



Ruminant Nutrition

The Art and the Science of Feeding

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Metabolic Disease and Toxicology

Outline

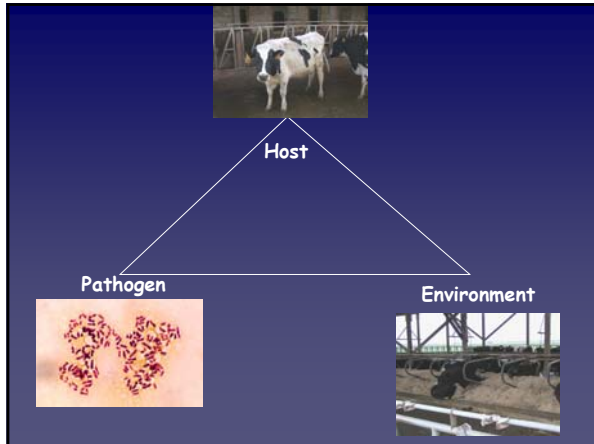
- The Big Picture
- Diseases
 - Ketosis
 - Hypocalcemia
 - Hypophosphatemia
 - Hypomagnesemia
- Monitoring
- Investigation
- Summary

Transition Cow Health

- Between Dry Period and Initiation of Lactation
- Any feed transition can be a problem area
- The fewer transitions the better
- Heifers are often very predisposed
 - Social status
 - Competition for feed and water

Where are the mistakes made?

- Cow count
 - Computers LIE
- Dry Matter Intake
 - Lack of Tracking Systems
- Overcrowding
 - Fresh cow and CU cow 90% density
- Farm formulation
 - Farmers change rations
- Forage Changes



Ketosis

- Starvation – Negative Energy Balance
- **Not Enough Groceries - Energy**
 - Massive Fat Mobilization
 - Liver overwhelmed
 - Ketone Body Formation
 - Acetoacetate
 - β -hydroxybutyrate

Ketosis

- Signalment
 - High producing - Genetics
 - Mature
 - Over conditioned BCS > 4/5
 - Obese
 - High parasite load
 - Confined - lack of exercise
 -
 - Incidence 5 – 90%

Ketosis Clinical Signs

- Digestive
 - Anorexia
 - Increased rumen motility
 - Massive decrease in milk production
 - Dry, firm, feces
 - Depressed
 - Often normal TPR
- Nervous
 - Digestive signs PLUS
 - Hyper-excitable
 - Ataxia,
 - Hypermetria
 - Excess salivation
 - Aggressive

Ketosis

Clinical Characteristics	Postpartum Ketosis	Peak Lactation Ketosis
Urine ketones	Moderate to High	High
Blood glucose	Low to Normal	Very Low
Blood NEFA	High	High
Response to Therapy	Poor	Good
Time of Occurrence	0 – 10 days postpartum	3 – 6 weeks postpartum

Clin. Path. and Ketosis

Acetoacetate, β -hydroxy butyrate, acetone

- Hyperketonemia
 - > 100 mg / dl
- Hypoglycemia
 - Normal 40 – 60 mg /dl
 - Ketosis 10 – 30 mg/dl
- Lymphocytosis, neutropenia +/-
- Increased NEFA
- Ketoneria

Clin. Path. and Ketosis

- NEFA = Definitive Diagnosis
- Sample on every cow
 - Not so with urine
- Objective analysis
 - Put a number to the symptom

Ketone Tests

- Keto Stix – Ames Company
 - Used on urine or serum, does not work well with milk.
 - Sensitivity – 10 mg acetoacetate/dl
 - Must be kept very dry or they deteriorate and false negatives

Ketone Tests

- Ross Test
 - Used on urine or serum
 - Sensitive at 2/5 mg/dl of acetone + acetoacetate (expressed as acetone equivalents).
 - Placed approximately one gram of a 1:100 mixture of sodium nitroprusside and ammonium sulphate in a test tube and add 5 ml of urine (or serum). Shake well and then add 2 cc of concentrated ammonium hydroxide. Look for purple color at liquid interface.

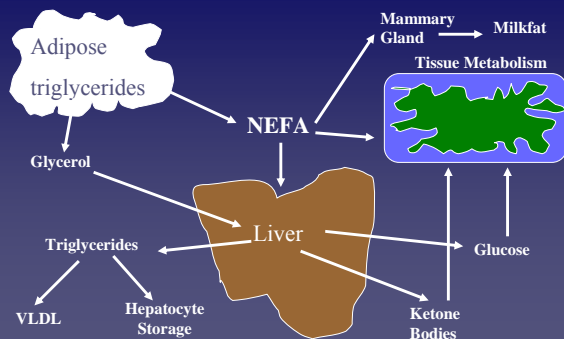
Ketone Tests

- **Denco Powder** (Denver Chemical Manufacturing Co.) consists of sodium carbonate, ammonium sulfate, and sodium nitroprusside in a granular form.
 - Can be used for milk, urine, or serum
 - Read at one minute rather than 15 to 30 sec. for other tests
- Acetoacetate tends to turn powder pink, acetone turns it purple. Because acetone is usually present in smaller concentrations compared to acetoacetate, a pink reaction is read as a trace to +1 and a purple reaction is +2 to +4.
- This test can be used as a screening test on milk for subclinical ketosis.
- Does not work well on colostrum
- Sensitive at 10 mg acetoacetate/dl

Ketone Tests

- Acetest – Tablet form - Ames Company
 - Used on serum or urine. Sensitive at 10 mg acetoacetate/dl

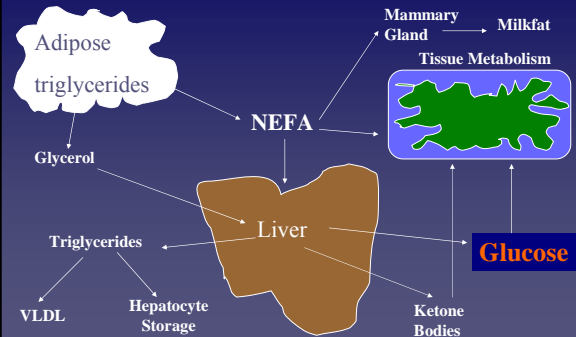
Metabolic Disposition of Mobilized Fat



Ketosis Therapy and Prevention

- Dextrose – d-glucose
 - 500cc at 50% solution IV
 - Effective time = 2 hours
- Glucocorticoids
 - 20mg Dexamethasone
 - Create hyperglycemia for 36 hours

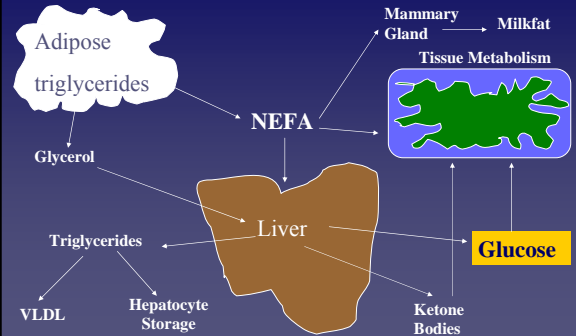
Metabolic Disposition of Mobilized Fat



Ketosis Therapy and Prevention

- Ca Propionate
 - Glucose precursor
 - 1#
 - Nutrical® - Not for Sheep
 - High copper

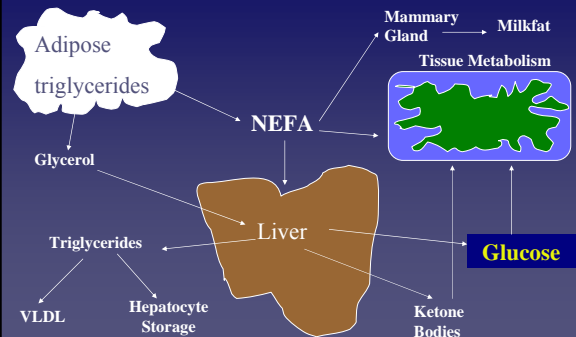
Metabolic Disposition of Mobilized Fat



Ketosis Therapy and Prevention

- Propylene Glycol
 - 8 oz.
 - Over dosage will decrease DMI via CNS depression

Metabolic Disposition of Mobilized Fat

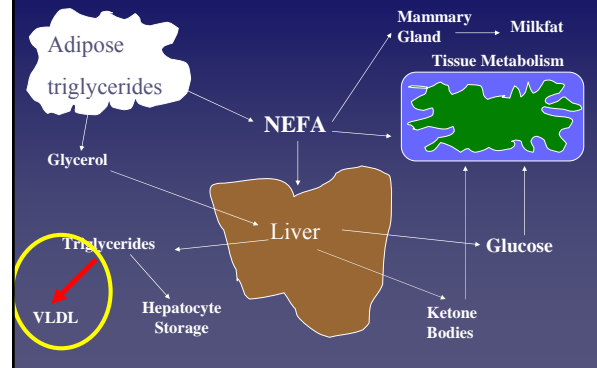


Ketosis Therapy and Presentation

Choline – Rumen Protected

- Reashure®
- 2 oz/cow/day close-up and fresh
 - -21 to +30 days
- Increase VLDL formation
- Increase fat transport from the liver

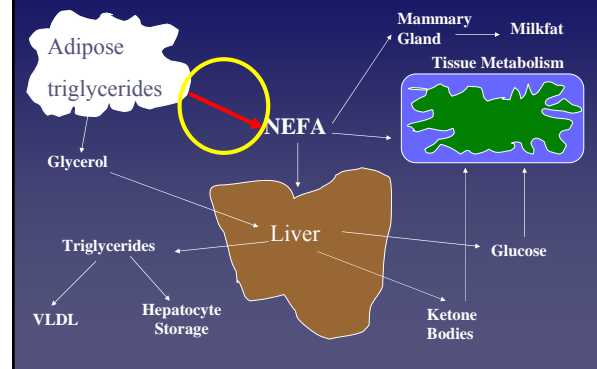
Metabolic Disposition of Mobilized Fat



Ketosis Therapy and Presentation

- Niacin
 - 6-12g/d PO
 - Decreased lipolysis

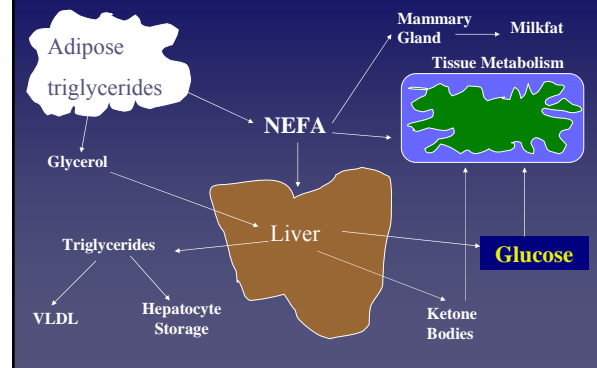
Metabolic Disposition of Mobilized Fat



Ketosis Therapy and Presentation

- Methionine - Alimet
 - One of two limiting amino acids – First?
 - Addition to ration decreases CHO need for microbial protein production
 - Methyl donation
 - Donation of methyl groups from methionine may further enhance energy balance

Metabolic Disposition of Mobilized Fat



Ketosis Drench

- 8 oz Propylene Glycol
- 1 lb Ca Propionate
- 2 oz Rumen Protected Choline
- 1 oz Methionine - Alimet
- 2 oz Yeast
- 6 oz KCL
- qs 5 gal Water

Why Do Cows Get Fat? Reproduction Failure

Ketosis Treatment and Prevention

- Maximize DMI
 - Bunk management
 - Stocking density
- Avoid Exogenous Ketones
 - Forage quality
 - Silage fermentation



Milk Fever Hypocalcemia * Low Serum Ca*

- Characteristics and Tendencies
 - Jersey > Holstein
 - > Third Lactation
 - Greater in BCS > 4/5
 - 90% within 72 hours postpartum
 - Watch for 120 DIM Milk Fever
 - Heritability

Three “Stages” of Milk Fever

I = **Standing**

Total Serum Ca 8 – 6.5 mg/dl

II = **Down**

Total Serum Ca 6.4 – 4.0 mg/dl

III = **Dying**

Total Serum Ca < 4.0 mg/dl

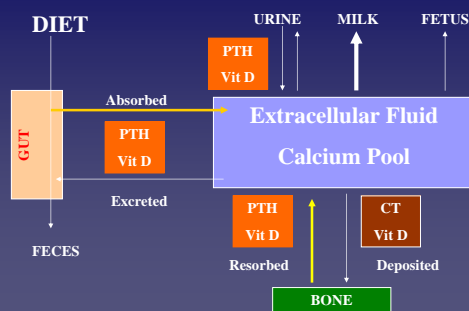
The Real World

- Diagnosis – Individual Cow
 - Down cow – just post partum
 - Cold ears
 - Lethargic
- Treatment – Individual Cow
 - 2 – 500ml – Ca f mg – IV
 - Drench – PO
 - FEED – at her level
 - Water – at her level

Monitor Response

- Differential Dx
 - Injury
 - Obturator paralysis
 - Uterine Torsion
 - Mastitis
 - Grass Tetany
 - Ketosis
 - Hypophosphatemia
 - Hemorrhage

Calcium Flux



Ca Endocrine Regulation

- PTH – Low Serum Ca
 - Increases GI Absorption – Vit D
 - Increased Renal P Excretion
 - Increased mobilization from bone
- Calcitonin – High Serum Ca
 - Increase Bone Deposition
 - Decrease GI Absorption
- Vit D
 - GI Absorption
 - Bone activity
 - Urine resorption

Milk Fever – Herd Presentation and Treatment

- Urine pH
 - Holsteins 6.2 – 6.8
 - Jerseys 5.8 - 6.2
 - pH < 5.8 = Acidosis

Ration Evaluation *DCAD Calculations

1. $(0.15 * Ca \text{ meq} + 0.15 * Mg \text{ meq} + K \text{ meq} + Na \text{ meq}) - (Cl \text{ meq} * 5 + .3 * P)$
Target 400 to 500
2. $(Na \text{ meq} + K \text{ meq}) - (Cl \text{ meq} + 5 \text{ meq})$
Target – 50 to -150

Milk Fever – Herd Diagnosis

- Total Ca v. Ionized Ca
- Serum Ca on 10 Fresh Cows
 - > 2nd lactation?
- Ration Evaluation
 - Close up dry
- Urine pH

Milk Fever Herd Prevention and Treatment

- Track DMI in Close Up Pen
- No Free Choice NaCl for dry cows
- 90% Stocking Density
- Feed Available to Cows During Parturition
- Treat All Suspected Milk Fever by a Protocol
- Monitor Response

Close Up Diet Formulation

K < 1.2% - No Acidification

K 1.2% - 1.5% - ?

K > 1.5% - Acidification

HCL Products
 Soy Chlor 16-7
 Nutri Chlor 18-8
 True Anionic Salts
 Ammonium Chloride
 Magnesium Sulfate

Close Up Diet Formulation

Ca 180 g/d – 220 g/d

P 35 g/d

K < 1.2%

S .3 - .4%

Mg .4%

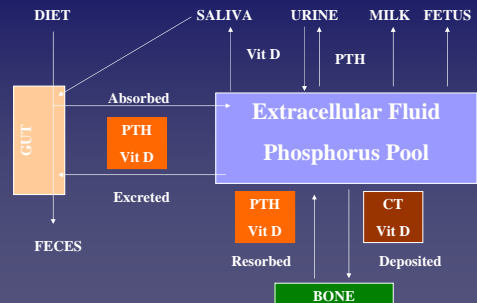
Vit E 2000 – 4000 IU/d

Vit D 65 KIU/d

Close Up Diet Ingredients

- Yeast – stabilize rumen health
- Ca Propionate – energy and calcium
- Acidification Agent
 - DMI
- Molasses –
 - Some is good
 - Too much increases insulin and decreases DMI
- Bypass Fat – Energy Source
 - .25 lbs per cow per day
- Tallow ??

Phosphorus Flux



Grass Tetany Hypomagnesemia

- Beef, Dairy, Sheep, Goats

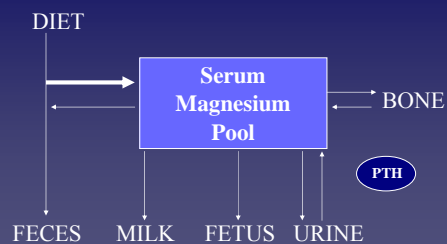
Signalment

- Older ruminants
- Spring
 - Lush, fast growing pasture
- Cereal crop – pasture / feed

Clinical Signs

- Down
- Twitching
- Hyper-aesthesia
- “Neurotic”
- Paralysis

Mg Flux



Why? - Pathogenesis

- Requirement ~ .2% Mg in DMI
- Dietary Mg has low availability
 - 7% - 35%
- High K reduces Mg availability
- High Na increases Mg excretion

Diagnosis – Real World

- Mature Beef Cow
- Down Post Calving – cold ears
- Spring Pasture
- Twitching / Neurotic
- Treat and Monitor

Treatment

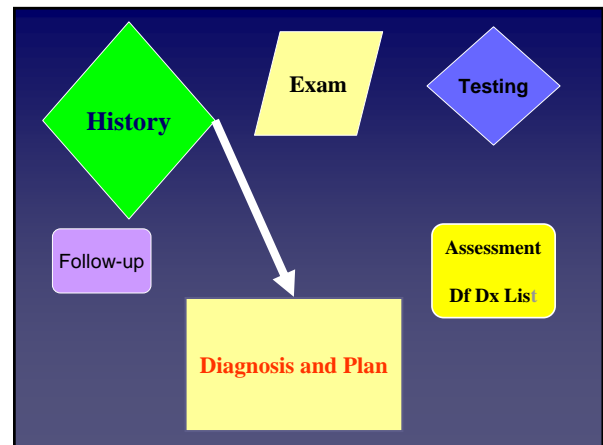
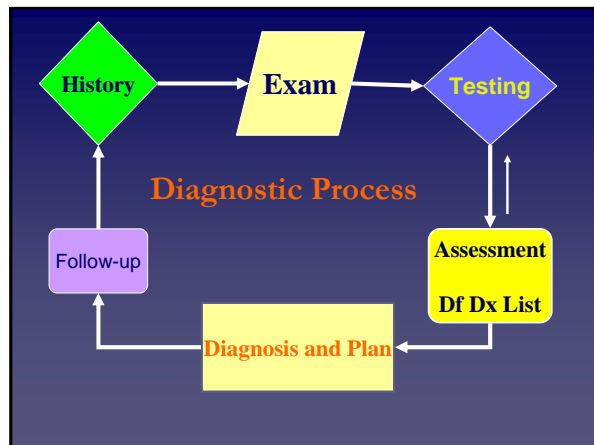
- 500 ml 23% Ca borogluconate – IV
 - [15% Mg gluconate]
- Oral Mg
- Enema
 - 60g Mg Cl₂ in 200 ml H₂O

Prevention

- Diet
 - TMR + MgO – **Mg to .4%**
 - Pasture + Mg Min block
- Grazing
 - Rotation
 - Fertilization
 - Limestone
 - Mixed legume - grass

Nutritional Investigation

- Step 1
 - Owners / management complaint
 - Owners / management goals
- Step 2
 - If the owner's Chief Complaint and employee's Chief Complaint are different then return to Step 1



Case 2 - Disease Investigation

- **History** – Poor Production, Some Mastitis
 - Nutritional
- **Exam and Testing**
 - Farm Visits – 3 – Interviewed all employees and owner
 - Visited with 2 nutritionists involved
 - Evaluated and balanced all rations
 - Attained written records from previous veterinarian
 - DHI Records
 - Weekly bulk tank milk samples for mastitis
 - Blood samples on all cows giving birth –
 - Ca, P, Mg

Disease Investigation

- **Results**
 - Owner was paying on SPC – owner induced reproductive failure
 - Severe Mycoplasma mastitis outbreak – Contagious
 - Improper load mixing of feed
 - Severe mechanical dysfunction in milking parlor
 - Slight improper balancing of ration

History

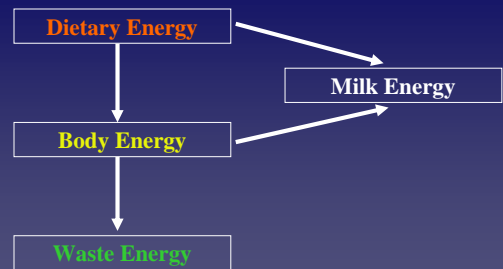
- Owner, manager, employee
- Ensure it is a nutritional problem
- #1 Blame = Nutrition

Objective Information

- Production – DHI – Daily Weights
- Reproduction – Computer
- Disease – Treatment Lists, Computer

The Four Rations of the Farm

- The formulated – nutritionist
 - The Reformulated – on the farm
- The fed – DMI tracking
- The consumed – DMI tracking
- The metabolized – Milk weights



Ration Evaluation

- Don't look for a Mn deficiency first
- **DMI Limitation**
 - Forage Quality
 - Water Quality
 - Poor Communication

Sample and Test

- NIR v. Wet Chemistry
- Table / Book Values
- Feed Tags

Sampling / Testing

- Feed Samples – Ingredient, TMR
 - Wet Chemistry
 - **DM**, CP, NE, ADF, NDF, Ca, P, Sol P, Nitrate, Fe, S, Mo
- **NEFA** – Non- Esterified Fatty Acid
 - Indicates insufficient energy intake - Ketosis

Body Condition Scoring Dairy / Beef

- Subjective measure of body fat
- 1-5 scale / 1-9 scale
- 1 = emaciated
- 5 / 9 = obese
- Change in condition within the life cycle is often more critical than the condition at 1 point in time

Rumen Fluid Analysis

- pH > 6
- pH 5.5 to 6 borderline
- pH < 5.5 = Acidosis
 - 4 hr post feeding
- Microscopic Evaluation
 - Protozoal activity
- Rumen CI
 - High rumen CI = GI stagnation

Analysis of Information

- Categorize History, Exam, Diagnostics
- Multiple categories
 - Multi path / multi disease
- Utilize objective information

Summary

- Find simple solutions to complex problems
- Think in the trenches – cause / the “why”
- Keep them eating
- Promote a simple feeding program
 - Easy to implement
 - Easy to manage



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Classification of Forage Trace Elements

Trace Mineral	Deficient, ppm	Marginal, ppm	Adequate, ppm
Copper	<4.0	4 - 7	>7.0
Manganese	<20	20 – 40	>40
Zinc	<20	20 – 40	>40
Selenium	<0.1	0.1 – 0.2	0.2 – 0.3
Cu:Mo ratio	<4:1	4.0 – 4.5:1	6 – 10:1

Protein Overfeeding The Consequences

- \$\$\$\$ Loss
- Poor Reproduction
- Metabolic Inefficiency

Diagnosis of Protein Over Feeding

- BUN
- MUN
- Manure Scoring
- Ration Evaluation

MUN

Milk Crude Protein %	Low MUN (<12 mg/dl)	Normal MUN (12-16 mg/dl)	High MUN (>16 mg/dl)
3.0	Low NSC +/-or NEL Low SIP +/-or DIP +/-or UIP	SIP, DIP, UIP, AAA in balance. Low CHO +/-or NEL	Excess SIP +/-or DIP relative to CHO/NEL. Excess UIP or imbalance in AAA
3.0 – 3.2	Low SIP +/-or DIP +/-or UIP	Balanced SIP, DIP, UIP, AAA, and CHO/NEL	Excess SIP +/-or DIP relative to DHO, NEL balanced
>3.2	Low SIP +/-or DIP +/-or UIP, AAA balanced, Excess CHO/NEL	Balanced SIP, DIP, UIP, AAA. Excess CHO/NEL	Excess SIP +/-or DIP relative to CHO, Excess of UIP vs NEL or AAA imbalance

NPN Toxicosis

- ≠ Nitrate Toxicosis
- Ruminants Hydrolyze ammonia
- Predispose by Low CHO Diets
- Generally Due to Mixing Error
- Failure of Use of NH₃ y
 - NH₃ → NH₄
 - ↑ H+
- NH₄ Alkalizes the Rumen
- TCA Inhibited → Acidosis
- Acidosis Creates Hyperkalemia
- Hyperkalemia = Death

NPN Toxicosis

- Dx – Rumen pH > 8
 - Ration evaluation
 - Feed samples

NPN Toxicosis

- Clinical Signs
 - Ab Pain
 - Muscle Tremor
 - Ataxia
 - Bloat
 - Violent Death

Nitrate Toxicosis

• NO₃ Reduction NO₂

Hb NO₂ Met Hb

Source

Oats, Pigweed
Stressed Grasses

Testing

NO₃ or NO₃-N (multiply by 4.4)
< .3% Nitrate (DM) Dairy
.5% Nitrate (DM) Beef
.8% Acute Toxicity

Nitrate Toxicosis

- Clinical Signs
 - Dyspnea
 - Poor Reproduction
 - Abortion
 - Decreased Milk Production
- Treatment – Methylene Blue
 - 5 – 15 g / kg IV

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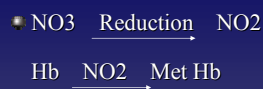
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- Treatment – Methylene Blue
 - 5 – 15 g / kg IV

Ruminal Acidosis

- Treatment – Individual Cow
 - Antibodies
 - Anti-inflammatories
 - Mineral Oil PO
 - Charcoal PO
- Treatment – Herd
 - Yeast
 - Bicarb / Sesquicarbonate
 - Ration Evaluation
 - Particle Separation Evaluation
 - Forage Evaluation

Excess CHO Intake Ruminal Acidosis

- Excess CHO = *Strep bovis* proliferation
- *Strep bovis* produces Lactic Acid
- Reduction in Rumen pH until *Strep bovis* Enables Bactobacilles Growth
- Lactobacilles Produces D-Lactate
 - D-Lactate cannot be metabolized to propionate

Ruminal Acidosis

- Clinical signs
 - Diarrhea – Hindgut fermentation
 - Ab Pain
- Diagnosis
 - Rumen pH
 - 5.0 - 5.8 = subclinical
 - <5 = Clinical

Dietary Urea Levels

- < 3% of Concentrate
- < 1% Total Diet
- .1% /cow/d is common with corn silage diets
- Ensure adequate CHO

Treatment of Urea Toxicity

- Treat early and fast
- Large quantity COLD H₂O
 - 7 – 10 gal in adult cattle
 - Dilutes NH₄
- 2-6 Liters Vinegar (cattle)
 - Reduces pH
 - Reduces NH₄ absorption