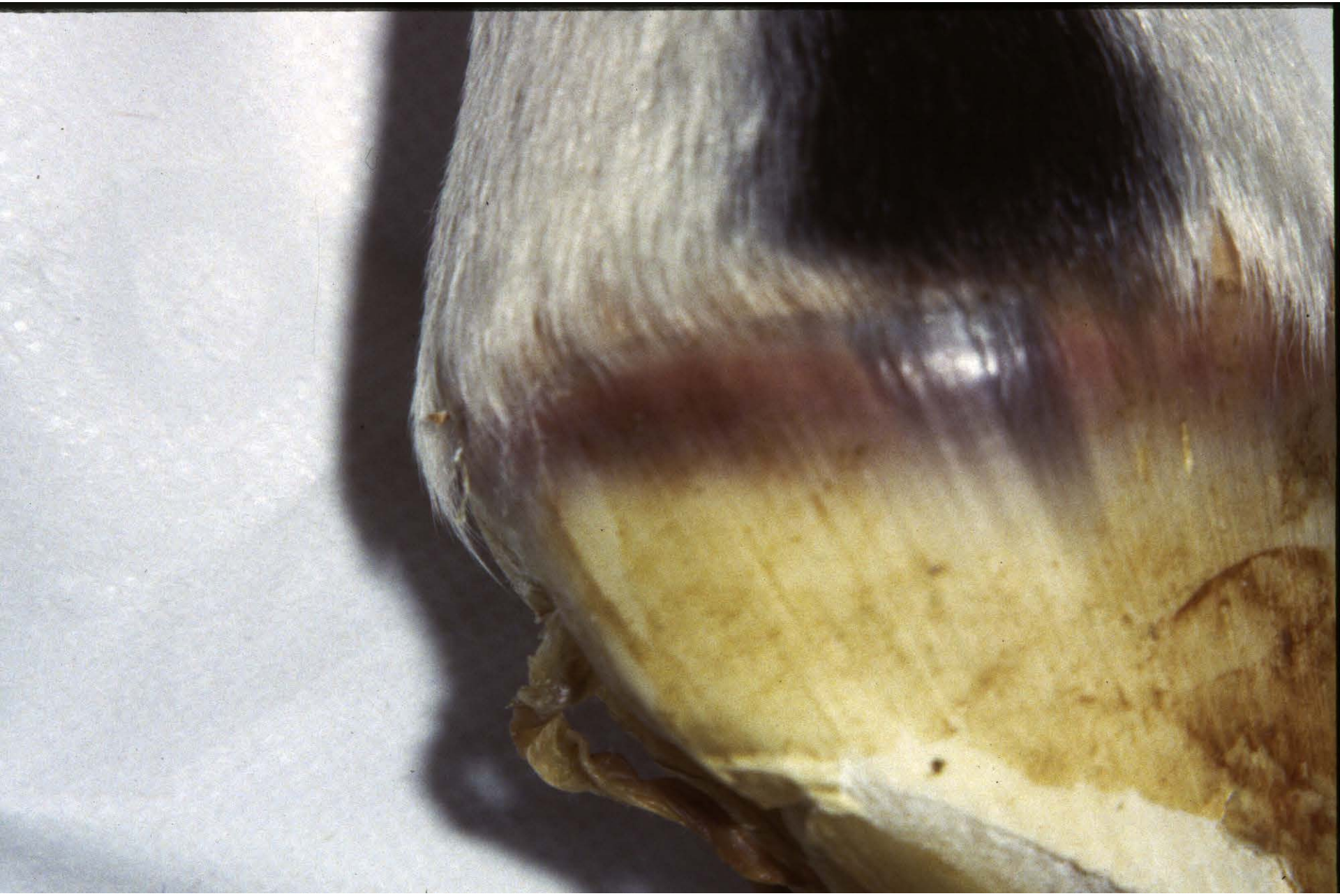


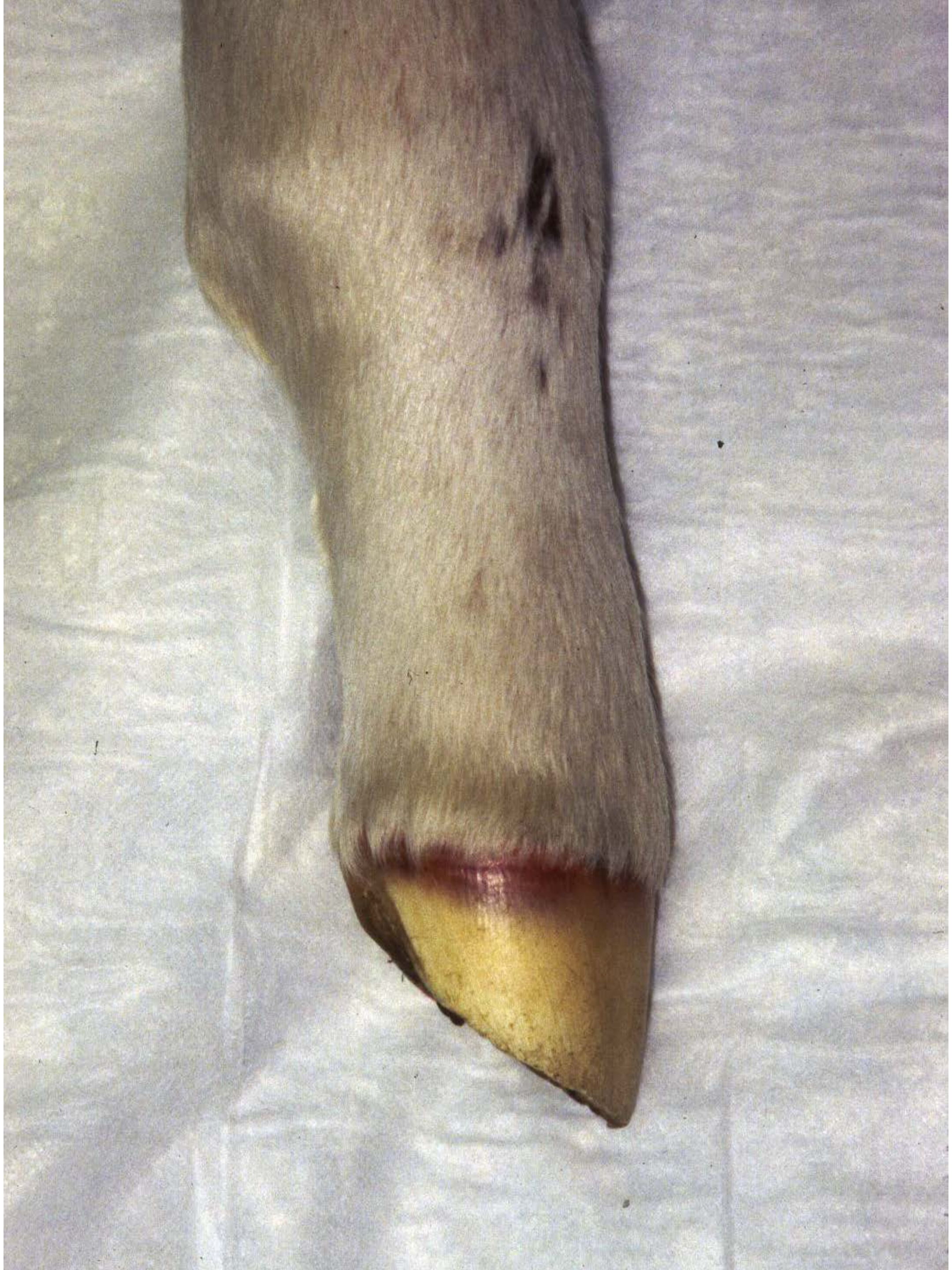


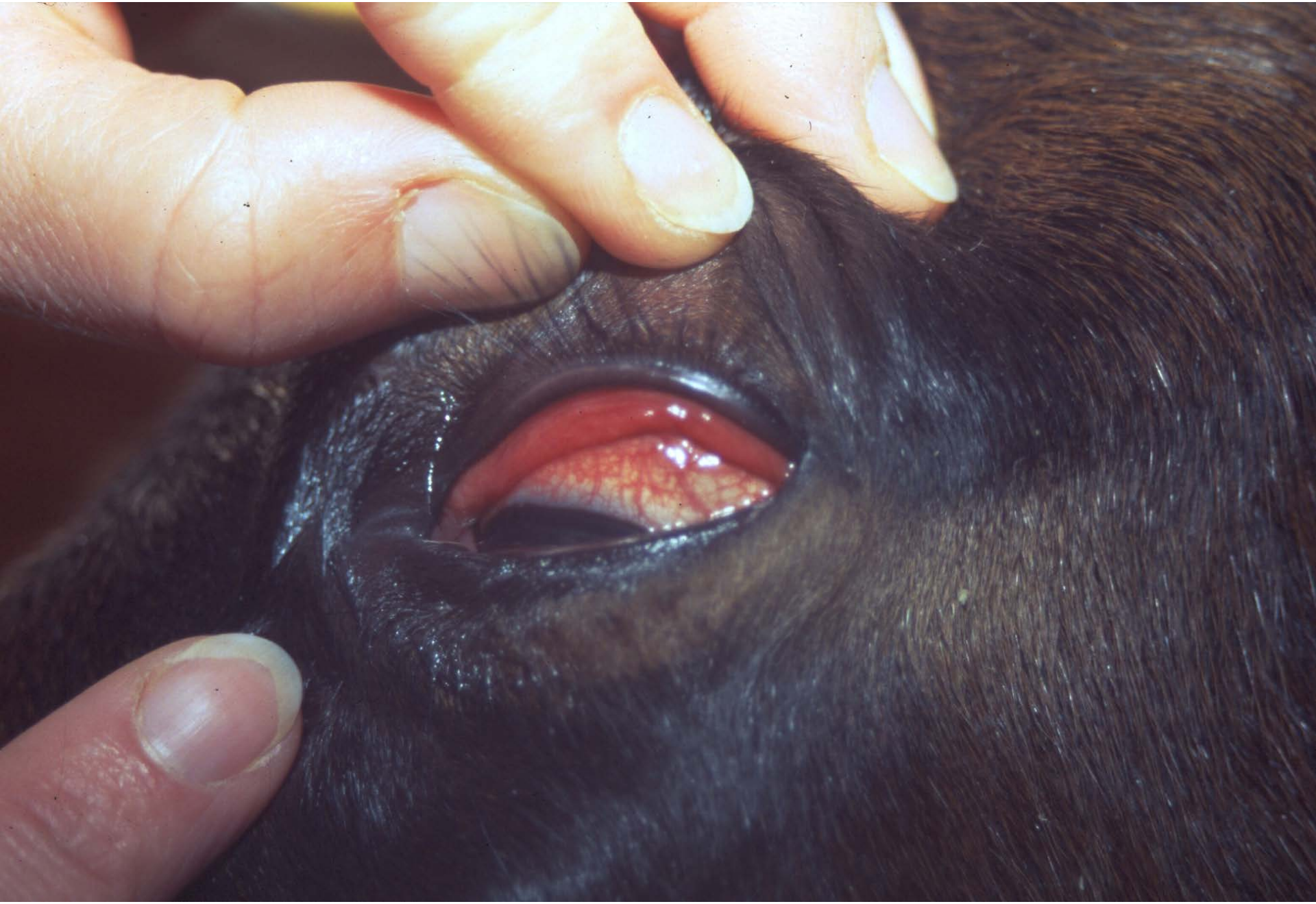


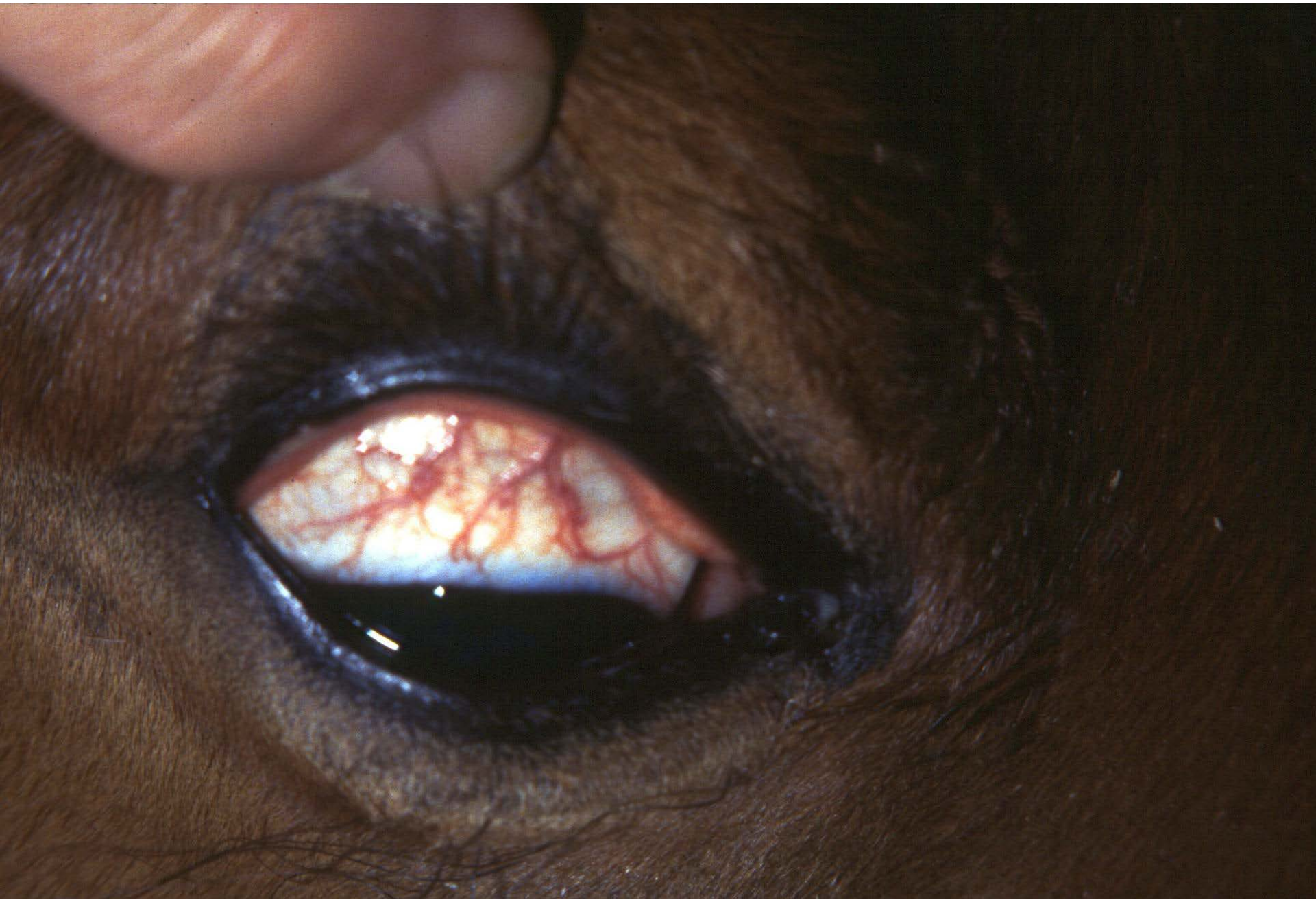


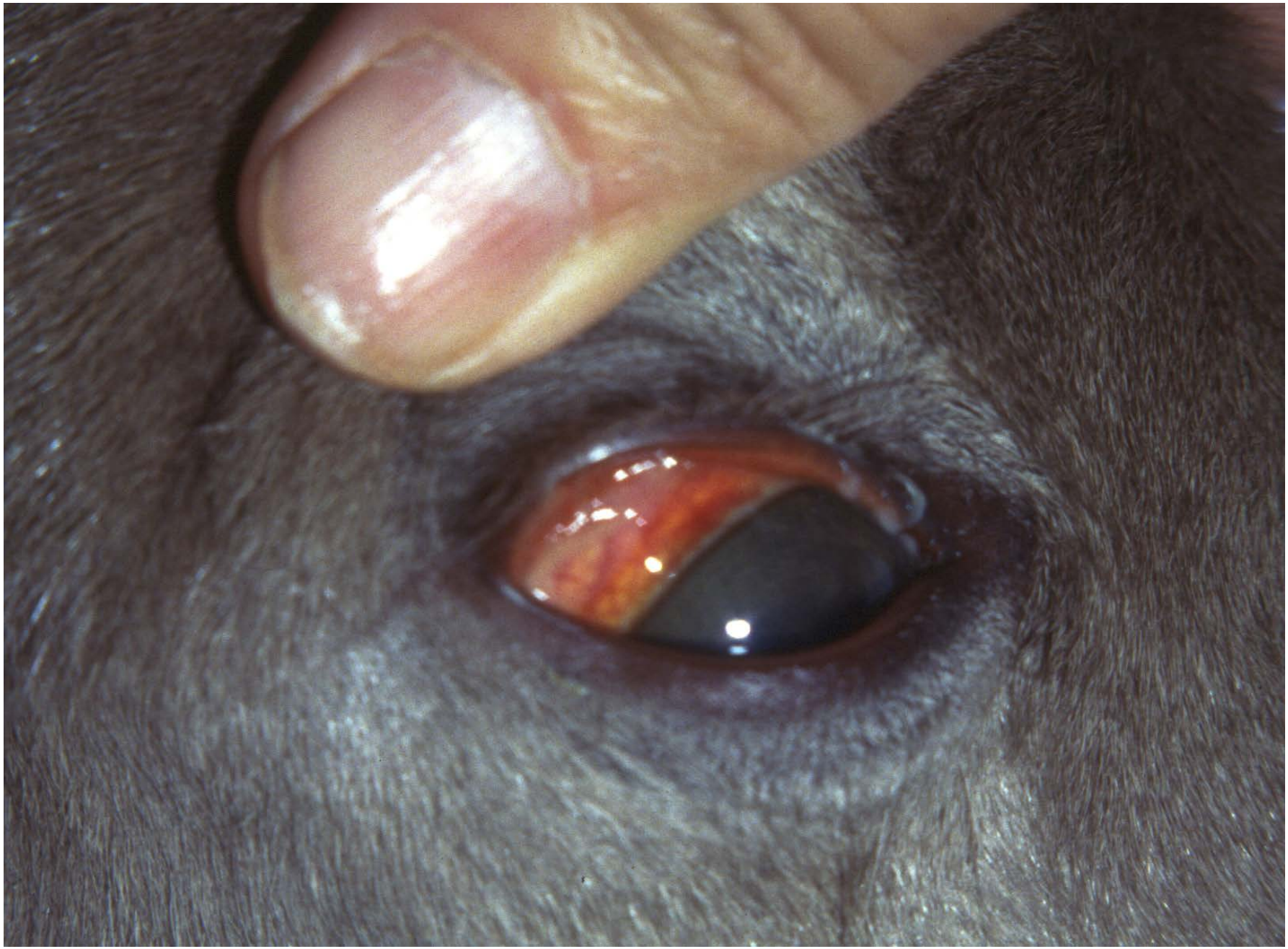


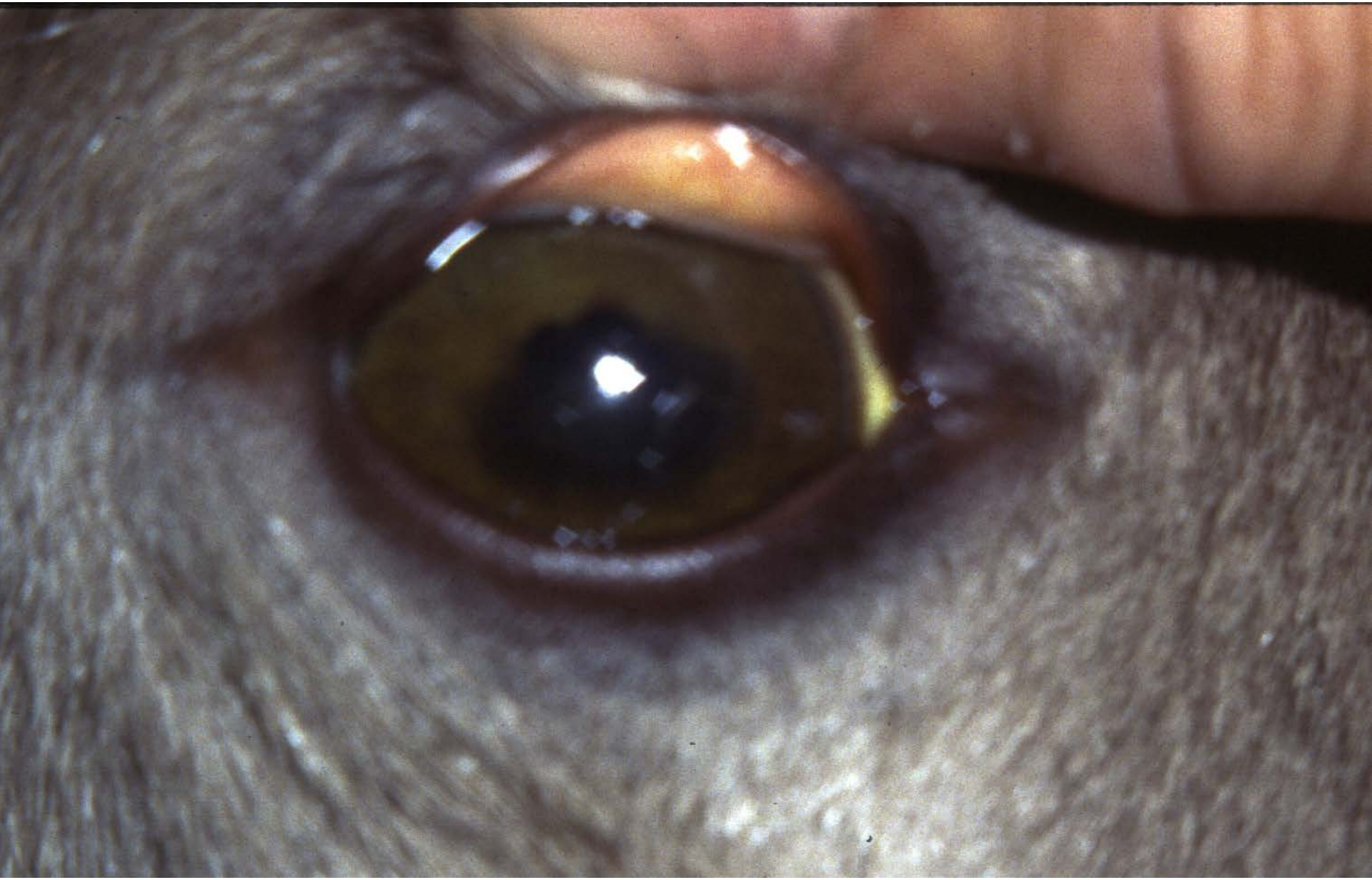


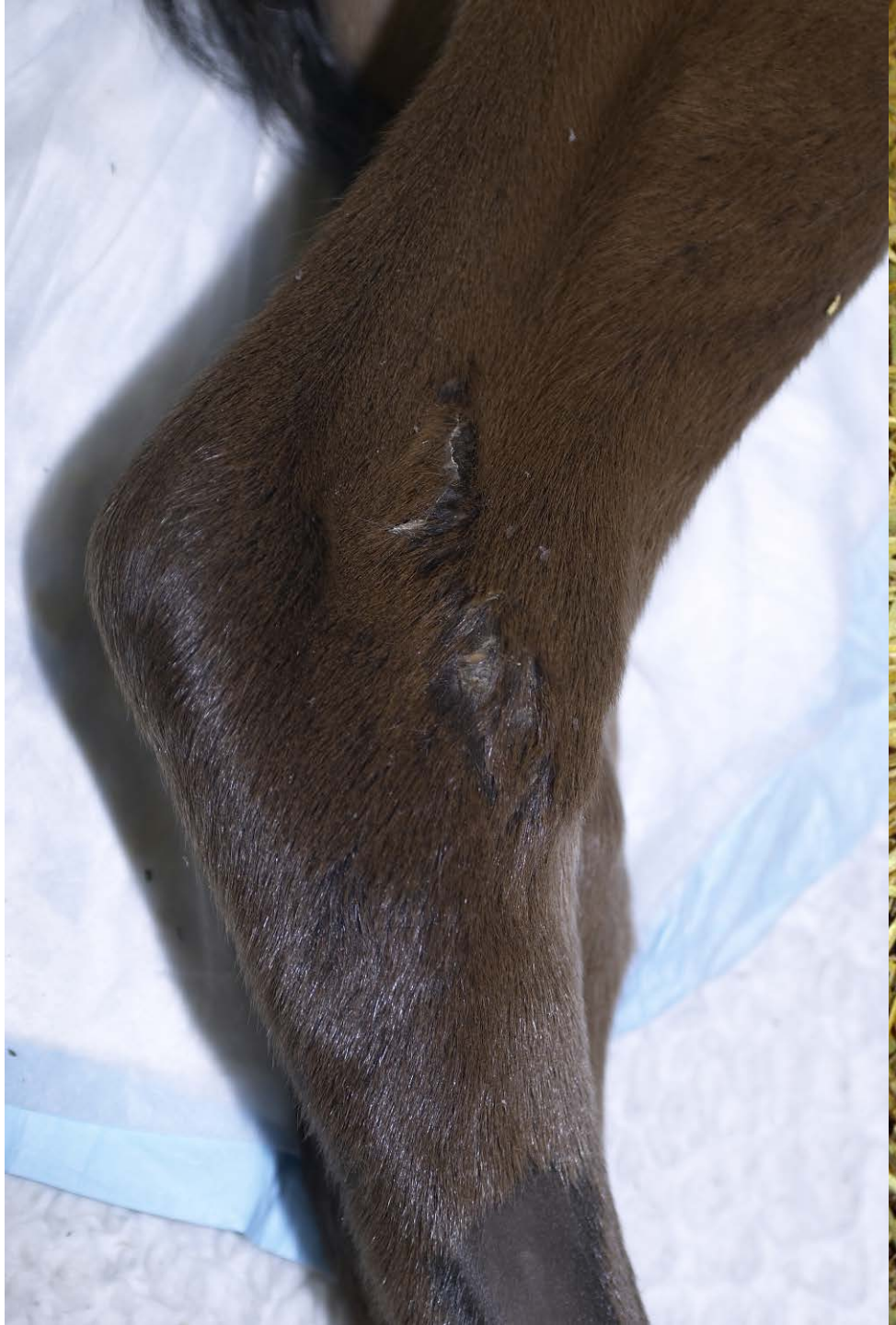
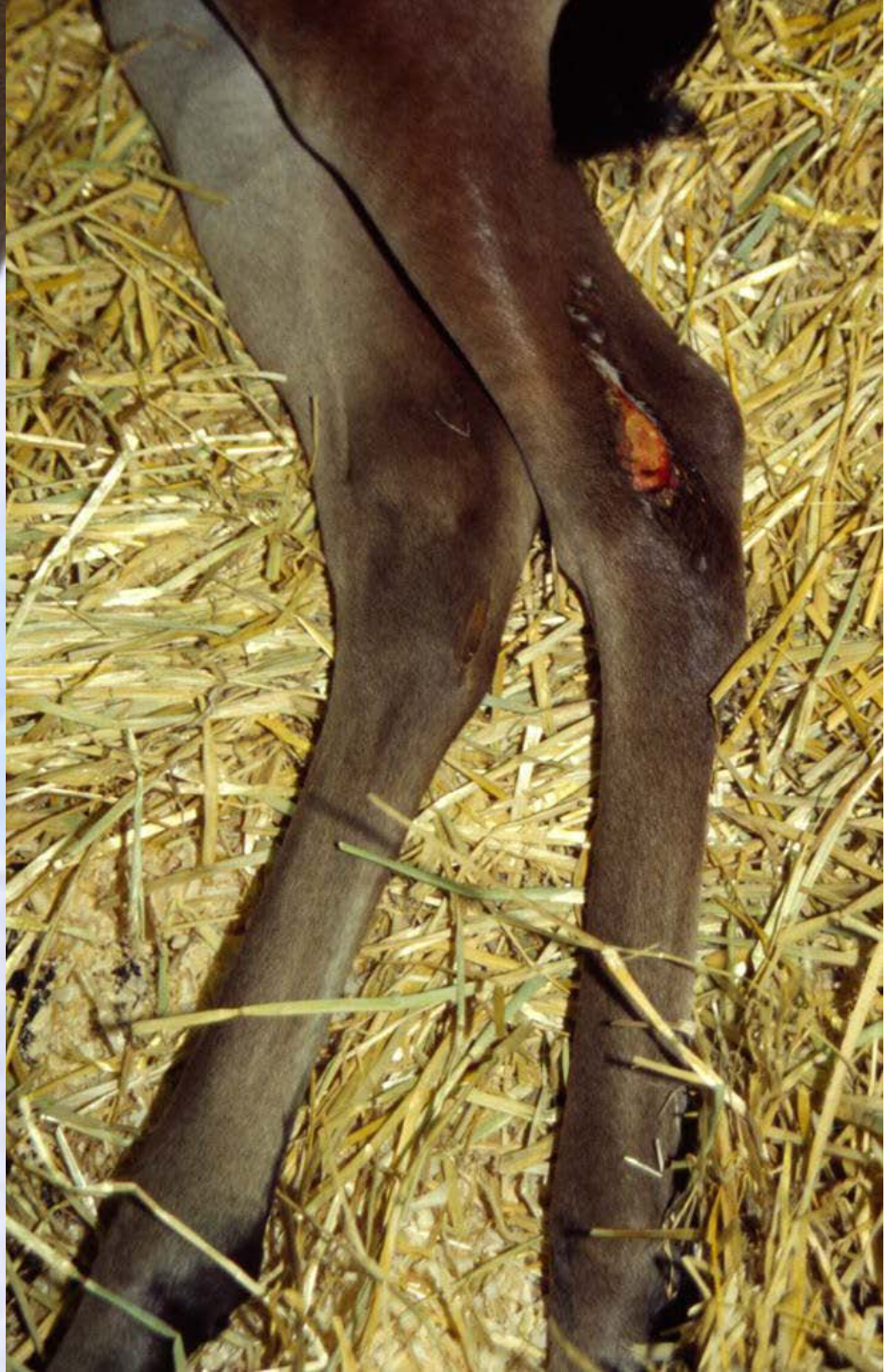










SIRS damage
MODS

GI tract
- Breach of the intestinal barrier
- Translocation of bacteria

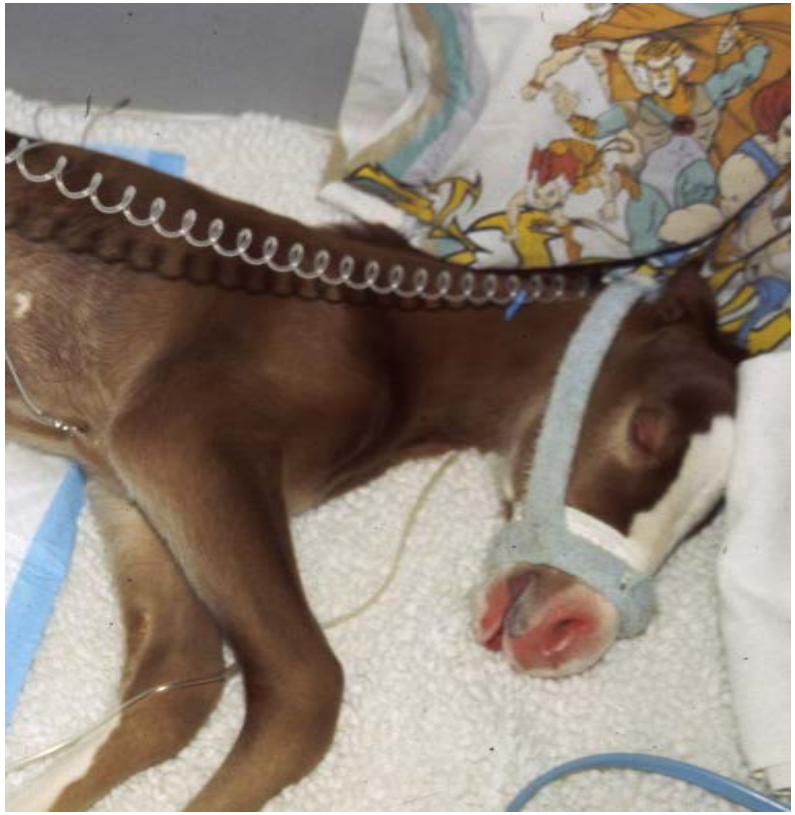
Lungs
- Acute Respiratory Distress Syndrome (ARDS)

CNS
- Breakdown blood brain barrier
- Inflammatory mediators
- Neurosteroid balance

Renal failure
- Decreased renal blood flow – vascular damage
- Acute tubular necrosis

Recognition of SIRS
Release of inflammatory mediators

- Fever
- Tachycardia
- Tachypnea
- Vasodilatation (warm skin)
- Mild controlled infection or systemic responses



Recognition of SIRS/Septic Shock

Bounding pulses
- Widen pulse pressure
- Increased cardiac output
- Increased systemic vascular resistance

Hypoperfusion
- Somnolence
- Fall asleep on feet
- Decreased urine output

Before endothelial damage/dysfunction
- Intervention is most dramatic

Recognition of SIRS/Septic Shock

Shock progresses

Other signs of decreased perfusion

- Cool extremities

  Secondary to increase vasomotor tone

  Normal or high BP

  Cold progressing to ice cold legs

Recognition of SIRS/Septic Shock

- Homeostatic mechanisms fail
  - Hypotension occurs
  - Pulse pressure narrows
- Legs cold
- Tachycardia
- Tachypnea
- Recumbent and nonresponsive
- Decreased cardiac output
- Hypoxia and metabolic acidosis

Sepsis and Septic Shock
Therapeutic interventions

Key interventions

- Treat underlying infection
- Provide hemodynamic support
- Support during MODS and metabolic crisis
- Block proinflammatory mediators

Sepsis and Septic Shock
Therapeutic interventions

- Treat underlying infection
- Anticipate bacteria infection

  Antimicrobial therapy
- Viral infections

  Acyclovir
- Hyperimmune plasma transfusion

Sepsis and Septic Shock
Antimicrobials

- Penicillin
- Amikacin
- Cephalosporins
- Ticarcillin/clavulanic acid
- Imipenim

Septic Shock
Hemodynamic support

Goals

- Clear blood lactate
- Normalize perfusion
- Optimize cardiac output
- Increase systemic oxygen delivery

Septic Shock
Hemodynamic support - Fluid therapy

Crystalloids or colloids?

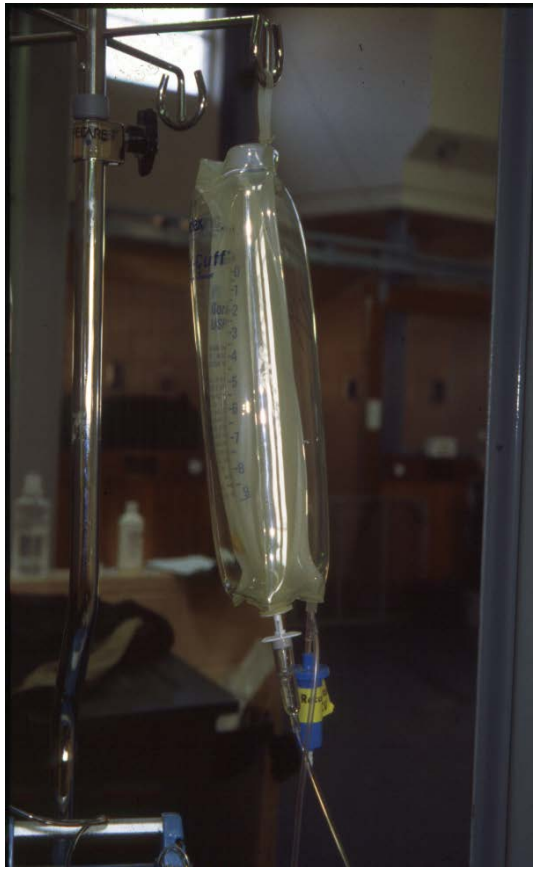
Crystalloid push

- Bolus 20 ml/kg over 10-20 minutes
- Reassess patient after every push
  - Blood pressure
  - Leg temperature
  - Peripheral pulse - arterial fill
  - Urine production
  - Mental status

Transfusions

- Plasma
- Whole blood

Don’t fluid overload



Septic Shock
Pressors/Inotropes

- Therapeutic goal
  - Increase perfusion
  - Not “get good BP numbers”
- Inotropic effect most important
  - Increase cardiac output
- Pressor effect
  - Can negate inotropic effect
  - Hopefully will correct malperfusion
- Use a mix of inotropes and pressors
- Each patient - pharmacokinetic experiment
- Arrhythmias - tachycardia


CRITIKON
DINAMAP
VETERINARY BLOOD PRESSURE MONITOR
MAP
45
SYSTOLIC
73
PULSE
97
DIASTOLIC
35
AUTO MANUAL
START
POWER
OFF
ON

Septic Shock
Pressors/Inotropes

- Dopamine
- Dobutamine
- Norepinephrine
- Epinephrine
- Vasopressin

Septic Shock
Oxygen therapy

- Optimize O2 availability
- Internasal O2 as soon as shock recognized
  - High flows 8-10 lpm
  - Utilize even if Pao2 appears adequate
- Ventilate early
  - Decrease work of breathing
    - 25% of O2 consumption to support respiration
  - Cardiovascular function improves
  - Make respiratory failure easier to manage
  - Modest PEEP
    - Decrease work of breathing, pulmonary resistance
    - Decrease hypoxia, need for high FIO2
- Improve gas exchange with inhaled NO


VITALMIX
CLINIC

Sepsis and Septic Shock
Nutritional Support

Sepsis is associated with
- Hypermetabolism
- Catabolism

Hyperglycemia
- Catecholamine stimulated glycolysis
- Catecholamine mediated insulin resistance
- Insulin therapy
  - Strict glucose control

Hypoglycemia
- Often profound, refractory hypoglycemia
- Monitor blood glucose levels frequently
- IV glucose therapy

Sepsis and Septic Shock
Inhibiting Toxic Mediators

Antitoxins - Antiendotoxin

Anti-interleukin-1 receptor

Antibradykinin, AntiPAF

AntiTNF, TNF antagonists, NSAIDs

Steroids, Interleukin-1 antagonists

Bradykinin antagonists, Modulate NO

Antiadhesion factors

Large clinical trials in man

- Not show improvement of survival
- Activated protein C (Xigris)

SIRS/Septic Shock
Inhibiting toxic mediators

Why the failures?

Interactions are very complex

Compensatory anti-inflammatory response syndrome (CARS)

Genetic variations in mediators

Timing – interactions

SIRS/Septic Shock
SIRS – CARS Balance

Effective therapy for septic shock await

- Understanding the interaction and balance
- Understanding the timing