

Management to improve neonate piglet survival

Claudio Oliviero

Department of Production Animal Medicine, Faculty of Veterinary Medicine, University of Helsinki, Paroninkuja 20, 04920 Saarentaus, Finland.

In the recent years the use of hyper-prolific sows has increased and litters with more than 14-16 born alive piglets are not uncommon. However, piglets' mortality after birth before weaning can range between 11 to 24 % in several countries. Recent findings show that, without human assistance of piglets (cross fostering, movement to a nurse sow, split- or suckling assistance), sows with an average litter size of 13.5 ± 0.8 piglets managed to wean 10.6 ± 0.6 piglets (average \pm SD). This indicates that the upper limit that the domestic sow is capable of taking care till weaning is much lower than the current average total number of piglets born. The average number of weaned piglets obtained in many European countries is possible only with high standards piglets' management practices. In this review, the most recent findings in physiology of new-born piglets and their implication in the management to improve perinatal piglets' survival are described.

Introduction

In the last two decades there has been a clear trend in developing hyper-prolific pig breeds in many countries, which has increased the litter size (Bjerre *et al.* 2010, Paredes *et al.* 2012). In order to evaluate the productivity of a sow, it would be best to select for number of piglets weaned. However, due to the common practice of cross fostering small piglets at an early age of life, the number of total piglets born has been preferred as a mean of selection (Su *et al.* 2007). Litters with more than 16 total born piglets have been associated with higher stillbirth rates (1.5 piglets) than litters of 11-12 total born piglets (0.6 piglet) (Boulot *et al.* 2008). Comparing similar litter sizes, Canario *et al.* (2006) found the probability of stillborn piglets in large litters to be almost twice as high. Large litters are also associated with longer farrowings, higher risk of hypoxia for piglets during birth (Herpin *et al.* 2001), and higher within-litter weight variation (Milligan *et al.* 2002). Piglets' mortality after birth before weaning can range from 11 to 24 % in several countries, and it is mostly concentrated in the first 5 days of life (Pedersen *et al.* 2011, KilBride *et al.* 2012). The main causes of death included crushing, low viability, starvation and diseases. These levels of pre-weaning mortality represent a challenge to modern pig production and also an animal welfare concern. The purpose of this review is to summarize the recent findings on physiology of new-born piglets and their implications in the management to improve perinatal piglets' survival.

Physiology of new-born piglets

Body thermoregulation is a challenging process for neonate piglets. They are born wet covered by foetal fluids, which decreases considerably their skin temperature if they don't dry quickly.

They are provided with a very little pelage which could reduce body temperature dissipation, and they lack brown fat which could be metabolized to generate heat and balance their body temperature (Berthon *et al.* 1994). Therefore new-born piglets are very vulnerable to the environmental temperature, and they can display adequate metabolic responses to reduce heat loss only if their body temperature is above 34° C (Lossec *et al.* 1998). Those main metabolic responses are: mobilization of free fatty acids, shivering, and a modest gluconeogenesis using own liver's glycogen reserve. The latter is available and metabolized within a maximum of 15-20 hours in starving piglets (Svendsen & Bengtsson 1986, Lossec *et al.* 1998). Pedersen *et al.* (2011) found that piglets with a rectal temperature of 36.1 °C 2 h after birth, had greater odds (0.09) of being crushed by the sow, while for piglets with a rectal temperature of 38.6 °C the odds were smaller (0.05). Furthermore, Herpin *et al.* (1996) demonstrated that piglets which suffered from hypoxia (rupture of the umbilical cord or detachment of the placenta) during parturition were less vital, took more time to reach the sow's udder (120 ± 35 vs 25 ± 3 min). They also showed a hampered ability of maintaining the body temperature (36.3 ± 0.9 vs 38.4 ± 0.1 °C) during the first 24 hours of life. In contrast to older animals, the early neonatal piglet does not increase its energy intake in response to cold temperature. Actually, colostrum intake decreases by 36.8 % during a cold exposure (18-20 °C), when compared to piglets at ambient temperature between 30-32 °C, exacerbating the likelihood of starvation (Lay *et al.* 2002). Kammersgaard *et al.* (2011) found that birth weight over 1.1 kg was the most important single factor in successful recovery from postnatal hypothermia. In addition, Milligan *et al.* (2002) found that birth weight over 1.3 kg was positively correlated to higher piglet pre-weaning survival. It has been shown that the birth process and individual characteristics influence the piglet's thermoregulatory mechanism. However, in an environment like the modern farrowing unit, with different zones at different temperatures, it is heat preservation rather than mere heat production that determines thermoregulatory success and recovery from postnatal hypothermia (Kammersgaard *et al.* 2011).

Because of the epitheliochorial nature of the porcine placenta, the neonate piglets lack of maternal IgG at birth. They must acquire maternal immunoglobulins from ingested colostrum for passive immune protection before they will start to produce own immunoglobulins around 3-4 weeks of age (Rooke & Bland 2002). However, colostrum is produced only during the first 16-24 hours after parturition starts, and already after the first 6 hours the IgG content in colostrum is halved (Le Dividich *et al.* 2005). The colostrum intake at the right time frame and amount can be challenged by sibling competition, delayed farrowing time and reduced viability. All these factors have a major impact in large litters (Devillers *et al.* 2007). The same authors found that individual colostrum intake ranged from 0 to more than 700 g during the first 19 hours of life (450 g/kg birth weight), indicating that the intake capacity of the piglet can be extremely high when colostrum supply is not restricted. However, in large litters those ad libitum quantities of colostrum are rarely available to all piglets, and probably an amount around 200-250 g consumed per piglet induces a sufficient protection. Devillers *et al.* (2011) found that pre-weaning mortality rate was 7.1% when piglets ingested more than 200g of colostrum and increased to 43.4% when intake was less than 200g. It appears that piglets' intake capacity is not the limiting factor for colostrum intake, while the limitation could be found in the sow's colostrum availability, especially in large litters. Colostrum yield is highly variable, it averages 3.3–3.7 kg, ranging from less than 1.5 kg to more than 6.0 kg (Devillers *et al.* 2007, Quesnel 2011). However, Andersen *et al.* (2011) found that without human assistance of piglets (drying, placing under a heat lamp, cross fostering, movement to a nurse sow, split- or suckling assistance), it can be difficult for many sows to adequately nurse more than 10-11 piglets. Furthermore, Quesnel *et al.* (2012) suggest that the genetic selection for

higher prolificacy is probably one of the major causes for the greater incidence of low vitality and low birth weight piglets. These characteristics are likely to end up in consequent higher mortality due to an inadequate colostrum intake.

Practices to improve neonate piglet survival

Once piglets are born the farmers need to quickly implement a strategy to reduce piglet mortality. This is important especially in large litters in which chances to have low viable piglets, competition for colostrum and milk access are higher (Lund *et al.* 2002). Those strategies can vary according to the type of farrowing unit, the availability of workers and the degree of experience. The measures directed to improve neonatal piglet survival can be divided in three areas of action: environment, sow, and piglets.

Environment

According to the existing literature, during the first 1-3 days of life crushing accounts between 20-43 % of perinatal mortality of piglets (Tubbs *et al.* 1993, Edwards 2002). Activity level, lying down and rolling, of loose-housed sow has been found to affect piglets' crushing (Wechsler & Hegglin, 1997). This is one of the reasons why the farrowing crate, which accommodates the sow before parturition till weaning, is the most commonly used type of housing (70-83 %) during farrowing and lactation period (Johnson & Marchant-Forde, 2009). However, the reduced crushing rate in crate systems when compared to free farrowing systems has been questioned in some studies (Phillips and Fraser 1993, Cronin *et al.* 2000). Moreover, restraining sows in crates before parturition may prevent normal movement and expression of natural mothering behaviour, such as nest building (Damm *et al.* 2000). There is some evidence that crated sows not allowed to perform nest building behaviour, using adequate substrate like straw or saw dust, showed an average increase of 93 min in farrowing duration and a 4.7 % rise in stillbirth rate, compared to sows in pen with available substrate (Oliviero *et al.* 2008 & 2010). Mousten *et al.* (2012) found the highest piglet survival among sows that farrowed freely and were crated for 4 days after the end of farrowing, compared to sows loose-housed before farrowing and for the whole lactation. Presence of bedding like straw and sawdust at farrowing can be beneficial also for neonate piglets to maintain their body temperature. Recent studies show that some piglets may reach the udder within one minute after birth, while many others may spend up to 3 h from birth to the first successful suckling (Thingnes *et al.* 2008). During this long time these piglets will suffer from a considerable heat loss that can compromise their survival. Therefore, after piglets are born and in search of the udder, a layer of straw can offer a good insulation from plain concrete or slatted floor (Curtis, 1970). However, straw should be replaced when it has become wet during or after farrowing. In crated pens, with slatted or semi-slatted floors, placing a removable rubber soft mattress behind the sow can decrease chilling of the piglets immediately after birth. If chopped straw is used, the mattress can also help to keep the layer of straw in place on the slats. In order to reduce heat loss, it can be useful to have a creep area in the farrowing pen, which can be equipped with a heat lamp generating a comfortable microclimate for neonate piglets (over the lower critical temperature of 34 °C) This allows them to efficiently dry off and regulate their body temperature (Adams *et al.* 1980). However, neonate piglets seem to be more attracted by the sow's body, other piglets and birth fluids, without going firstly to the warm creep area (Andersen *et al.* 2007). Some studies found that all causes of mortality (starving, crushing and other causes) were significantly lower when the piglets were placed under the heat lamp / dried immediately after birth compared to piglets that

were not handled (Christison *et al.* 1997, Andersen *et al.* 2009). Use of floor heating (33-34°C) around farrowing resulted in earlier onset of suckling and reduced piglets' mortality rate (7.2 % vs 12.2 % no floor heating) during the first three days of life (Malmkvist *et al.*, 2006) However, housing in those temperatures during lactation could negatively affect the sow reducing the feed intake (McGlone *et al.* 1988). In contrast, Damgaard *et al.* (2009) found that floor heating from 12 h after the onset of nest building behaviour and until 48 h after birth of the first piglet, compared with no floor heating, did not compromise physiological parameters such as water intake and body temperature in loose-housed sows. Therefore, floor heating seems to be useful in the first days around parturition. Later on, only a warm creep area for piglets would be more beneficial for the sow, and for the piglets which start to make use of creep area more actively from the third day of life on (Vasdal *et al.* 2009).

Sow

Assuming that the sow has been given the opportunity to properly express the pre-farrowing nest building behaviour, as described in the previous paragraph, the main role of the sow immediately after birth is to produce enough colostrum and milk for the litter. The first thing that should be evaluated at the end of parturition is the correspondence between the number of functioning teats and the number of piglets born alive. Sows of different breeds can have between 12 to 18 teats (Labroue *et al.* 2001), however not all teats may be active. This is of particular importance in first parity sows. Farmer *et al.* (2012) found that piglets suckling teats that were previously used and functioned in first lactation had a 340 g of body weight gain advantage from day 2 to day 14 of lactation, compared to piglets which suckled teats not active during the previous lactation. Insufficient colostrum and milk production can affect the whole mammary gland and it is known as postpartum dysgalactia syndrome (PDS). However, in presence of a large litter (> 16 piglets), even with a full functioning mammary gland it is often necessary to intervene and ensure an adequate colostrum and milk intake to all piglets. The necessity and importance of human intervention in presence of large litter is confirmed by recent studies in which no manipulation of litter size (cross fostering, movement to a nurse sow), and no human assistance (split- or suckling assistance, drying), determined a constant number of surviving piglets at the time of weaning between 10 and 11. These findings suggest that this number could be the upper limit that the domestic sow is capable of taking care of (Andersen *et al.* 2011). The most common strategy, dealing with excess of newborn piglets, is to reallocate them to other sows. However before doing this, an adequate colostrum intake from the own mother should be ensured as described in the following paragraph. One simple way to deal with extra piglets is to cross foster them within litters of piglets born during the same day. This way litters can be evened ensuring that low birth weight piglets compete with litter mates of similar size. This practice reduces the risk of being excluded from the udder by the heavier ones (English, 1998). The competition for teats is even more marked in large litter size. Deen and Bilkei (2004) found that the mortality at weaning of low-birth weight cross fostered piglets (0.9-1.0 kg) was 34.5 % if allocated in large litters (12 piglets) with high-birth weight littermates (> 1.6 kg). When allocated in small litters (8 piglets) with average-birth weight littermates (1.2-1.59 kg) or high-birth weight littermates, the mortality was 16.1 % and 19.6 %, respectively. Cross fostering should therefore be performed during the first day of age, after piglets get adequate colostrum from their own mother. Roberts and Martineau (2001) found that cross-fostering disrupted behavior (more fights, vocalizations, nonproductive nursings) and growth of fostered litters at different ages during lactation (day 4, 7, 10, 13 and 16) except on day 1. Similarly, Price *et al.* (1994) found that cross fostered piglets were more likely ($P < 0.01$) to be among the last two animals to contact the sow's udder than resident piglets. This occurred

during milk ejections if fostered at day 2, 4, or 7 of lactation but not on day 1. However, cross fostering become more and more challenging with increasing of litter size, and other strategies are needed. Recently in some countries, like Denmark, with hyper-prolific pig lines, the use of nurse sows has become common. Nurse sows can be made with a one-step process. This implies weaning a litter of piglets ready to be weaned (usually at 21 days of lactation). The donor sow then receives all the one-day old excess piglets from the sows recently farrowed. The quality of the milk is considered acceptable to the newborn piglets (assumed that they've all got colostrum from their own mothers) However, the nurse sow is used to her own piglets initiating the lactation, being suckled more intensively and being used to more active and older piglets (Jensen *et al.* 1991). Consequently, she will often have a temporary decrease in her milk production (2-3 days) before turning back to standard levels. Nurse sows can also be made in a two-step process by weaning a litter of piglets ready to be weaned from an "intermediate nurse sow". This sow is supposed to receive piglets of 2 to 7 days of age from another selected sow with a good milk production, which is then ready to receive all one-day old excess piglets. In this way the two-step nurse sow will not have a decrease in milk production, as she is still used to initiate the lactation. Nurse sows should probably be made in a two-step process if the objective is to move one-day old piglets to them. However in both processes, no more of the same amount of piglets removed from the nurse sow should be collected and moved to her from the other sows. The extra piglets to be chosen for transfer to the nurse sow should be the bigger among the litters, because they stimulate the nurse sow's udder better and will create a more uniform new litter.

Piglets

As described previously, neonate piglets are challenged to keep their body temperature over their functional level of 34°C. Therefore a great effort should be put to quickly dry them off soon after birth and place them in an adequate microclimate minimizing their body heat loss. A second important step is to provide the whole litter with a sufficient individual colostrum intake (200-250 g) within 12-16 hours from the beginning of parturition (Devillers *et al.* 2011). When possible, small and low viable piglets should be assisted to suckle, helping them to attach to the teat, ensuring that colostrum is ingested. It is important to remember that small piglets have difficulties to suckle from big teats, therefore the smallest functioning teats should be preferred when assisting suckling. This procedure should be repeated 3-4 times within the first few hours if those piglets are not seen actively suckling. Additionally, low viable piglets can be hand fed with colostrum collected from their own mother or other sows within 6-12 hours from beginning of farrowing. At this phase, milking by hand is relatively easy, due to almost continuous (every 5–40 min) milk ejections (Algers & Uvnäs-Moberg 2007). Piglets can be hand fed using a feeding bottle with a suitable nipple or using a syringe connected to a soft silicone plastic tube (3-4 mm in diameter) to insert in the oesophagus till the piglet's stomach and allowing 20-25 ml of colostrum. To estimate the right length of the part of the tube to introduce in the piglet's mouth till the stomach, the tube can be previously marked with the distance from the edge of the nose to the last rib on the chest of the piglet. Particular care should be taken to avoid wrong positioning of the tube in the trachea or injuries of the larynx. Assisted suckling and hand feeding work well in small to normal litters with only one or two small piglets. In large litters and more low viable piglets, a split suckling strategy could be more effective. In order to minimize the sibling competition for colostrum intake, the litter is split in two groups. The heavier and stronger piglets are kept in the creep area or in a separate box, allowing the smaller piglets to suckle for 60-90 minutes, and then the groups are switched. When separating the piglets, both groups should always have free access to a warm creep area.

This can be easily obtained using a box with an additional heat lamp for the separated group, which leaves the creep area accessible for the remaining group to suckle. If some small piglets are still not able to successfully suckle, assisted suckling should be combined with split suckling.

Concluding remarks

Here are listed the most important management procedures to improve neonatal piglet survival.

- Provide sow with a substrate (like straw) 1-2 days before the start of parturition, in a free farrowing space when possible.
- Measures to reduce piglets' body heat loss include: presence of bedding material on the floor (straw, sawdust) to be replaced when wet, removable rubber mattress on slatted floor, floor heating, a creep area with a heat lamp, promptly dry and place new-born piglets in adequate microclimate (34° C).
- Evaluate teat functionality and whether functioning teats are in accordance with the number of piglets born.
- Ensure colostrum intake to all piglets in the litter by assisting suckling, hand feeding and split suckling.
- Cross foster piglets during their first day of life, levelling the litters by weight.
- Use nurse sows to rear excess piglets of several large litters.

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