Vitamin D Research

An Opportunity to Integrate UW Research and Teaching with Industry – 2013

Unexplained diseases and mortality a consequence of vitamin D deficiency?

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Swine Research & Teaching Center
Acknowledgements

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Vitamin D

7-dehydrocholesterol → D₃

25-OHase → 25-OHD₃

24,25-OHase → 1α,25-OH₂D₃

1α,24,25-OHase

Supplemental Vitamin D₃

Rortvedt, 2011. Tues Noon seminar
Diminishing Knowledge of Vitamin D, %

- Vit D regulates Ca homeostasis
- Novel hormones regulate Vit D & P homeostasis
- What regulates Vit D?

Crenshaw, yr

- Kyphosis in SRTC herd
- Reproduced Kyphosis
- Induced w/i 5-wk trial
The hump-back pig challenge
Dig a bit deeper!

Kyphosis – idiopathic disease induced by vitamin D, Ca & P deficiencies

Rortvedt et al., 2010.
Vitamin D Deficiency Induced Kyphosis

- Spontaneous outbreak of kyphosis in UW herd in 2008 attributed to an accidental deletion of vitamin D from premix
- Reproduced kyphosis under controlled conditions (Rortvedt and Crenshaw, 2012)

Kyphosis Incidence, %

<table>
<thead>
<tr>
<th>Sow Diet</th>
<th>Pig Diet (-D)</th>
<th>+D</th>
<th>-D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HCaP</td>
<td>LCaP</td>
<td></td>
</tr>
<tr>
<td>0/16</td>
<td>0/20</td>
<td>0/16</td>
<td>4/19</td>
</tr>
<tr>
<td>0/13</td>
<td>5/17</td>
<td>0/12</td>
<td>5/15</td>
</tr>
</tbody>
</table>

All pigs fed HCaP diets from wk 9 to 13

Observed Kyphosis/Total pigs
Dramatic Increase in Bone Disease Cases
- ISU Swine Diagnostic Laboratory

Adopted from Madsen, 2012
**Vitamin D Deficiency in a 5-wk Nursery Trial**

**Gain**

- Pigs produced by sows fed 325 IU D$_3$/kg
- All data collected from 9 wk old pigs

**Gain reduced by >30% in pigs fed -D diets**

**BMD**

- BMD reduced by >30% in pigs fed -D diets
- Not recovered by excess Ca and P

* Difference due to: vitamin D, $P < 0.01.$

Rortvedt et al., 2011
Vitamin D deficiency in pigs – Fad, Fiction, and Facts.

Tom Crenshaw and Laura Rortvedt

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Vitamin D deficiency in pigs

The order of our thought processes determines the outcome

Fad
↓
Fiction
↓
Facts
↓
A new F word

Facts
↓
Fiction
↓
Fads
↑
Solutions
<table>
<thead>
<tr>
<th>Requirements</th>
<th>Vitamin $D_{3}$, IU/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swine</strong>&lt;sup&gt;a&lt;/sup&gt;, NRC, 1998</td>
<td></td>
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<tr>
<td>3 - 10</td>
<td>220</td>
</tr>
<tr>
<td>10 - 20</td>
<td>200</td>
</tr>
<tr>
<td>20 - 120</td>
<td>150</td>
</tr>
<tr>
<td>Sows</td>
<td>200</td>
</tr>
<tr>
<td>a. “No studies ... of requirement of sows ... reported”</td>
<td></td>
</tr>
<tr>
<td><strong>Rats</strong>&lt;sup&gt;b&lt;/sup&gt;, NRC, 1995</td>
<td>1,000</td>
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<tr>
<td>b. “Information ... surprisingly limited”</td>
<td></td>
</tr>
<tr>
<td><strong>Humans</strong>&lt;sup&gt;c&lt;/sup&gt;, DRI, 2011</td>
<td></td>
</tr>
<tr>
<td>EAR</td>
<td>400</td>
</tr>
<tr>
<td>RDA</td>
<td>600</td>
</tr>
<tr>
<td>UL</td>
<td>4,000</td>
</tr>
<tr>
<td>C. Adequacy based on bone health</td>
<td></td>
</tr>
</tbody>
</table>
The rise and fall of clinical cases of vitamin D deficiency in commercial swine operations

Darin Madson
Iowa State University
madson@iastate.edu
Dramatic Increase in Bone Disease Cases
- ISU Swine Diagnostic Laboratory

Swine Bone Disease, # of cases

Adopted from Madsen, 2012
“THE RISE”

• Timeline of problem
  – January 2010
    • First suspected case
  – March 2010
    • First confirmed case
  – June 2010
    • Feed recall
  – June 2010 to July 2013
    • Still occurring
    • *Decreased incidence in the last 12 months*
Clinical signs

• Clinical signs are variable
  – 2010; what was reported and heard
    • **Sudden death** (found dead)
      – #1 complaint
    • Tremors/seizures (CNS like disease)
    • Muscle fasciculations/tetany
    • Weakness
    • **Lameness**
      – Generally reported following sudden death
    • Painful gait and reluctance to move
    • Bone fractures
• Clinical signs are variable
  ◦ Classical lesions

Clinical signs associated with disease
Section of Pig Limb with Fractures in the Tibia and Femur

Madsen, 2013
Vitamin D research – ISU take 2

Objective of proposal

– Assessing the quality of vitamin D from multiple suppliers overtime

• 5 feed manufactures
• Sample bulk vitamin D 1x per month
  – Mixed from multiple locations
• Sampling for 12 months
  – October 2011-September 2012
Vitamin D research – ISU take 2

• Results
  – No company was found to be significantly lower the 500,000 IU
    • No difference in US vs. Foreign vitamin D manufactures
  – Month was found to be significant
    • $P= 0.0022$
    • Storage???
“THE FALL”

• **Quality control measures**
  
  – Feed companies/manufacturers
    • Routine sampling and testing for assurances purposes
      – Verification
  
  – Accurate measuring of inputs
    • Vitamin A?
    • Backside testing
      – Testing complete feed
“THE FALL”

• **Diet changes**
  – Diet formulation changes
    • 5-8x NRC values for vitamin D
      – Cheap insurance
  – Vitamin premix changes
    • Increased vitamin D
  – Ingredient costs
    • Calcium
    • DDG vs corn
      – Vitamin E transfer to pigs known to decrease with DDG sow feeding
“THE FALL”

• **Industry products**
  – Oral supplementation
    • At least 6 manufactures
      – Drench or water supplementation

• **Veterinarians**
  • Awareness factor
  • Understanding clinical signs
    – Breaking ribs
    – Testing serum levels
  • Preventative measures
    – Known impending disease challenges or rapid growth phases
An oral dose of vitamin D at birth increased serum 25-OH D at weaning but failed to alter bone mineral density in pigs

An oral dose of vitamin D at birth increased serum 25-OH D at weaning but failed to alter bone mineral density in pigs

Vitamin D deficiency in pigs
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A new F word: **Fantasy**