FAILURE TO THRIVE

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ABSTRACT

Enteric diseases are some of the most significant contributors to baby pig morbidity and mortality in the farrowing house. Piglet immunity must be maximized in order to provide them with the opportunity to thrive in the farrowing house. The production of consistent, high quality pigs is a goal all sow operations are working to achieve. By maximizing piglet immunity and using proper husbandry practices, scouring problems can be minimized. *Escherichia coli*, clostridial diseases, rotavirus, and coccidiosis continue to be the major pathogens of concern in the pre-weaning period. Some things have changed over time while others continue to be the same. It is the goal of this paper to briefly review key concepts on maximizing piglet immunity as well as address some of the current trends in enteric pathogens in the farrowing house.

INTRODUCTION

All sow farms have a common goal: produce a high quality piglet. This sounds like an easy task. There are a lot of great farms out there producing good quality pigs consistently. There are also many operations that continue to struggle year after year. Even in those operations where performance is great, there is always room for improvement. The goal of improvement is not always just to produce a high quality pig, but also to do that in the most consistent, efficient, and profitable way. Consistency is critical as it helps those who end up feeding these piglets out to market (slaughter or breeding stock sales). Efficiency is critical as farm labor availability is becoming more and more of an issue worldwide. Finally, profitability is of the utmost importance as ultimately it is the driving force for the existence of any industry.

Enteric diseases are some of the most significant contributors to baby pig morbidity and mortality in the farrowing house. The latest U.S. National Animal Health Monitoring System (NAHMS) Swine Report data from 2006 indicated that scours were identified as the third leading producer-identified cause of pre-weaning death accounting for 13.2% of deaths. Crushing by sow (42.0%) and starvation (29.7%) were the other two main causes reported. The top three causes of pre-weaning mortality are the exact same ones identified by Crooks et al. (1993) from the 1990 NAHMS National Swine Survey. It is the goal of this paper to briefly review key concepts on maximizing piglet immunity as well as address some of the current trends in enteric pathogens in the farrowing house. The goal is to provide relevant and practical tips that will help sow farms achieve a consistent goal of producing high quality pigs efficiently and profitably.
MAXIMIZING PIGLET IMMUNITY

Weaning weight is considered one of the most important factors impacting post-weaning and lifetime growth performance (Lawlor et al., 2002). Piglet enteric problems in the farrowing house are a major contributor to poor performance. Before discussing farrowing house enteric pathogens and their consequences, it is important to start at the beginning. To maximize piglet survival, pigs must obtain sufficient, good quality colostrum in a timely manner.

Colostrum

Pigs are not able to obtain antibodies from their mothers while in utero due to the placental characteristics. This necessitates that piglets obtain all their passive antibodies through colostrum. It is estimated that piglets need about 240 - 255 ml (1.5 kg X 160-170 ml/kg) of colostrum to survive (Le Dividich et al., 2005). These needs are not only for the antibodies (IgG) needed but also for the glucose and fat (both are energy sources) found in colostrum. A recent study by Foisnet et al. (2010) estimated the average sow produced 3.22 ± 0.34 kg of colostrum (range 0.85-4.80 kg). These are similar ranges found by Devillers et al. (2005) which estimated colostrum production to average 3.6 kg with a range of 1.9-5.3 kg. Low colostrum production is not related to litter size or birth weight or due to the inability of newborn piglets to nurse (Foisnet et al., 2010).

Many publications emphasize the importance of allowing piglets to obtain colostrum within the first 24-36 hours after birth before gut closure occurs. It is true that gut closure occurs, but what is more important is to emphasize that this closure is exponential and therefore from a producer standpoint, making sure that piglets get colostrum within the first 6 hours of life is critical. This can be seen in Figure 1 (adapted from Miller et al., 1962). These changes in gut absorption are due to physiologic changes occurring in the intestine related to protein digestion as well as physical changes in the intestine cells (tightening of junctions between cells). In a study by Foisnet et al. (2010) it was found that the average time between birth and the first suckle (colostrum) was 29 ± 2 min.

Figure 1. Serum antibody titer in piglets absorbing antibodies from colostrum.
Colostrum yield and mean piglet birth weight are important determinants of newborn viability. Birth order also plays an important role in determining which piglets get access to the most colostrum as reported in the review article by Farmer and Quesnel (2009). This same article emphasizes that research supports the theory that it is the sow which limits the quantity of colostrum pigs can consume in a day. The overall mortality rate of piglets within the first two days of life is significantly different between litters nursing off low-colostrum producing sows than in litters with high-producing sows (21 ± 10 vs. 4 ± 3%. P=0.04) (Foisnet et al., 2010).

Colostrum also plays an important role in eliciting dramatic changes in intestinal growth, structure and function of newborn pigs during the first 6 hours of suckling. This is highly related to the amount of colostrum ingested and can result in approximately 100-fold increase in absorptive area in the intestines (reviewed by Farmer et al., 2006). It should be the goal of all farrowing house personnel to maximize piglet immunity and intestinal function by maximizing the opportunity for piglets to have access to good amounts of high quality colostrum as soon as possible after birth. This requires not only that the mothers produce the colostrum, but that the right husbandry skills are used to enable this process.

Husbandry

1. Minimizing pathogen exposure. Disease does not occur unless there are three conditions that are met. You must first have a pathogen that is viable and in high enough numbers to cause disease. Then you need to get these pathogens in contact with the pig. Finally you need to have a pig that is susceptible to the pathogen and therefore disease can manifest. One of the first things to do is to eliminate, if not minimize, pathogen exposure. There are several ways this can be achieved. In the case of enteric problems, other than TGE, most of the other pathogens we deal with are commonly found in farms (Clostridia, E. coli, Rotaviruses, and Coccidia). Three of the most common practices to reduce pathogen exposure to the newborn piglets involve the cleaning and disinfecting of the farrowing crate, cleaning of the sow before moving into farrowing rooms, and scraping manure behind the sows. These practices make sense and most are supported by some research.

Washing, when done correctly, will remove >99.99% of the microorganisms in the environment. This can be done in conjunction with detergents and hot water to maximize the efficiency and effectiveness of this process. Then the right disinfectant needs to be used targeting specific pathogens on the farm. The disinfectant serves just as the added bonus and should not be relied as the primary means of pathogen control. This is because most disinfectants are inactivated by organic matter and therefore will not be effective unless all organic debris is first removed from the farrowing house. The effect of poor hygiene in morbidity and mortality associated with enteric disease was demonstrated by Svendsen et al. (1975).

Washing the sow before moving into the farrowing crate will minimize the chances of bringing in extra manure from the gestation barn. This is probably more important in outdoor facilities, but even in today’s confined environment, some sows get pretty dirty. Cleaning the sow especially regarding the udder and the vulvar area will minimize pathogen exposure especially considering these animals are being placed in a nice clean farrowing crate. It is also a psychological process that helps emphasize the importance of cleanliness. Finally scraping
farrowing crates is not a fun job, but can be an important one. I am not familiar with any research to support the practice, but it just makes common sense that the less manure there is in the back of the crate when baby pigs are born, the less likely they will be exposed to high numbers of different pathogens. Remember that these newborn pigs also have an umbilical cord that has a fresh open wound and will be dragged around right after birth.

Field data also supports the concept of pathogen load. Those piglets that are born first in a room will take 3-4 days before they will start scouring while those born later in the week will start scouring in 24 hours (Cutler et al., 2006). Environmental pathogen buildup can occur quite rapidly especially during an outbreak with enteric pathogens.

2. Farrowing assistance and immediate post natal care. Over 50% of preweaning mortality occurs within the first 3 days after birth with most piglets dying having had consumed much less colostrum than survivors in the first day of life (reviewed in Foisnet et al., 2010). Additional supervision of piglets in the first 3 days of life has been shown to decrease mortality from 1.29 to 0.85 pigs per litter (Probst Miller, 2007). To maximize piglet care one must be present at the time of farrowing to be able to help these newborn piglets sooner rather than later. In Foisnet et al. (2010) it was calculated that the average duration of farrowing for 16 sows used in three replicates was 284 ± 50 min. In a study by Gunvaldsen et al. (2007) even with the use of induction protocols, 60% of the sows started farrowing overnight. This same study showed that for every day of gestation, piglet growth increased by 26g ($P < 0.01$). This translated into a pig that averaged 576 g less ($P < 0.01$) at 16 day of age and was 2.0 times more likely to have a relative risk for higher morbidity ($P < 0.01$). The induction of premature farrowing also affects the composition of colostrum and milk especially in regards to fat (Jackson et al., 1995). Fat is an important energy source needed for newborn piglet survival as pigs are born with minimal fat stores.

3. Split-suckling and cross-fostering. The concept of split-suckling and cross-fostering theoretically make sense, but research does not always support the practices. With split-suckling the idea is to allow the piglets to maximize opportunity for colostrum intake. I have been unable to find research supporting the practice but I think there are many challenges. A key point is that split-suckling does have the potential of working IF it is done properly. With most piglets being born overnight, it is hard to know how long since the pigs have really been born. This is critical as from the colostrum section we know that the sooner we get pigs to nurse, the better the chances for absorption of antibodies. If not done properly, we can actually create more variation in the process.

A study by Donovan and Dritz (2000) showed there was no statistical difference between split-suckled groups in ADG, weaning weights, and serum IgG concentrations. They did find that the percentage of pigs weighing < 3.6 kg at weaning was higher in the control group (1.3 and 1.6% vs. 3%, $P \leq 0.05$). In this study they split sucked for 2 hours within the first 24 hours of life. It is difficult to know what the effects of just split suckling in the first 6 hours of life could have on the piglets.

In regards to cross-fostering (moving pigs from one sow to another) the overwhelming data suggest that although litter weight variation is reduced, individual pig performance is actually
compromised (Straw, 1997; Cutler et al., 2006). Price et al. (1994) reported that in pigs over 2 days old < 50% of pigs had suckled 6 hours after being moved to a new dam. Pieters and Bandrick (2008) showed that cross-fostering can help transfer antibodies as long as it occurs within the first 6 hours after initial colostrum intake (Table 1).

Table 1. Proportion of piglets positive to Mycoplasma hyopneumoniae antibodies (ELISA). Adapted from Pieters and Bandrick (2008).

<table>
<thead>
<tr>
<th>Group</th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>20</th>
<th>Not cross-fostered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vax Control</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>10/10 (100%)</td>
</tr>
<tr>
<td>Unvax Control</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0/26 (0%)</td>
</tr>
<tr>
<td>Vax --&gt; Vax</td>
<td>12/12 (100%)</td>
<td>11/11 (100%)</td>
<td>11/11 (100%)</td>
<td>10/10 (100%)</td>
<td>11/11 (100%)</td>
</tr>
<tr>
<td>Vax --&gt; UnVax</td>
<td>0/10 (0%)</td>
<td>11/10 (100%)</td>
<td>10/10 (100%)</td>
<td>9/9 (100%)</td>
<td>9/9 (100%)</td>
</tr>
<tr>
<td>Unvax --&gt; Vax</td>
<td>10/10 (100%)</td>
<td>7/9 (78%)</td>
<td>1/10 (10%)</td>
<td>0/8 (0%)</td>
<td>0/8 (0%)</td>
</tr>
</tbody>
</table>

Dewey et al. (2008) have also shown that cross-fostering before and after 1 day of life can have a negative impact on piglet weight at 26 days of age. In their multivariate model, after controlling for other significant parameters, piglets cross-fostered before day 1 were 0.18 kg smaller ($P=0.002$) and those cross-fostered after day 2 were 0.80 kg smaller ($P=0.0001$) at 16 days of age than those not fostered. Wattanaphansak et al. (2002) also have shown that continuous cross-fostering created almost 3 times as many light weight pigs at weaning than non-cross-fostered litters. They speculated that this could have been due to aggressive fighting amongst commingled littermates. This aggressive fighting could result in less milk consumption by these piglets.

4. Chilling. A brief note is important in making sure that the environment in which these newborn piglets are raised is adequate. It is critical to remember that a clean, warm and dry environment is desirable. The challenge becomes in establishing room temperatures and zonal heating in order to maximize sow feed intake, which has a direct impact on lactation, and still meet piglet needs. Newborn piglets have a lower critical temperature (LTC) range of about 30-34$^\circ$C while sows have a LCT around 15-19$^\circ$C. For the first 2 days of life, piglets have difficulty dealing with cold stress (temp < 34$^\circ$C) due to physiological immaturity which does not allow them to mobilize carbohydrate energy reserves (glycogen) efficiently (reviewed in Cutler et al., 2006).

From an immune system standpoint, chilled pigs use energy directed to warming up themselves instead of growing and developing their own immune protection (antibody production uses a lot of energy). Intestinal motility is also slowed down at lower temperatures which then predispose piglets to enteric diseases. Decreased intestinal motility will allow for bacterial overgrowth to occur allowing more time and more pathogens to be exposed to the intestinal tract. Intestinal motility serves as part of the body’s innate immune system.
TRENDS IN FARROWING HOUSE ENTERIC DISEASES

Moeser and Blikslager (2007) have provided an excellent review on enteric pathogens of swine and is a resource that helps summarize the mechanism by which different pathogens cause diarrhea in swine (Table 2). Understanding the mechanism of action by most of these pathogens helps explain the anticipated disease outcome of the different agents. Combining this knowledge along with current trends in disease diagnosis will help better understand the current impact of enteric diarrhea in the farrowing house.

Table 2. Mechanism that causes diarrhea by different enteric pathogens (adapted from Moeser and Blikslager 2007).

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Hypersecretion</th>
<th>Malabsorption</th>
<th>Inflammation</th>
<th>Increased intestinal permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETEC*</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Clostridium difficile</em></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><em>Salmonella Typhimurium</em></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rotavirus group A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lawsonia intracellularis</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em> Type A</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Clostridium perfringens</em> Type C</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>TGE virus</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Brachyspira spp. †</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isospora suis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*ETEC – Enterotoxigenic E. coli
†B. hyodysenteriae and B. pilosicoli

When dealing with farrowing house enteric problems, quick identification and diagnosis of the problem is critical as the pathogens are highly contagious and spread very quickly. This is why it is always critical to treat all pigs in a litter and not just the affected ones. If antibiotics are needed, the right selection needs to be done to maximize effectiveness and minimize the possibility for resistance development.

The latest summary of enteric diagnosis findings from case submissions at the Iowa State University Veterinary Diagnostic Laboratory (ISU-VDL) suggest rotaviruses, E. coli, and salmonella are the top three enteric pathogens found in all aged pigs (Figure 1).

**Escherichia coli**

The number one pathogen in the farrowing house continues to be E. coli. Diagnostic submissions do not reflect this often because diagnosis is made many times in the field. There are many different genotypes. The frequency of these varies from area to area.
Figure 1. Summary of swine enteric diagnosis made by the Iowa State University Veterinary Diagnostic Laboratory based on all case submission from 2009.

Table 3 summarizes some results from the ISU-VDL. Although the PCR genotyping provides information regarding their genetic potential, this technique does not tell us if the genes are being expressed. Knowing the fibrial types we find is critical as it helps to select the correct vaccine that would be needed to maximize effectiveness. The diarrhea that is caused by the ETEC (Enterotoxigenic E. coli) is due to hypersecretion leading to malabsorption meaning the piglets will be dehydrated and have electrolyte imbalances.

Table 3. Results on PCR genotyping at the Iowa State University Veterinary Diagnostic Laboratory in 2008.

<table>
<thead>
<tr>
<th>Associated genes</th>
<th>Number of positives</th>
</tr>
</thead>
<tbody>
<tr>
<td>K88 (F4)</td>
<td>199</td>
</tr>
<tr>
<td>K99 (F5)</td>
<td>79</td>
</tr>
<tr>
<td>987P (F6)</td>
<td>155</td>
</tr>
<tr>
<td>F18</td>
<td>162</td>
</tr>
<tr>
<td>F41</td>
<td>75</td>
</tr>
<tr>
<td>Heat stable A toxin (STa)</td>
<td>306 (35%)</td>
</tr>
<tr>
<td>Heat stable B toxin (STb)</td>
<td>431 (50%)</td>
</tr>
<tr>
<td>Heat labile toxin (LT)</td>
<td>236 (27%)</td>
</tr>
<tr>
<td>Shiga-like toxin (Stx2e)</td>
<td>76 (9%)</td>
</tr>
</tbody>
</table>
**Clostridial diseases**

Traditionally when talking about clostridial diseases it has been in reference to *Clostridium perfringens* Type C. In the U.S. this pathogen has been controlled very effectively with the use of standard pre-farrowing vaccination protocols. Today we have two other clostridial agents that are of greater concern: *C. perfringens*; Types A and *C. difficile*. These two agents of greater concern have not been able to be controlled effectively. In addition, the lack of effective control measures and an increased concern over the agents has led to significantly higher diagnosis of these agents. Survey data from Yaeger (2001) suggested and increase in *C. difficile* diagnosis in cases submitted to the ISU-VDL in 2000 as compared to 1988 (Table 4).

**Table 4. Agents detected in 100 live pigs submitted to the Iowa State University Veterinary Diagnostic Laboratory with a complaint of diarrhea in pigs less than 1 week of age. Adapted from Yaeger (2001).**

<table>
<thead>
<tr>
<th>Agent</th>
<th>1988 (%)</th>
<th>2000 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotavirus</td>
<td>8</td>
<td>42</td>
</tr>
<tr>
<td><em>Clostridium difficile</em></td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>No Diagnosis</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>PRRS</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>TGE</td>
<td>26</td>
<td>6</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Necrotic Clostridial Enteritis</td>
<td>18</td>
<td>6</td>
</tr>
</tbody>
</table>

The incidence of *C. perfringens* Type A is a challenging disease as we currently do not know what toxins are of primary concern in the pathogenesis of disease. It has been reported that a beta 2 toxin was an important predictor of pathogenesis, but current findings do not fully support this (Songer, personal communication). Without the correct toxin identified, it is difficult to have a vaccine which will be effective in providing protection to piglets.

**Rotavirus and TGE**

Rotaviruses and TGE (transmissible gastroenteritis virus) are the two most common viral pathogens contributing to enteric problems in pre-weaned piglets. Both can cause significant problems, but definitely TGE is much more severe. Rotaviruses are commonly found in all farms in most aged pigs. Traditionally our veterinary diagnostic laboratories have been focused on diagnosing only Type A rotaviruses. This really means that most of the time a negative result for rotaviruses usually only means the samples were negative for rotavirus Type A only. The lack of test development has been due to the fact that Type B and C rotaviruses have not been adapted for cell growth and therefore it has been very difficult to produce any type of antibodies for testing. New advances have now allowed diagnostic labs to use PCR technology in helping diagnose the presence of all three types of rotaviruses. This is now allowing for the investigation into a better understanding of possible implications in finding PCR positive results for rotaviruses Types B & C in piglets. This area of research is still in its early stages and time will hopefully provide better direction on how to interpret, as well as what actions need to be taken, when finding these agents in scouring piglets.
For TGE the answers are simple. It is not a pathogen expected to be found in any pig. This means that any positive result is significant and must be addressed though an eradication plan. The severity of disease for TGE decreases dramatically with the age of the pig. Piglets less than 2 weeks of age exposed to TGE have a mortality rate close to 95%. In finishing pigs, mortality is rare in affected pigs.

**Coccidiosis**

The incidence of coccidiosis in U.S. herds has decreased dramatically since slatted floors and farrowing crates have been used. In the U.S. *Isospora suis* are the primary coccidia of concern in swine. Coccidia eggs are very resistant to environmental degradation. Once a farrowing house begins to have problems with coccidia, sanitation becomes the primary means for prevention by decreasing egg loads as much as possible. Scouring due to coccidiosis usually manifest in 7-10 day old pigs and definitely cannot occur in pigs < 5 days of age due to organism’s natural life cycle. In the U.S. coccidiosis becomes a bigger problem in the farrowing house during summer months when humidity is at its greatest. Currently in the U.S., there are no approved products for the treatment of coccidiosis in swine.

**CONCLUSIONS**

Weaning weight is considered one of the most important factors impacting post-weaning and lifetime growth performance (Lawlor et al, 2002). Piglet enteric diseases are a significant contributor to piglet morbidity and mortality in the farrowing house. Piglets must be cared for properly in order to maximize their immunity which will ultimately have a better outcome on their survivability and performance during this early phase of life. Proper colostrum and husbandry management are critical in helping maximize piglet survival. A better understanding of the mechanism for diarrhea by the most common pathogens found in the pre-weaning period are critical in better diagnosis, treatment, and prevention of enteric problems in the herd.

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