AUTO-TRANSFUSION

Amanda A Cavanagh, DVM, DACVECC
Auburn Annual Conference October 2024

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Road Map

- Indications
  - Severe hemorrhagic shock
- Benefits of Shed Blood
- Risks of Shed Blood
- Collection Techniques and Administration

2

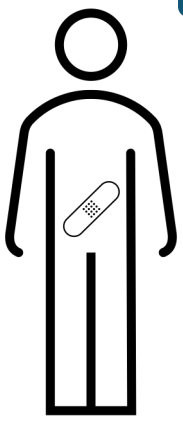
Indications

- Severe hemorrhagic shock

- Trauma
- Coagulopathy
- Neoplasia
- Surgical hemorrhage

3

Hemorrhage



Class I Hemorrhage: <15% loss
- no intervention

Class II : 15 - 30% loss
- crystalloids

Class III : 31 - 40% loss
- crystalloids + blood

Class IV : > 40% loss
- blood

Edwards TH, Rizzo JA, Pusateri AE.. Transfusion. 2021
American College of Surgeons ATLS 10th Edition

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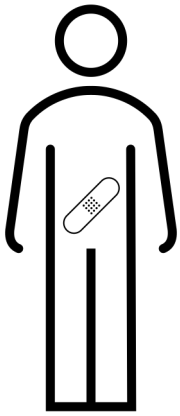
Hemorrhage



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Edwards TH, Rizzo JA, Pusateri AE.. Transfusion. 2021
American College of Surgeons ATLS 10th Edition

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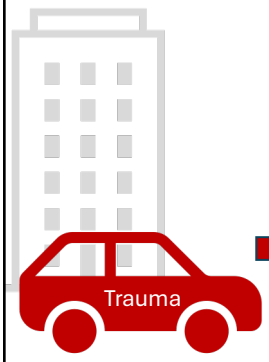
Blood failure



Blood Loss, Shock, Inflammation

Blood Failure: Class III and IV hemorrhage

Endothelial Dysfunction

Coag-ulopathy

Platelet Dysfunction

Edwards TH et al., Transfusion. 2021

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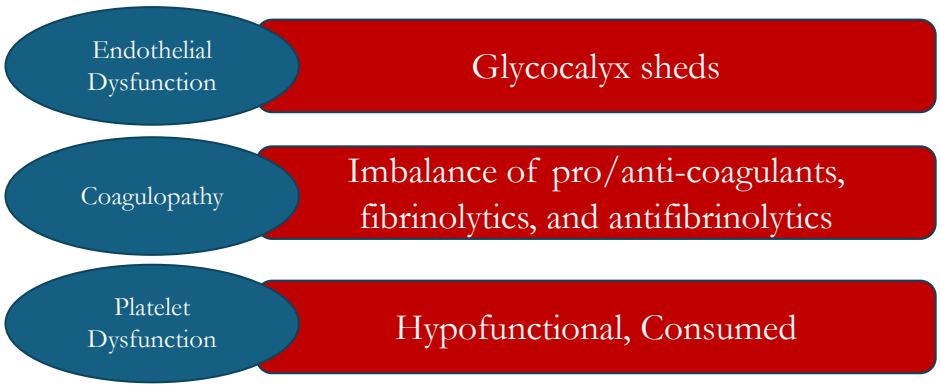
Hemorrhage = Blood Failure



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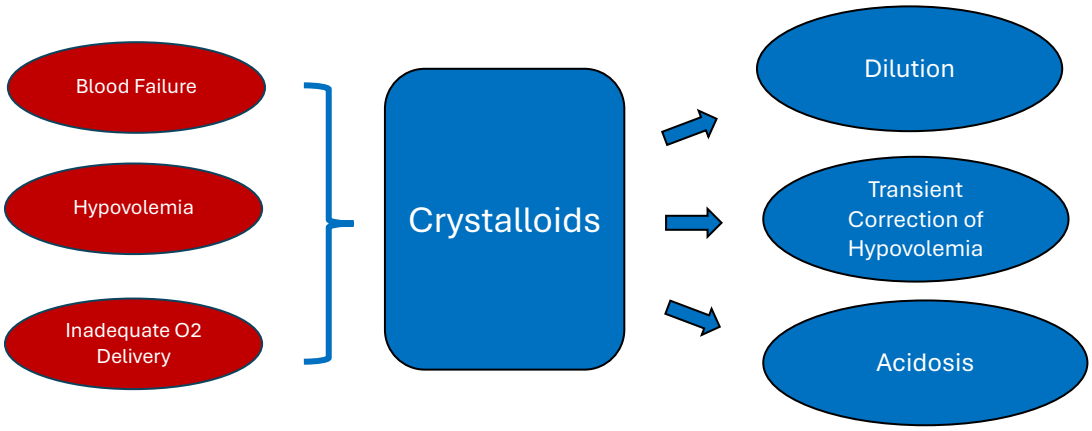
Crystalloids



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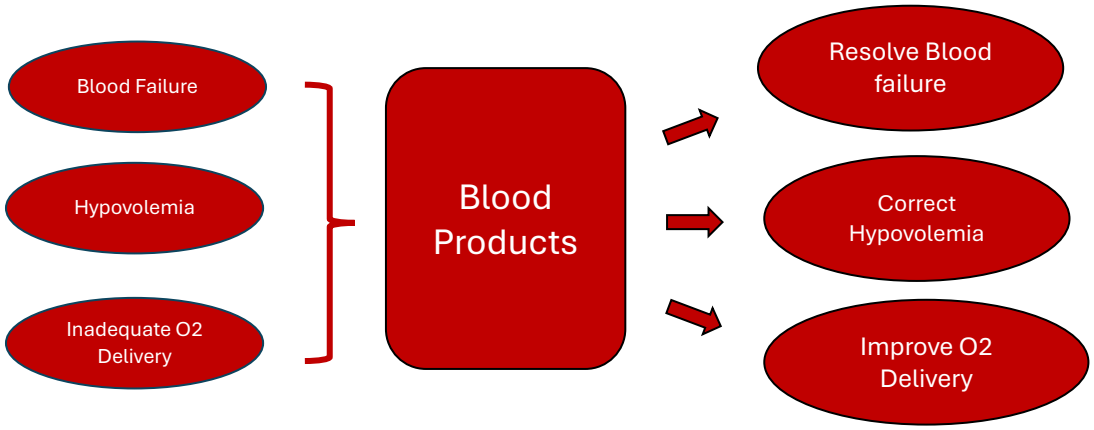
Blood for Resuscitation



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Hemostatic Resuscitation

- Stop bleeding early: tourniquet, packing, compression
- Address hypothermia
- Minimize crystalloids
- Use blood products to restore volume and O2 carrying
- Antifibrinolytics to stabilize clots

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The use of a kaolin-based hemostatic dressing to attenuate bleeding in dogs: A series of 4 cases

Andrea Huther DVM[1] | Thomas H. Edwards DVM, MS, DACVECC[1,2,3] | Ericka L. Jaramillo DVM[1] | James T. Giles III DVM, MS, DACVS[1] | Sarah K. Israel DVM, DACVS[1] | Michael Mison DVM, DACVS[4] | Lisbeth Ambrosius DVM, MS, DACVIM[5] | Teresa Kaiser DVM[5] | Guillaume L. Hoareau DVM, PhD, FCCM, DACVECC, DECVECC[6]

STOP THE BLEED

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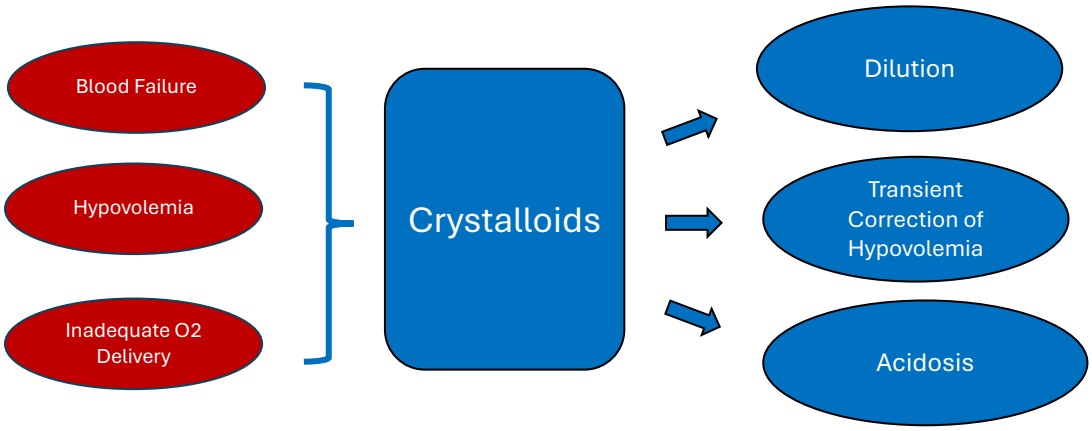
Minimize crystalloids



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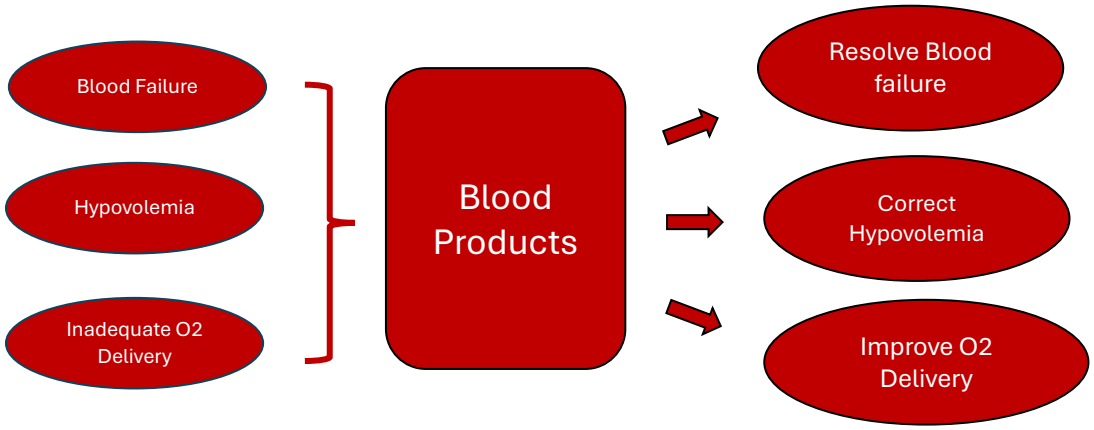
Blood for Resuscitation



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Timing

Delays in balanced blood product resuscitation increases mortality

Early use of pRBC and plasma decreases mortality, particularly with > 20-minute transport times

Sperry et al., NEJM. 2018
Pusateri et al., JAMA Surg. 2020

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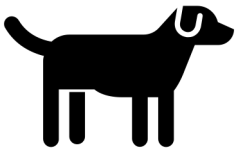
Crystalloids, if you must

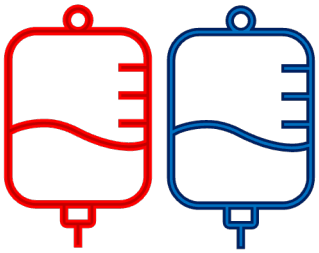
10 ml/kg



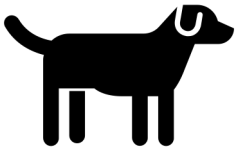
5 ml/kg

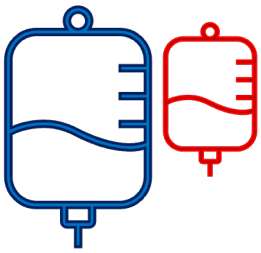
17

Crystalloids, if you must



10 ml/kg

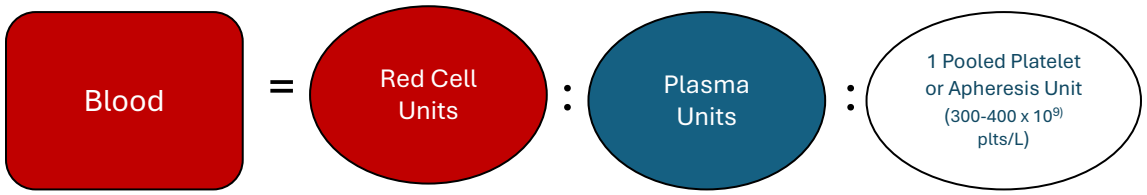




5 ml/kg

18

Blood for resuscitation



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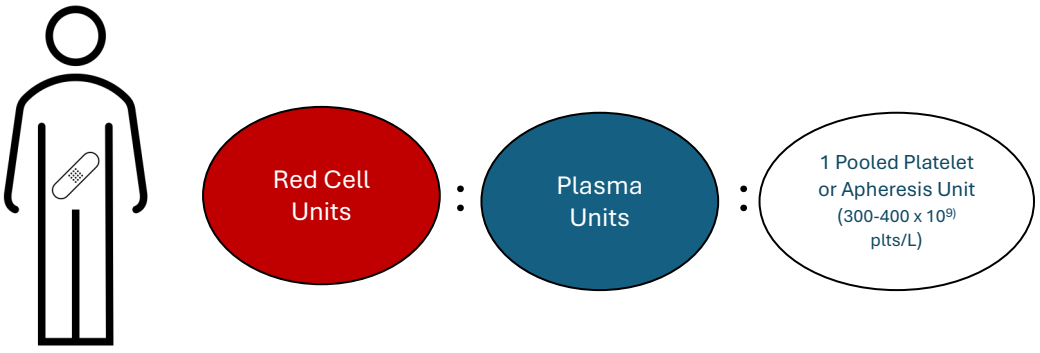
Blood for resuscitation



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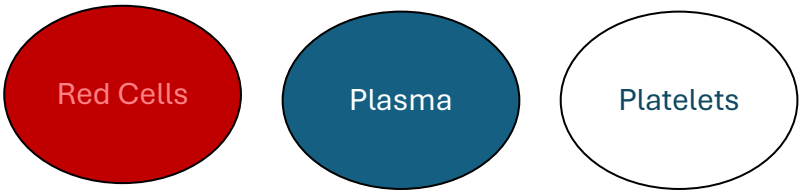
Veterinary Products

- Fresh Whole Blood
- Chilled Whole Blood
- pRBC + Plasma + Platelets
- Auto-transfusion + Plasma + Platelets



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Hemostatic capacity of canine chilled whole blood over time

Thomas H. Edwards DVM, MS, DACVECC[1] | Daniel N. Darlington PhD[1] |
Anthony E. Pusateri PhD[1] | Jeffrey D. Keesee[1] | Daikor D. Ruiz[1] | Joshua S. Li
Jacquelyn S. Parker DVM, MS, DACVS[2] | Andrew P. Cap MS, MD, PhD[1]

- Whole blood in fridge (4° C) for 28 days
- In vitro evaluation of platelet function and hemostasis

- Forms strong clot to day 14 (compared to FWB)
- Maintains hemostatic properties for 21 days

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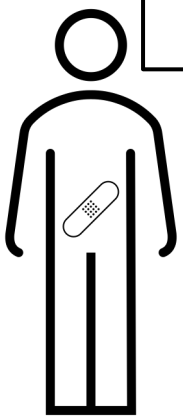
Safety profile and impact of low-titer group O whole blood for emergency use in trauma

James Williams, BS, Nicholas Merutka, BS, David Meyer, MD, MS, Yu Bai, MD, PhD, Samuel Prater, MD, Rodolfo Cabrera, BSN, EMT-P, John B. Holcomb, MD, Charles E. Wade, PhD, Joseph D. Love, DO, *and* Bryan A. Cotton, MD, MPH, *Houston, Texas*



- Chilled whole blood
  - 53% reduction in blood product transfusion
  - 2-fold increase in survival compared to component therapy

Williams et al., J Trauma Acute Care Surg. 2020

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Packed RBC + Plasma + Platelets

1:1 Ratio

Platelets on round 2
- platelet concentrate
- platelet rich plasma

Edwards TH, Rizzo JA, Pusateri AE. Transfusion. 2021

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Shed Blood

- Cavitary Hemorrhage
  - Trauma
  - Coagulopathy
  - Neoplasia
  - Surgery
- Collect and Transfuse
  - RBC
  - Plasma proteins and colloid support

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Shed Blood: Benefits

- Warm
- Type Compatible
- Higher 2,3-DPG
- No transmission of infectious disease
- RBC to carry O2
- Plasma proteins for oncotic support
- Better than crystalloids

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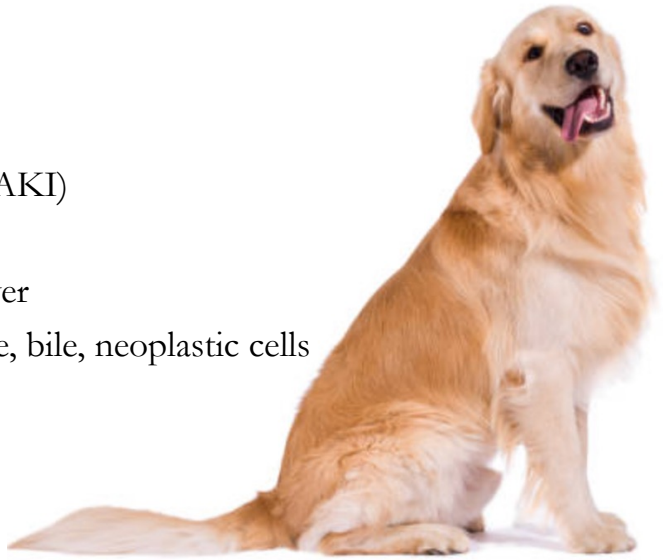
Cons

- No platelets
- No clotting factors
- Hemolysis (pigment induced AKI)
- Anti-coagulant properties
- Inflammatory cytokines = fever
- Must screen for bacteria, urine, bile, neoplastic cells



Kongsgaard et al., ACTA, 1993.

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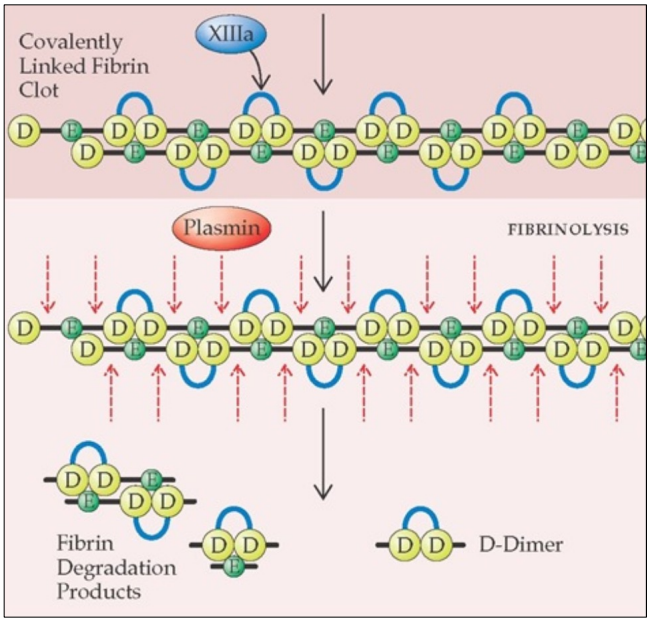
Defibrinated Blood

- Liquid Blood: no active platelets or clotting factors
- No anti-coagulant needed for collection of cavitary effusion
  - 20 minutes – 1 hour



Wu et al., PLOS one. 2020
Chapin et. Al., Blood Rev, 2015
https://www.erbamannheim.com/article/scientific-updates/178

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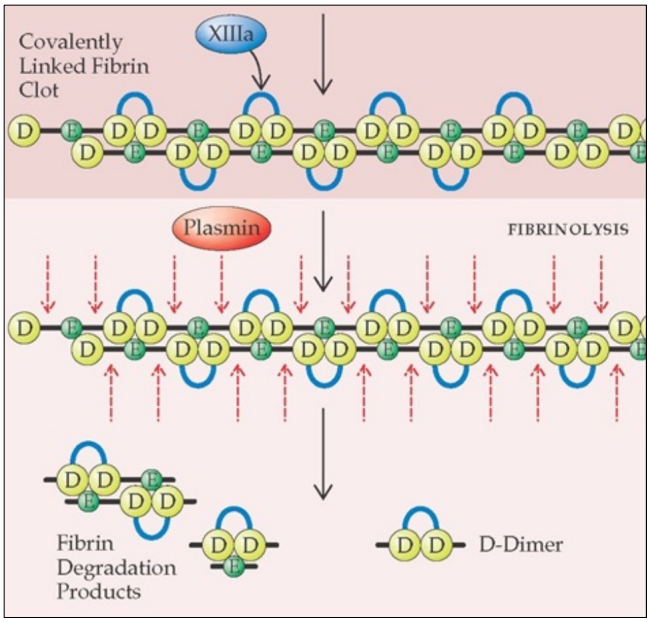
Defibrinated Blood

- Auto-transfused blood can lead to coagulopathy
- FDP's prolong clot formation
- Need to combine with FFP to arrest hemorrhage



Wu et al., PLOS one. 2020
Chapin et. Al., Blood Rev, 2015
https://www.erbamannheim.com/article/scientific-updates/178

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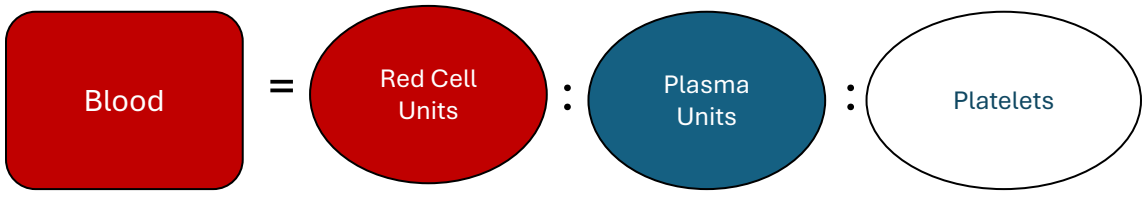
Shed Blood for Resuscitation



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Shed Blood for Resuscitation

Blood = Shed Blood : Fresh Frozen Plasma : Platelet Product

RBC
Plasma Proteins

Clotting Factors

Active Platelets

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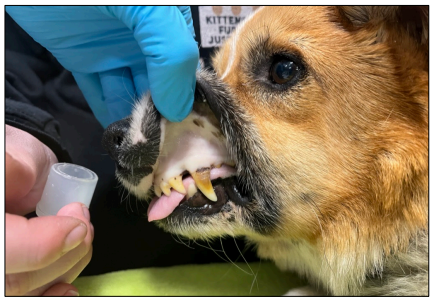

Diagnosing Cavitary Bleeding

Perfusion Parameters

- MM Color/CRT
- Heart Rate
- Pulse Quality
- Limb and Rectal Temp
- Weakness
- Dull mentation

POCUS

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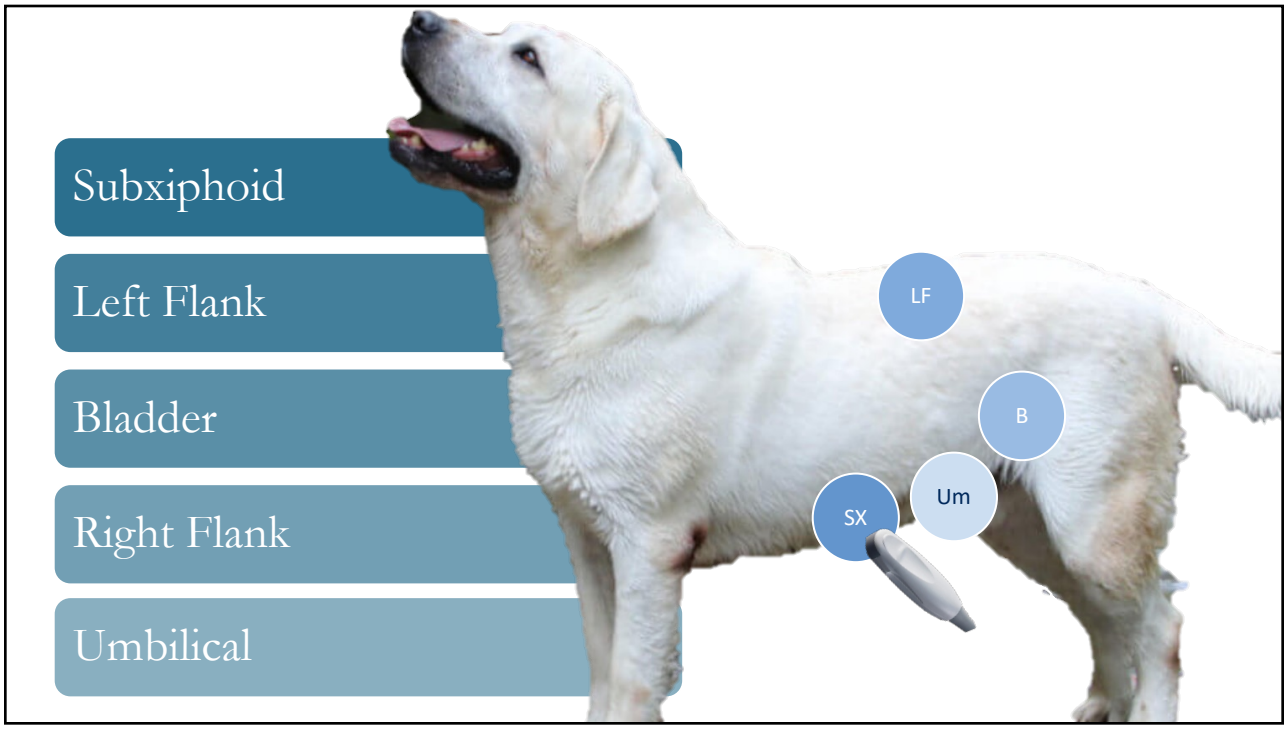
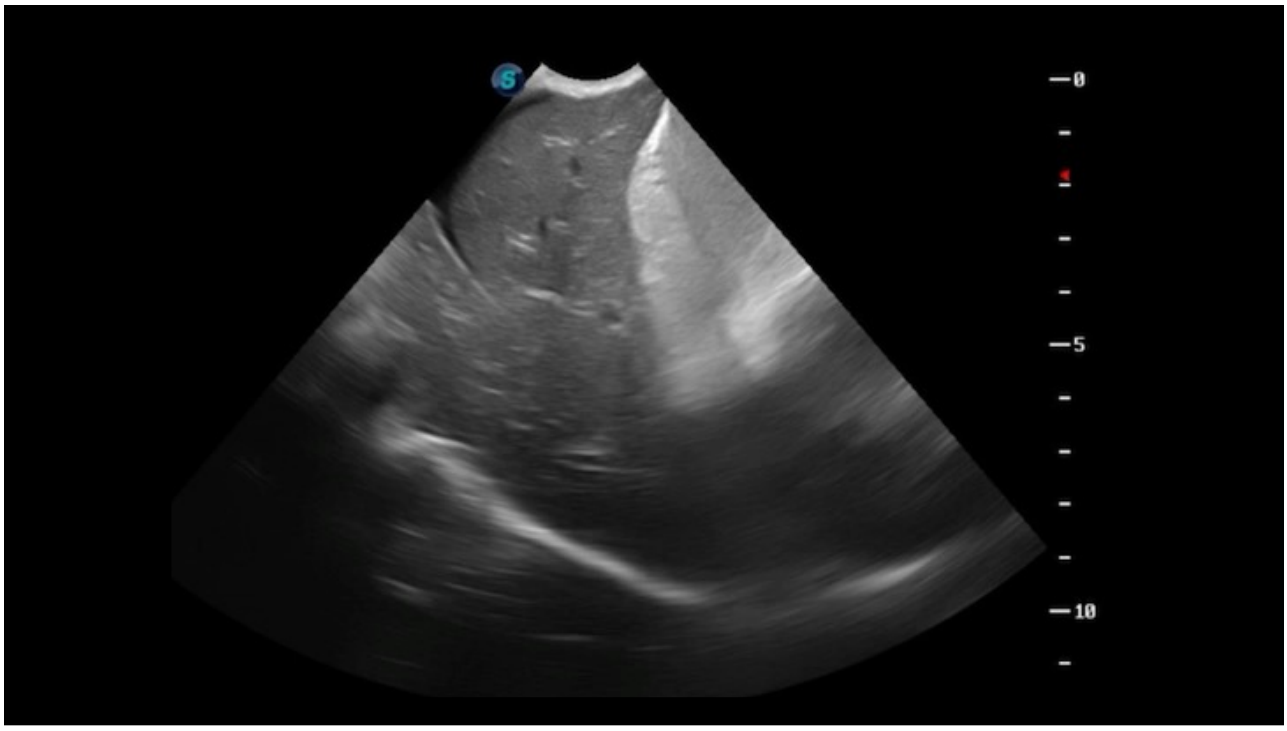
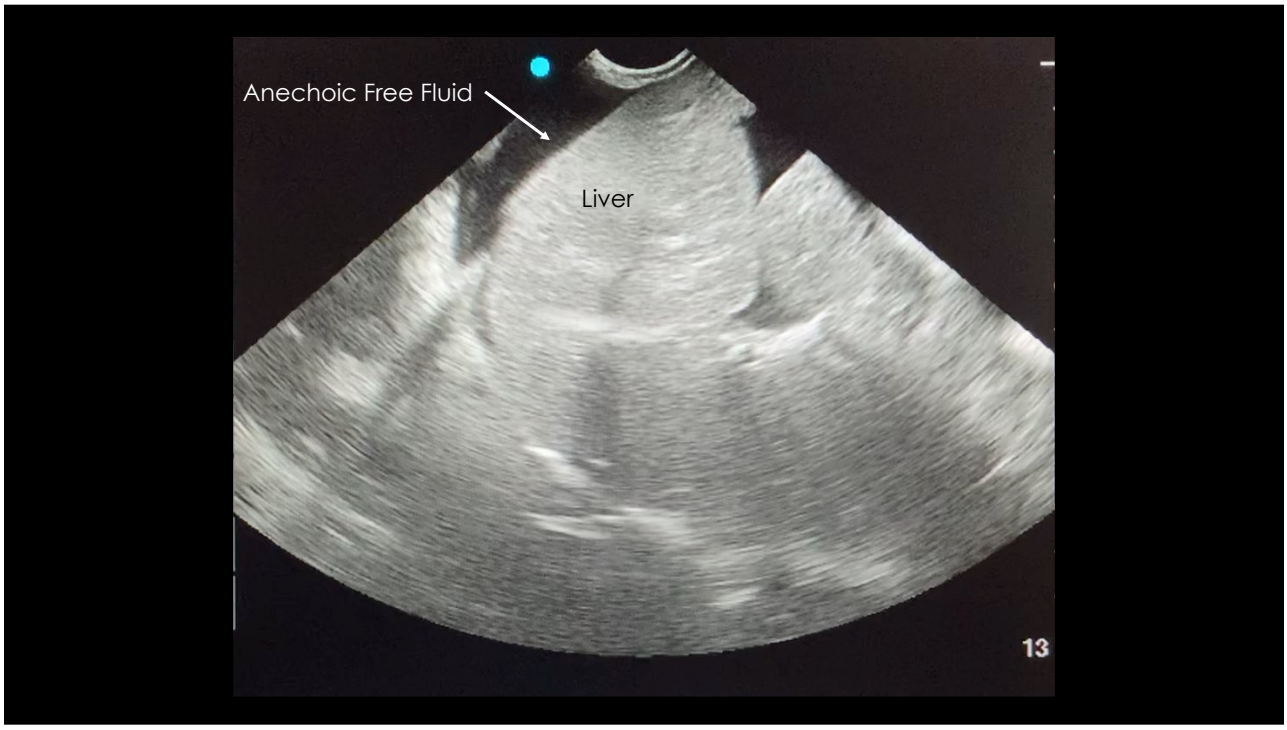

Subxiphoid
Left Flank
Bladder
Right Flank
Umbilical
LF
B
Um
SX

35


0
5
10

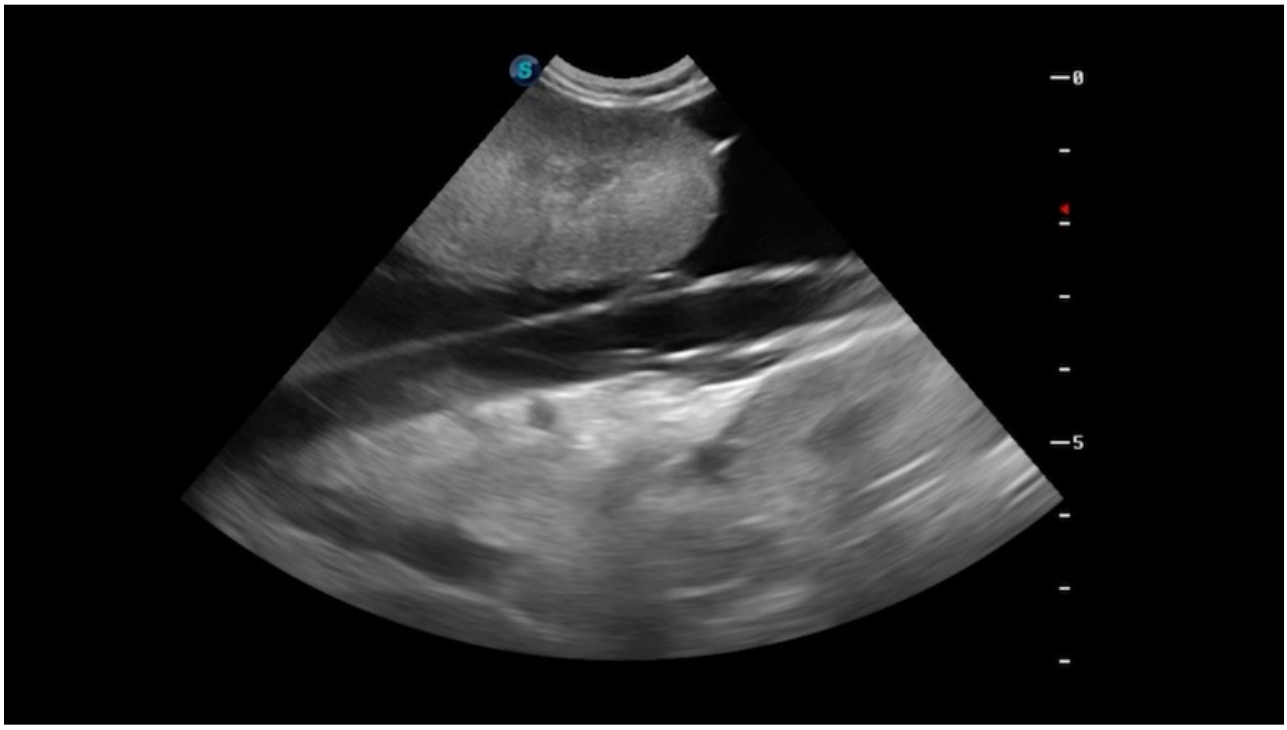
37


Anechoic Free Fluid
Liver
13

38


Spleen
Anechoic Free Fluid
Kidney
11

39



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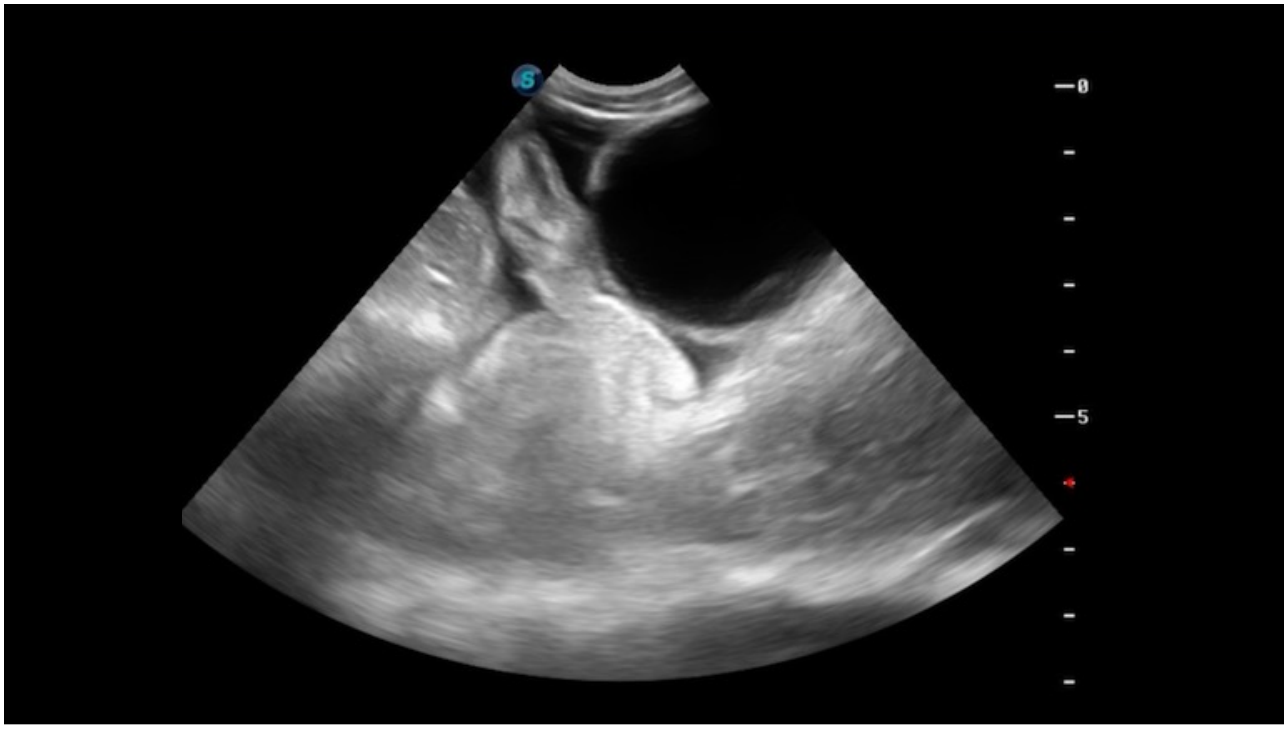
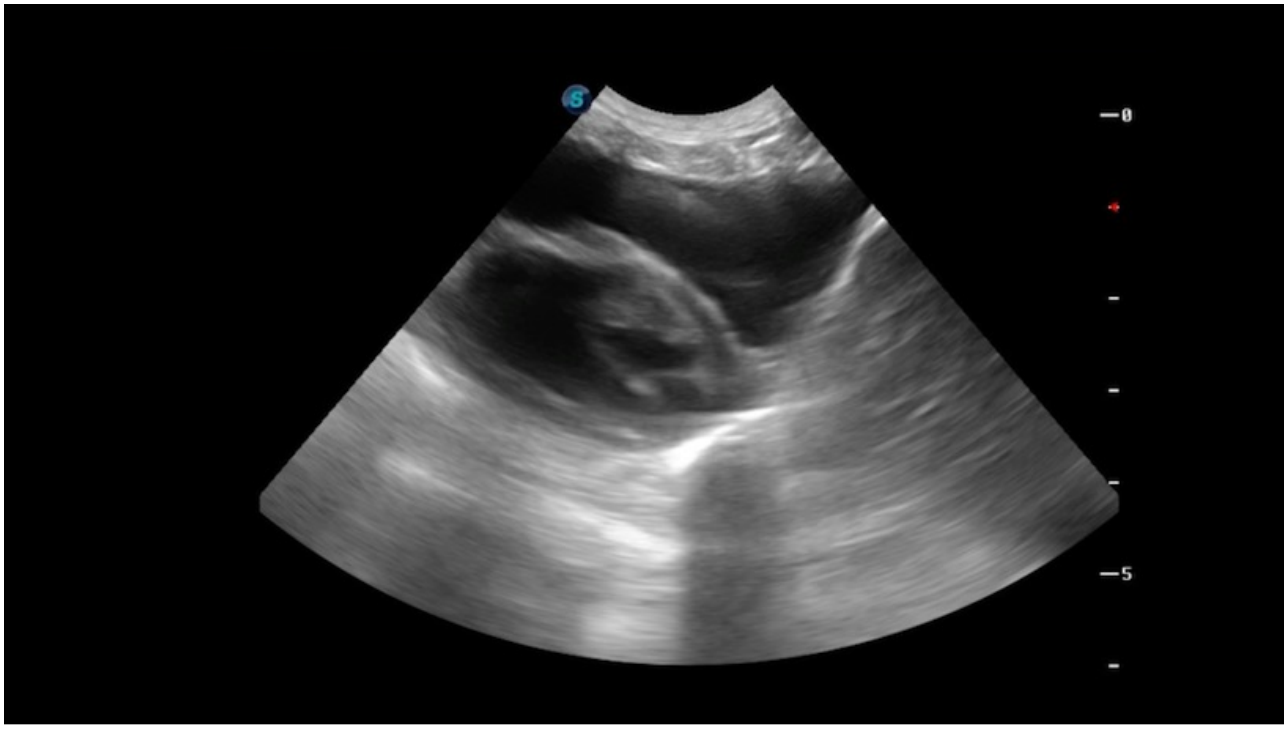


41

42



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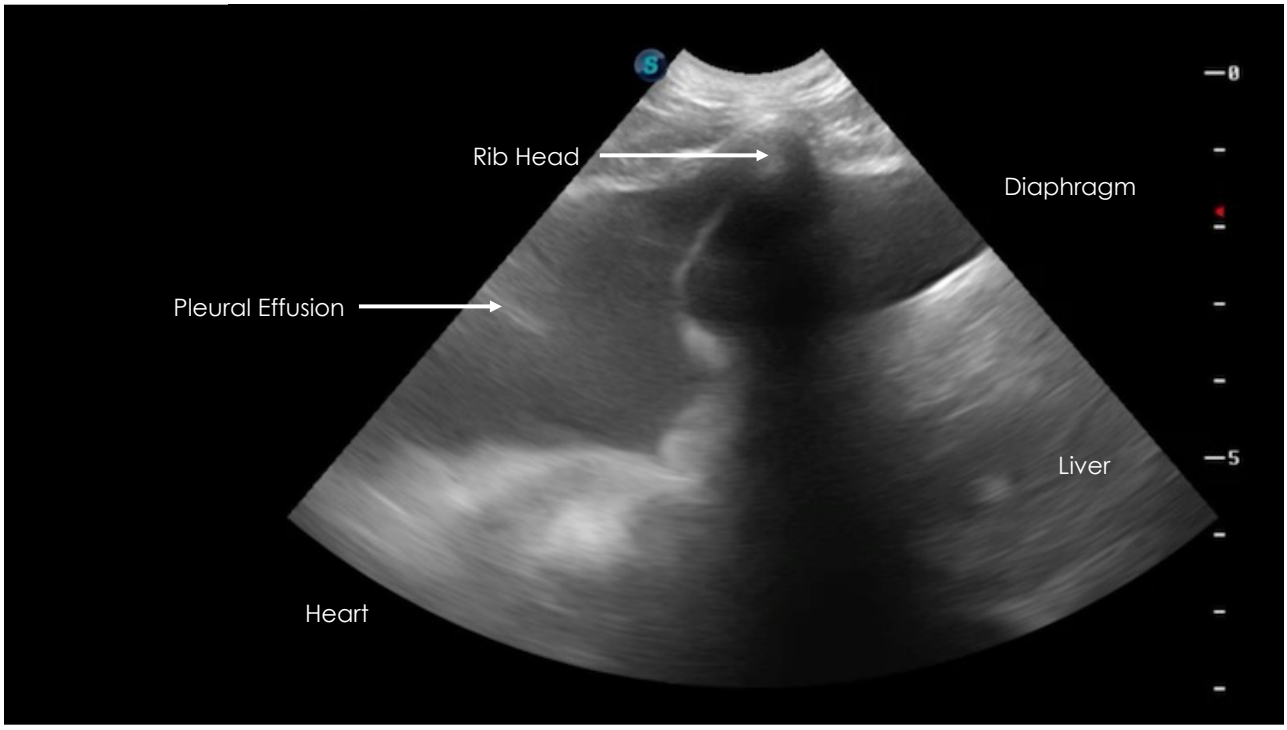
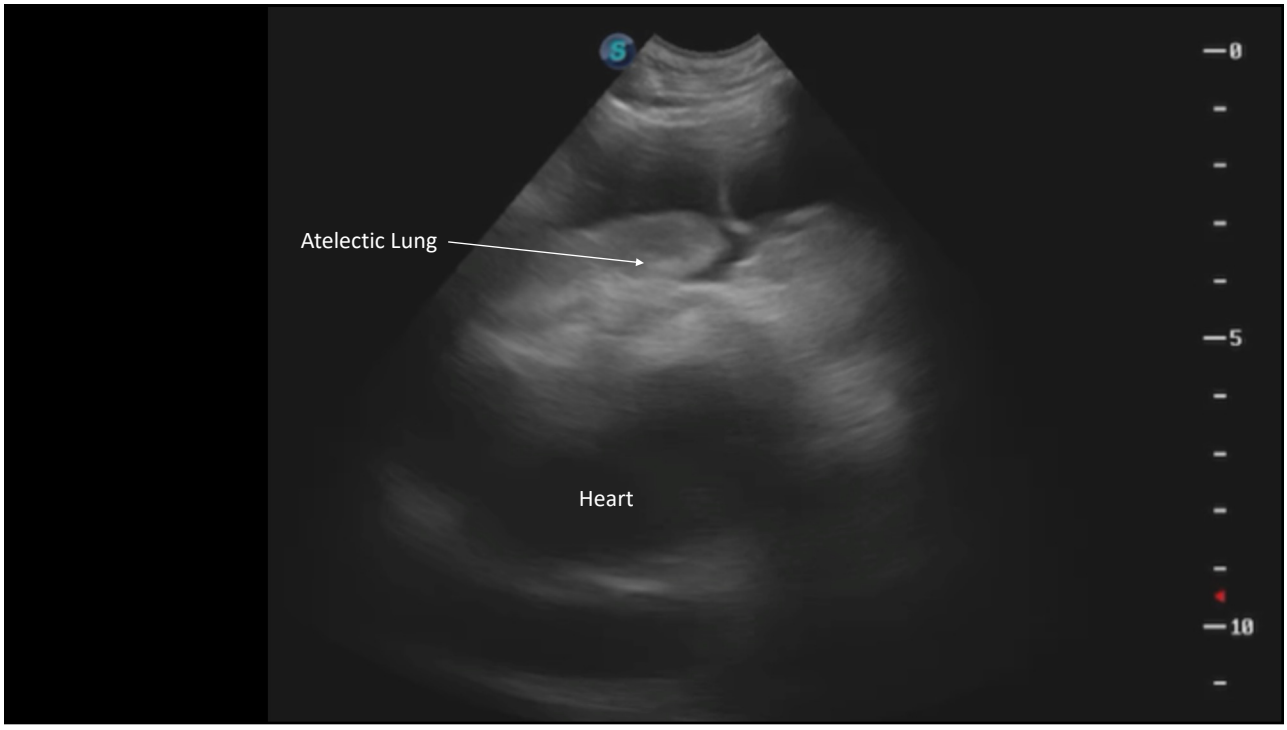

Rib Head
Diaphragm
Pleural Effusion
Liver
Heart
0
5

44


Atelectic Lung
Heart
0
5
10

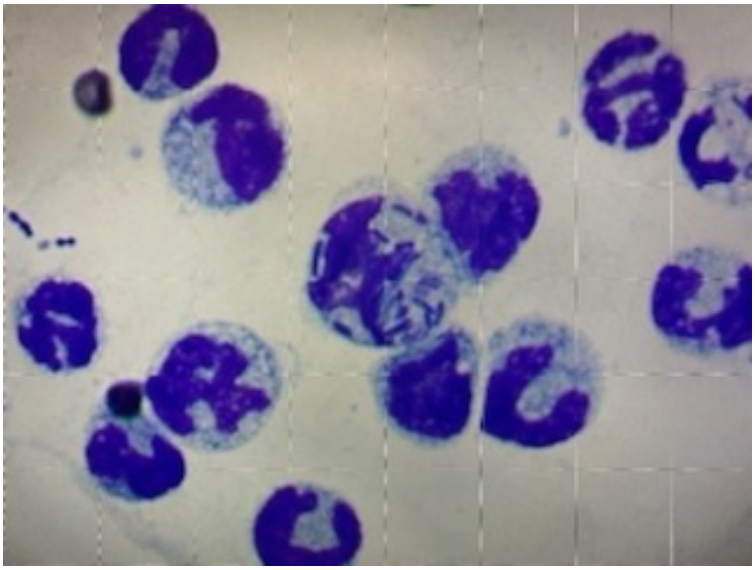
45

46

47

- Check PCV/TS
  - Actually hemoabdomen?
  - PCV > 10%
- Cytology
  - Screen for bacteria

48



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Biochemical Analysis

- Rule out Septic Abdomen
  - Septic suppurative inflammation
  - Serum Glucose at least 20 mg/dL greater than Fluid Glucose
  - Fluid Lactate to Blood Lactate difference > 2mmol/L
- Rule Out Uroabdomen
- Rule out Bile Peritonitis

Levin et al., JAAHA, 2004
Bonczynski et al., Vet Surg, 2003

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Biochemical Analysis

- Rule out Septic Abdomen
- Rule Out Uroabdomen
  - Suppurative inflammation
  - Fluid [K+] : Serum [K+] >1.4 (dog) or >1.9 cat
  - Fluid Creatinine : Serum Creatinine > 2
- Rule out Bile Peritonitis

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Biochemical Analysis

- Rule out Septic Abdomen
- Rule Out Uroabdomen
- Rule out Bile Peritonitis
  - Suppurative inflammation with bile crystals
  - Fluid bilirubin : Serum Bilirubin > 2

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54

55

56

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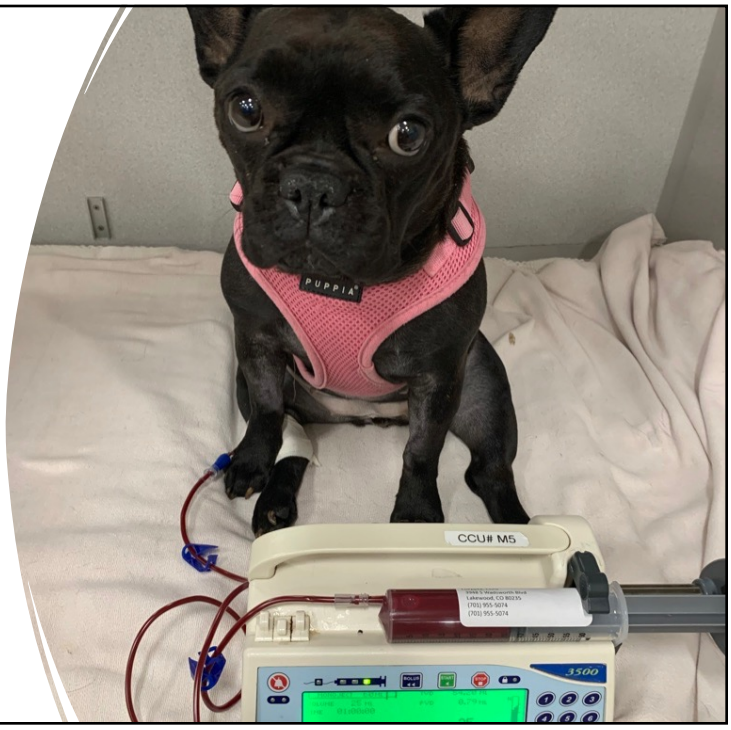
Blood Administration

- Rate
  - Bolus to normalize perfusion parameters
- Return blood through a filter
  - Fibrin
  - Clots
  - Debris from collection (hair)



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250 ml Whole Blood
50 ml/min max rate

50ml Whole Blood
20ml Other Product

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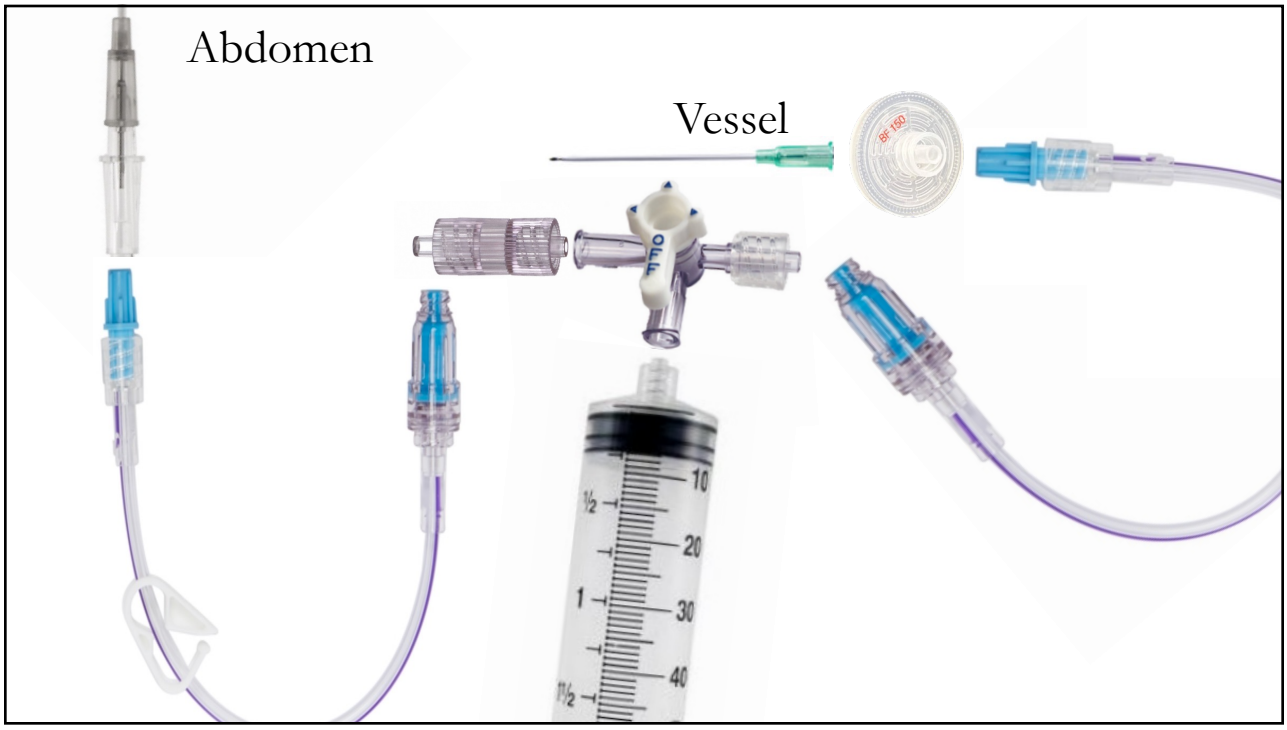
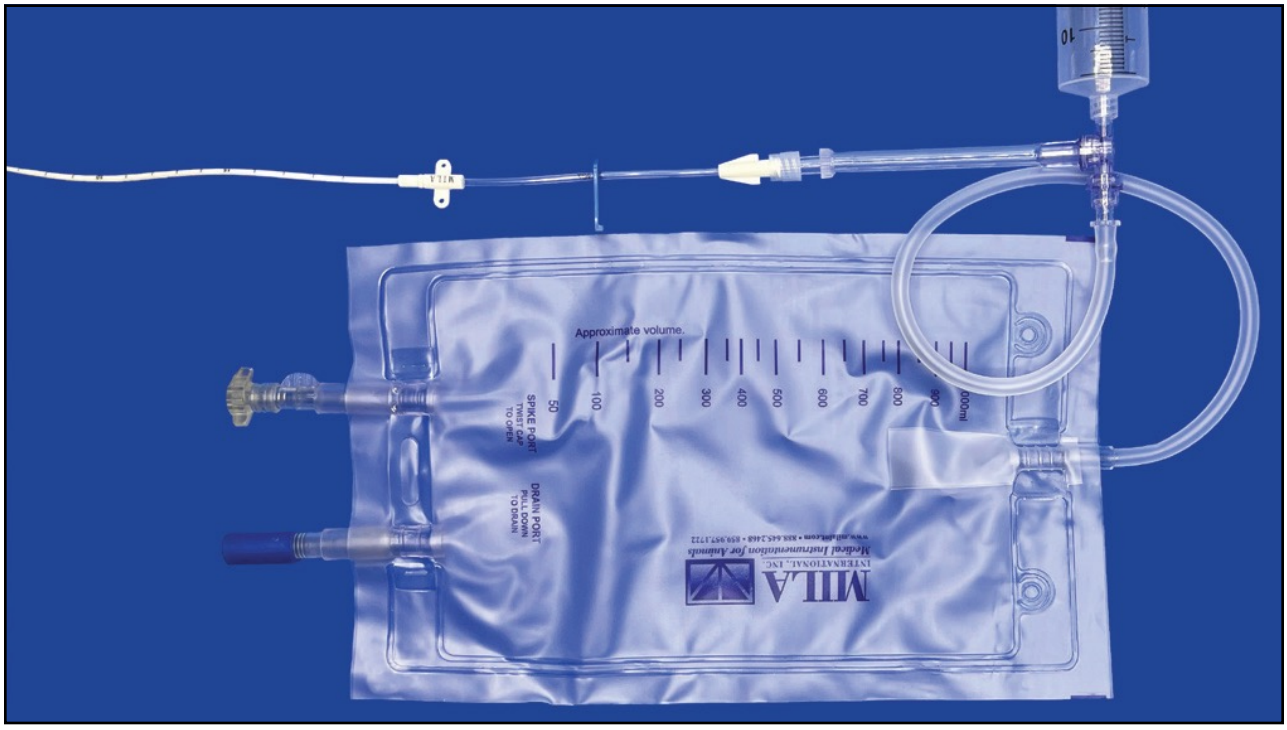
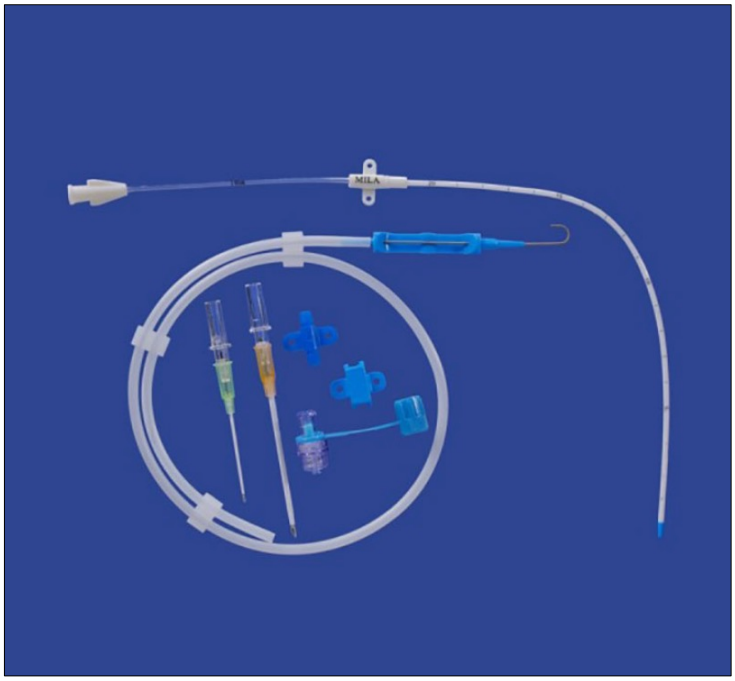

Abdomen
Vessel
OFF
10
20
30
40
½
1
1½

60


Approximate volume.
50
100
200
300
400
500
600
700
800
900
1000ml
SPIKE PORT
TWIST CAP
TO OPEN
DRAIN PORT
PULL DOWN
TO DRAIN
MILA
INTERNATIONAL, INC.
Medical Instrumentation for Animals

61



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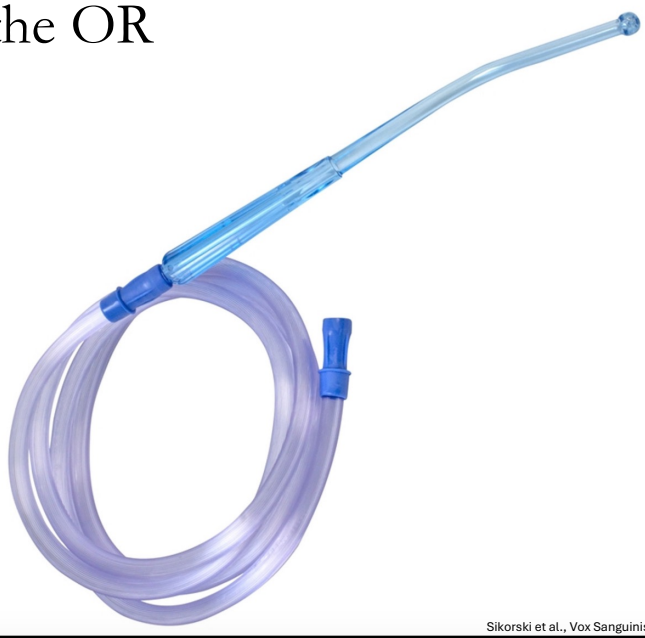
Surgical Suction for the OR

- Set Suction <150mmHg
  - Hemolysis if higher
- Suction Deep into Pool
  - Avoid skimming
- Avoid contaminants
  - Amniotic or GI fluid
  - Hemostatic agents
  - Antiseptics



Sikorski et al., Vox Sanguinis, 2017

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Surgical Suction

Anticoagulants for active bleeds

- CPDA 1ml for every 7ml blood
  - Stored
- Heparin 10 units for every 1ml blood
  - Immediate use

Add to sample sterilely while collecting

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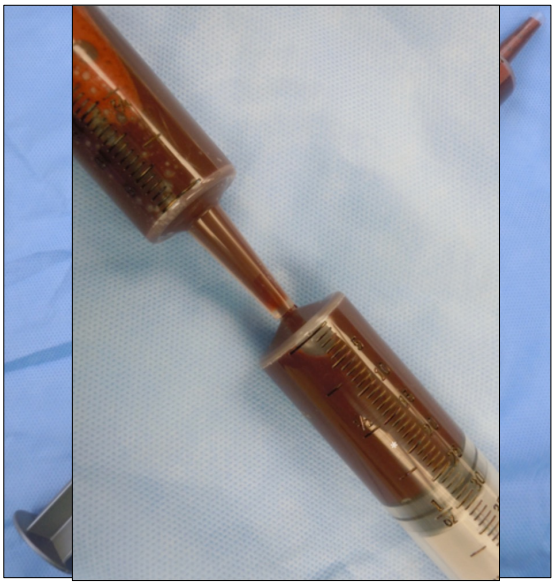
Surgical Suction

- From Canisters, Transfer into:
  - 60cc syringes
  - Blood collection bag
  - Used IV Fluid Bag
- Deliver blood via filter



Sikorski et al., Vox Sanguinis, 2017

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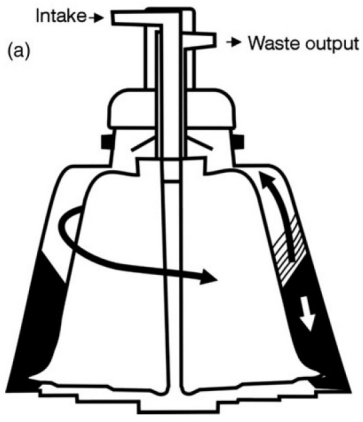
Cell Salvage Devices

- Double Lumen Suction Tubing
  - Sucks blood
  - Continuous flow of heparin to suction tip
- Collects blood in reservoir
  - Requires specific volume (250-750ml)
- Centrifuges blood to separate RBC from plasma
- Wash RBC with saline



Sikorski et al., Vox Sanguinis, 2017

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Cell Salvage Devices

- Septic Effusion
  - Leukoreduction decreases bacteria 98-99%
  - Wash cells to remove inflammatory cytokines
  - Antibiotic prophylaxis
- Neoplastic Effusion
  - Leukoreduction filters
  - Gamma radiation of the collected product

Sikorski et al., Vox Sanguinis, 2017

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Summary

- Contains
  - Red Blood Cells
  - Plasma proteins
- Lacks
  - Clotting Factors
  - Platelets
- Caution
  - Sepsis, urine, bile, neoplasia

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