NEW CONCEPTS FOR THE CONTROL OF PRRS: WITHIN PIG STRATEGIES

Monte B. McCaw
Department of Population Health and Pathobiology
North Carolina State University

Past problems

PRRS is the most demoralizing swine disease I’ve seen hit the swine industry. Others have come and pretty well gone, important in their times but paling in cost to the industry to what was to come. Pseudorabies was a piece of cake once modified live vaccines were released. Pigs died and sows got sick, but it spread quickly through the herd, the outbreak was short (few reproductive losses followed), and the herd was immune to subsequent exposures and replacement gilts were well protected by vaccination. The original MLV vaccines marketed were in the end the same gp1 vaccines we used to eradicate the disease. Some herds reported chronic pneumonia of finishing pigs, but the true role of PRV was obscured by poor finisher management such as continuous flow production with frequent remixing of pigs in pens, multiple sources of pigs to fill finishers, and temperature fluctuations. Once we got the management right and the differential ELISA was available elimination of the virus became possible, not just control of the disease. Quarantine primarily affected only seedstock and feederpig producers. Swine disentery or bloody scours was a chronic disease problem affecting every group of pigs marketed. It was a constant problem, but usually responded to at least one antibiotic. It’s impact was elevated cost of production due to extensive use of antibiotics throughout the finishing phase of production. With the advent of all-in-all-out production, reliable medication protocols for eradication, and SD free breeding stock sources bloody scours became a passing memory by the 1990’s. Endemic TGE scours in the farrowing house and nursery were also very demoralizing to producers. The scours were unresponsive to treatment and often occurred even after pig facility designs shifted to AIAO production for all age groups. While buildings were designed for one age group per room, producers were prone to holding slow-growing or even sick pigs back to younger groups. Pigs were lost or growth was stunted through the nursery phase, but grow-finish was usually not severely affected. Vaccines were not effective as primary immunizers, but immunity was solid following natural infection. This immunity seemed to be effective against any TGE isolate. Therefore, veterinarians developed protocols for eradicating TGE by infecting all sows and gilts in the herd and closing it for 4 months. This strategy, along with STRICT AIAO movement and disinfection between groups of suckling and nursery pigs, was nearly always successful for eliminating TGE from endemically infected herds. TGE is still seen nearly every winter in NC when weather conditions favor occurrence, usually a result of spread by pigs, personnel, and trucks from some initial outbreak.

Current crisis

But then, along came PRRS. I have commonly stated that if we gave vet students a test asking them to design the most challenging disease to control following teaching them principles of
vaccination, herd management, and biosecurity, their answer would essentially describe what PRRS does to us today. PRRS is costing us AT LEAST $6.00 per head marketed, or $600,000,000.00 per year. Even worse, it makes workers so frustrated and demoralized, many of them quit and go look for jobs in some other areas. This is particularly true of our best workers who cared how healthy the pigs were produced, and who strived to make bonus. Commercial vaccine now often does not work well enough to control significant economic losses from PRRS. Most groups of nursery and finishing pigs are affected by various bacterial or viral disease problems in combination with PRRS which makes them very hard to treat with antibiotics and results in elevated rates of poor growth and mortality. Reports of 40% or more of live-born pigs dying, being culled, or not making market weight are common in PRRSv infected herds and systems. Unlike the previously mentioned disease problems, PRRSv also causes significant reduction in the number of pigs born alive by abortion or elevated numbers of stillborn or mummified piglets. These reproductive problems are usually limited to a few weeks to possibly one turn of the breeding herd. HOWEVER, IMMUNITY FOLLOWING DISEASE DOES NOT ALWAYS PREVENT SOWS FROM ABORTING AND HAVING DEAD OR WEAK PIGS AGAIN WHEN EXPOSED TO A DIFFERENT PRRSv ISOLATE. Also reproductive losses can reoccur if gilts are not infected prior to entry into the herd with PRRS, and subsequently become infected because they were susceptible and older sows shed the virus to them. PRRSv is actually moderately hard to spread, and shedding of the virus after infection can occur months later, so moderately large groups of susceptible gilts can build up in the herd, they get infected, and result in significant numbers of abortions and piglet losses even in some older sow litters. Since vaccines currently don’t always control disease losses and infection of incoming gilts by contact with nursery pigs or cull gilts is often inconsistent and unpredictable, veterinarians have turned to a new, yet ancient, method for immunizing replacements to the herd.

The Keys to PRRS Control

What are the keys to controlling PRRS? There are two, both essential to success. Until recently it was thought we could not do either.

1) Design biosecurity measures to prevent the entry of (other) PRRSv and follow them religiously. Dr. Baker will talk extensively on methods he’s used to successfully keep PRRSv out of sow herds. “Outside the pig measures”

2) Stop circulation of the virus or spreading of infection among sows in breeding herds. “Inside the pig measures” Sows or gilts infected in later gestation can give PRRSv to their piglets either in utero or during lactation. Piglet infection may only occur in one litter per breeding group after the initial reproductive disease outbreak has ended, but those piglets will subsequently infect others in the nursery or finisher resulting in the all too common chronic disease and performance losses associated with PRRS. PRRSv circulation within breeding herds has been stopped by a) Total depopulation of the herd (costly and too great a risk of reinfection to be used in pig-dense areas), b) Vaccination, and 3) Planned Exposure of the whole sow herd combined with herd closure following some of the principles used for TGE eradication.

PRRS Vaccines: Why aren’t they as good as other vaccines?
PRRSv vaccines have failed to **consistently** control disease losses or more importantly continued spread of the virulent virus to sows and gilts within infected herds. There have been some reports, mainly out of the Midwest, where aggressive and regular vaccination with commercial live or killed vaccines, often coupled with herd closure to new gilt introductions, has been able to ultimately stop virus circulation within the herd (PRRSv free nursery pig flow achieved) or even eliminate PRRSv from the herd. Keep in mind the modified live vaccine is itself a PRRSv which can continue to spread among sows in the herd after vaccination has ended. More commonly, vaccination of the herd or nursery pigs will reduce the severity of disease seen, but does not stop virus circulation in the sow herd, vertical infection of piglets, and ultimately disease in nursery and finishing pig flow. In certain cases, it appears that vaccine completely failed to protect sows or pigs following introduction of a new PRRSv isolate into the herd since severe disease outbreaks (Acute PRRS) were observed in “well vaccinated” herds.

How could it be that PRRSv vaccines don’t work well whereas PRV vaccine made it possible to eradicate that disease from the United States? We don’t know for sure, but two mechanisms are being researched as possible causes. First, PRRSv infection (and MLV vaccination???) may interrupt the normal function and development of innate (not specific, constantly present) and acquired (specific, needs to be developed) immune responses. PRRSv infection has been shown to be a very powerful blocker of InterFeroN alpha production by macrophage cells in the pig’s lung. IFN alpha is a critical and early nonspecific innate immune protein produced in response to RNA virus infections. Its job is to signal other cells (like a hormone) and keep them from manufacturing new virus at the beginning of an infection. IFN alpha also is very important in starting the development of the acquired specific long-term immune responses we expect to protect the pig following a virus infection. But since PRRSv infection has developed an unknown mechanism to block the switching on of IFN alpha production by infected immune cells it may be a cause for the observed **DELAYED** immune response needed to clear the virus from the pig’s body and provide protection. We know PRRSv infection does (eventually) result in total immunity against reproductive loss following challenge with the SAME (homologous) virus. However, this protective immunity takes a long time to develop (three to four months) compared to other diseases like PRV or Swine Influenza Virus.

The second mechanism PRRSv probably uses to evade the pig’s protective immune responses is by **mutation** of key parts of the virus that the immune system attacks. These mutations (changes in target proteins) evade previously created cell-based immune responses and possibly also antibody responses. Almost without exception, PRRSv isolated from previously infected or vaccinated herds during clinical PRRS outbreaks are **genetically different (heterologous)** than the original virus infecting the herd or vaccine being used. The only exception is from disease outbreaks following introduction of many PRRSv-free gilts into infected herds. Immune responses following natural infection only partially protect against heterologous PRRSv challenge, if at all (Acute PRRS outbreaks). PRRSv is known to mutate at a slow but steady pace, changing over time possibly enough to evade the immune responses developed following vaccination (as a result of vaccine development and safety testing laws vaccines are always created from earlier, “older” viruses, just like the situation for human Influenza vaccines). The amount of cross-protection seen between two different PRRS viruses or with a vaccine probably is a result of how many of the key immune-target protein genes in the virus that have been mutated. The more target genes that are mutated, the less protection we should expect. Research is currently being done to identify which parts of the virus
are targets of the immune system, and to identify any of these targets that stay the same for all viruses that can be used to make new broadly-effective vaccines.

**What Can Be Done TODAY to Stop Virus Circulation in Sow Herds?**

**Planned Exposure.**

The **best immune protection** seen is against reinfection with the SAME (homologous) strain of PRRS virus used to infect and make the pig immune (Lager et al 1997). Therefore **IF the herd is infected with only ONE strain of PRRSv**, then Planned Exposure with this homologous PRRSv of replacement gilts in isolation and or all sows in the breeding herd simultaneously may be used to stop birth of viremic piglets / nursery disease. Planned Exposure may possibly be used to eliminate the virus from the herd if it is coupled with a 6 month herd closure. The principle is simple and is based upon the TGE eradication strategy of WHOLE HERD IMMUNITY. The **GOAL** is to make **ALL breeding animals and replacements immune to the herd’s PRRSv simultaneously.** If ALL breeding animals are immune, then none can become infected! Therefore they can’t shed the virus to their piglets or new gilts and ultimately the spread of the virus in the herd ends. Sows and replacement gilts are injected with PRRSv infected serum from the herd prepared by a veterinarian rather than fed intestines and lungs as in TGE eliminations. **Planned Exposure is not a simple technique**, it requires much diagnostic investigation and planning to minimize the risk that the wrong (heterologous) PRRS virus is used. Extensive losses (many abortions, high preweaning and nursery mortality) can result if gilts or sows are injected with the wrong, heterologous virus! **Expect some reproductive losses even when the correct, homologous PRRSv is used!** These are due to deliberate infection of pregnant sows that are NOT IMMUNE to / weren’t infected before with the herd’s PRRSv. These losses usually last only 4 to 6 weeks following Planned Exposure. Typically after that no more PRRSv infected piglets are born and production reaches goal levels in lactation and the nursery. Again, the goal is to make all animals immune to your herd’s PRRSv isolate at the same time. Choose a veterinarian who has had prior success with PE to do the investigative diagnostic testing and evaluation necessary to determine that your herd is currently actively infected with only one strain of PRRSv, and that the virus you have in hand is that virus. The veterinarian will need access to past PRRSv sequence information from your herd, need to collect multiple samples from viremic and possibly weak piglets in the farrowing house to isolate and sequence current herd PRRSv from, and to help generate homologous PRRSv inoculum. **Inoculum should never be prepared from a sample returned from the diagnostic laboratory!!!**

Planned Exposure will be considered if only one PRRSv strain (determined from genetic sequencing of the isolated viruses) is found. The veterinarian should test any proposed inoculum for other unwanted disease agents. They also must inspect, evaluate, and propose any needed changes in herd biosecurity practices (see Dr. Baker’s proceedings). **This is no time for white lies!** If the veterinarian does not get accurate answers to their questions, it will be impossible for them to prevent entry of a new strain of PRRSv into the herd. Again, new heterologous PRRSv introduction into your herd would result in a new disease outbreak and much more complex challenge to stop virus circulation (remember, PRRSv immunity is good against homologous virus, unpredictable and often poor against a different, heterologous virus).
Planned Exposure is not a new vaccine, it works only against the virus in your herd, not against any outside viruses!

Biosecurity measures must be in place and capable of preventing entry of new strains of PRRSv!

Planned Exposure is used to:

1) Acclimatize PRRSv-free gilts in isolation to the strain of virus in your herd BEFORE entry. This will help minimize the number of susceptible animals in the herd capable of continuing the spread of PRRSv in the breeding herd and to piglets. [Gilt only exposure]

2) Speed the ending of clinical disease losses during a PRRSv outbreak (PRRSv actually doesn’t spread easily). [Whole herd exposure]

3) Stop constant *in utero* infection of a few piglets (“leaking”) each week and subsequent disease of their whole nursery or finisher groups with PRRSv. [Whole herd exposure]

4) Eradicate PRRSv from herds by stimulating *whole herd immunity* in sows and replacement gilts. This strategy appears to require at least 6 months of herd closure to new gilt introductions unlike the 4 months that has worked consistently for TGE. [Whole herd and gilt exposure]

**Take home lessons**

The best and most predictable immunity is against the same virus the pig was originally infected (vaccinated) with. Immunity against any other PRRSv cannot be predicted. It may be very good (hence trying vaccine to control PRRS in your herd is a prudent option), but it also may not be effective enough to control / eliminate your production losses. In some cases vaccination OR prior infection against a wild type PRRSv provide very little observable protection against a new strain of PRRSv.

Biosecurity is essential for PRRS control. For planned exposure to work long-term, we must prevent entry of any other unrelated PRRS viruses from entering the herd.

Planned exposure will probably cause reproductive and production losses for a few weeks. The goal is that production losses will stop for hopefully years. To achieve this you need to immunize / acclimatize all new gilts in isolation (#1 above) to the herd virus, or to move on to eliminating the virus completely from your herd by incorporating herd closure with your planned exposure (#4 above).

**Planned Exposure using a live PRRS virus different than the one active in your herd can cause very serious losses.**

**References**
2002 PRRS Compendiums, Producer and Research editions. National Pork Board, Des Moines, Iowa. [Www.npb.org  515-223-2600. These books are a must for anyone trying to understand the current state of PRRSv control and science. They have been written by experts (producer, veterinary, and researcher) in each field and are intended to provide an explanation of current knowledge and best possible summary of that knowledge.