

Case Report

Surgical management of pyometra in a miniature sow

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Abstract

An American Miniature pig sow (~ 5-year) was presented for abdominal distention and lethargy of 2 weeks duration. Initial diagnostics revealed distended fluid-filled structures in the caudal abdomen on ultrasonography, and minor alterations in biochemistry and complete blood count profiles. Exploratory laparotomy under general anesthesia revealed a large uterus distended with purulent material; ovariohysterectomy was performed. The uterine horns were friable and inadvertent rupture of the left horn occurred that was managed intraoperatively. Postoperative management included intravenous fluids, antiinflammatory and antimicrobial therapies. Complications encountered during hospitalization were mild hypotension under anesthesia and constipation/ileus during recovery. Culture of the uterine contents revealed mixed growth including *Escherichia coli*, *Schaalia hyovaginalis*, and *Trueperella abortusuis*. The sow was discharged 6 days after surgery and no complications were reported. Comparative management as described for other species was useful in the treatment.

Keywords: Sow, pyometra, surgery, transabdominal ultrasonography

Background

Miniature pigs, such as American Miniature pigs ('Mini pigs'), Vietnamese Potbellied pigs, Kunekune pigs, and other breeds are rapidly increasing in popularity as pets.¹ With this increasing popularity there is an increased demand for veterinary services and consultation. Nevertheless, there are few published resources for management of reproductive-related disorders of miniature companion pigs. This case presents an American Miniature Pig diagnosed with pyometra that was managed utilizing a comparative medicine approach that may provide clinicians with a case management example for similar clinical cases, as miniature pigs are increasing in popularity in the USA and Canada.

Case presentation

An American Miniature pig sow (~ 5-year) was presented for concerns of abdominal distention, anorexia, and decreased activity of 2 weeks duration. Owners obtained the sow 5 months ago after farrowing. Sow's previous medical and vaccination history was unknown. No medical issues were reported from other pigs on the farm.

Initial diagnostics included physical examination, serum biochemistry, complete blood count (CBC), and transabdominal ultrasonography. Sow weighed 66.4 kg, temperature was 38.7°C (reference: 37.6-39.1°C), pulse was 56 per minute (reference: 60-80) and respiratory rate was 20 breaths per minute (reference:12-18), and sow had marked abdominal distention (Figure 1). Sow was alert and had normal urination and defecation, but was inappetent. Initial CBC was unremarkable with exception of increased total protein of 9.6 g/dl (reference: 6.5-8.9) and decreased absolute lymphocytes of $0.32 \times 10^3/\mu\text{l}$ (reference: 1.5-7.6). Chemistry findings included decreased sodium (126 mmol/l; reference: 135-145), chloride (90 mmol/l; reference: 94-107) and phosphorous (3.0 mmol/l; reference: 3.9-7.5); as well as mildly increased blood urea nitrogen (22 mg/dl; reference: 2-19). Abdominal ultrasonography revealed distended uterine horns filled with mildly echogenic fluid (Figure 2). Due to the combination of clinical and diagnostic findings, the top differential diagnosis was pyometra.

Treatment

Initial treatment included intramuscular tulathromycin (2.5 mg/kg; Draxxin, Zoetis, Parsippany, NJ) and flunixin



Figure 1. Sow's standing caudal view at presentation (note distended left abdomen)

meglumine (2.2 mg/kg; Banamine S, Merck Animal Health, Rahway, NJ) and intravenous fluid therapy with a balanced polyionic fluid at maintenance rate (2-3 ml/kg/hour). Due to sow's stable condition and presumptive diagnosis of pyometra, anesthesia and ovariohysterectomy were planned for the following day. After several hours of fluid therapy, the sow had mild appetite for grapes and was observed drinking. Feed and water were withheld for 8 hours prior to surgery. The morning of surgery, several hours prior to premedication,^{2,3} the sow was given oral clonazepam (0.4 mg/kg) and maropitant (2 mg/kg) as an oral sedative prior to preanesthesia induction manipulation and as a preanesthetic antiemetic, respectively.

Anesthesia

Based on sow's presentation and clinical status, American Society of Anesthesiologists score of III was assigned prior to anesthesia. Intramuscular alfaxalone (1 mg/kg; Alfaxan Multidose, Zoetis) and ketamine (8 mg/kg; Ketaset, Zoetis) were given as premedications that resulted in moderate sedation. Sow was subsequently preoxygenated via mask and anesthesia machine and a 20 G x 1.5" catheter was placed in an auricular vein. Intravenous lidocaine (2 mg/kg; Hospira Inc, Lake Forest, IL) and propofol (1 mg/kg; PropoFlo, Zoetis) were given to induce anesthesia. Sow was orotracheally intubated using an 8 mm internal diameter, cuffed

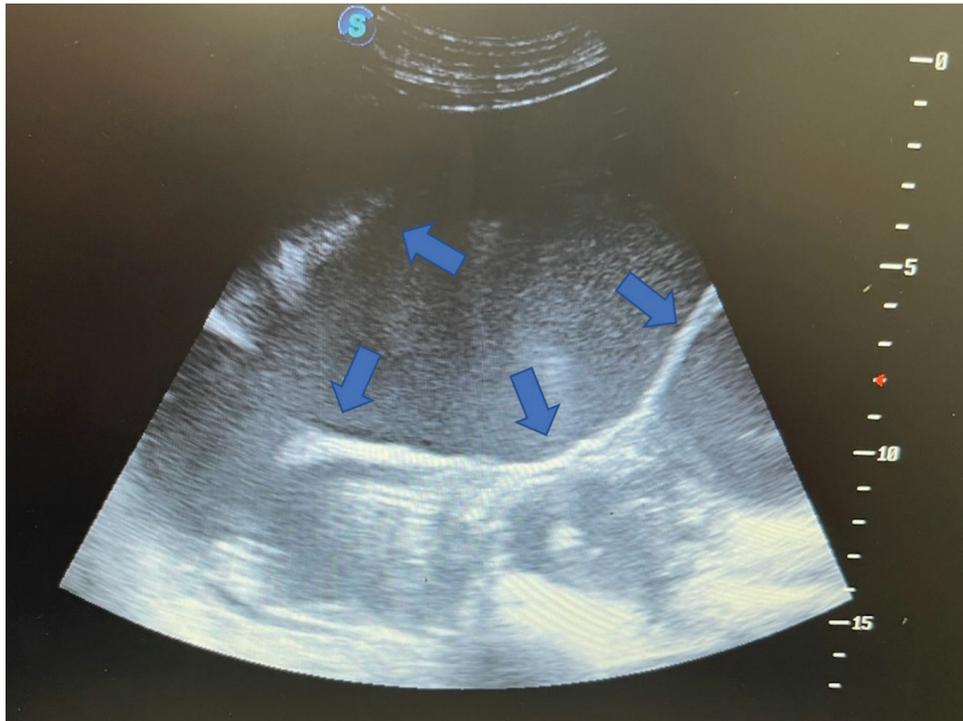


Figure 2. Transabdominal ultrasonographic image of sow's uterus at presentation (note distended uterine horns [blue arrows] filled with mildly echogenic fluid)

endotracheal tube. Anesthesia was maintained with isoflurane (ETIso 0.75-1.25%; Piramal Critical Care, Inc, Bethlehem, PA) in oxygen (via a rebreathing circuit and small animal anesthesia machine) and lidocaine as constant rate (3 mg/kg/hour) infusion. In addition, intravenous morphine (0.3 mg/kg, Hikma, Berkeley Heights, NJ) was given along with lactated Ringers (5 ml/kg/hour; LRS, ICU Medical, Inc). Transversus abdominis plane (TAP) block was performed, using bupivacaine 0.25% (1 ml/kg; Hospira Inc) and dexmedetomidine (1 µg/kg; Dexdomitor, Zoetis), delivered in 1 subcostal and 1 preiliac injection site, per hemiabdomen. As alpha 2 agonists such as dexmedetomidine prolong the duration of local anesthetics, this protocol was chosen to maximize the duration of analgesia provided by the local anesthetic to the abdominal wall to reduce the need for systemic analgesics.⁴

Sow exhibited hypotension (mean arterial pressure < 60 mm Hg) ~ 40 minutes after induction. A 10 ml/kg fluid bolus or LRS (over 10 minutes) was given, and a constant infusion rate (5 µg/kg/minute) of dobutamine (CRI; Hospira Inc) was started that transiently resolved the hypotension. The bolus was repeated ~ 30 minutes later when hypotension occurred again. Hypotension occurred once more ~ 30 minutes after the second fluid bolus, and a dose of intravenous ephedrine (0.1 mg/kg; Fresenius Kabi, Lake Zurich, IL) was given that resolved hypotension for ~ 20 minutes. Finally, intravenous hypertonic saline bolus (2 ml/kg) was given over 15 minutes that maintained normotension till the procedure was completed and anesthesia was terminated. Sow recovered from anesthesia uneventfully.

The premedication protocol consisted of alfaxalone (a neurosteroid with GABA_A agonistic properties) and ketamine

(n-methyl-d-aspartate receptor antagonist) were chosen to facilitate sedation, muscle relaxation, and for intravenous catheter placement; these 3 goals were accomplished. The induction protocol consisted of a loading dose of lidocaine, a sodium channel blocker, for the subsequent CRI and, together with the premedications, allowed for a small dose of propofol (a GABA_A agonist) to induce further muscle relaxation, hypnosis, and general anesthesia. This multimodal protocol allowed several classes of drugs use, lowering the required dose of each in attempts to mitigate any undesired effects (e.g. dose-dependent vasodilation) associated with propofol and/or isoflurane. The lidocaine CRI, morphine dose and TAP block were further efforts to reduce the MAC of isoflurane required for general anesthesia and surgery in efforts to mitigate isoflurane's dose-dependent cardiovascular depression. Accomplishing this was evidenced by the percentage of isoflurane required to maintain general anesthesia (well below reported MAC).⁵ However, there were several episodes of hypotension that were successfully treated with boluses of isotonic and hypertonic crystalloids, as well as sympathomimetics; dobutamine (positive inotrope via β agonism) and ephedrine (direct and indirect action on α and β receptors). Sow recovered uneventfully and had normal hemoglobin oxygen saturation, blood pressure, and temperature in the recovery stall. Sow also visually appeared comfortable and exhibited no clinical signs of pain associated with abdominal palpation, therefore no additional analgesics were given immediately after surgery.

Surgery

Sow received an additional dose of intravenous flunixin meglumine (2.2 mg/kg, ~ 24 hours after first), and respiratory (RespiSure-One/ER Bac, Zoetis) and tetanus (Tetanus Toxoid, Colorado Serum Company, Denver, CO) vaccinations

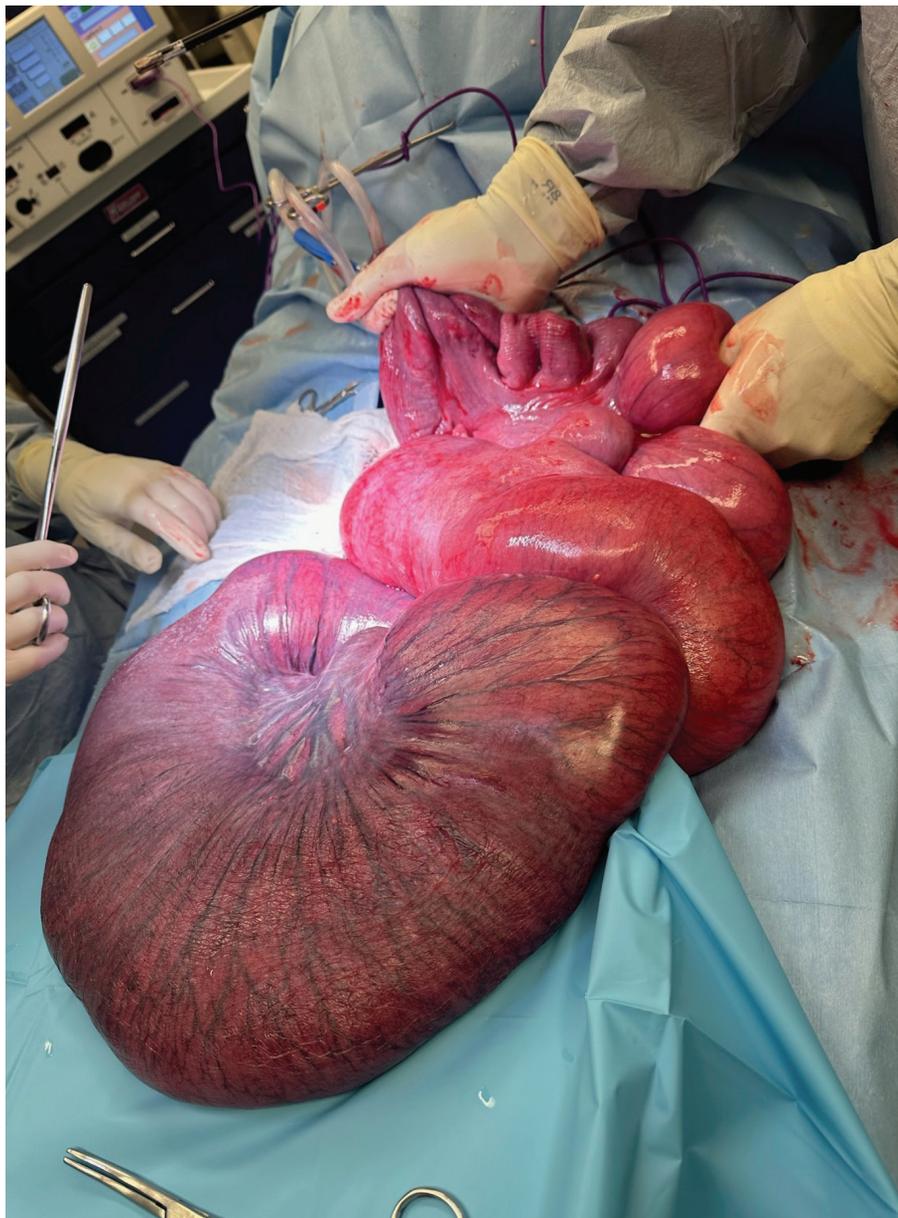


Figure 3. Uterus during surgery prior to completion of ovariohysterectomy as partially exteriorized on a mayo stand (note the large distended horns and darkened vessels)

prior to surgery. Sow was subsequently placed in dorsal recumbency, clipped, and aseptically prepared and draped from xiphoid to pubis. Approximately 15 cm ventral midline skin incision was made with size 10 scalpel blade on the caudal abdominal midline. The subcutaneous adipose tissue was incised with a scalpel blade and bluntly dissected digitally. Once the linea alba was visualized, it was incised by tenting the tissue with thumb forceps and making a stab incision with an inverted size 10 scalpel blade. This incision was extended with Metzenbaum scissors cranially and caudally until peritoneum was visualized. The peritoneum was incised by tenting and making a stab incision as described for the linea alba. Metzenbaum scissors were used to extend linea alba and peritoneum the length of the skin incision. The distended uterine horns were visualized immediately upon entry into the abdomen (Figure 3) and were used to locate ovaries (had several corpus lutea).

The left ovarian pedicle was ligated with 3 encircling ligatures placed proximally to the ovary by introducing the swagged portion of the needle first to minimize the risk of inadvertently puncturing a vessel within the broad ligament using 0 polydioxanone (PDS, Ethicon, Bridgewater, NJ). These were placed ~ 1 cm apart from each other, and a bipolar electro-surgical device (Ligasure, Stryker, Portage, MI) was used to ligate and seal the pedicle between the remaining ligatures as previously described for bipolar pedicle ligation.^{6,7} The Ligasure was used to transect along the broad ligament toward the uterine body to allow for exteriorization of the left uterine horn. One transfixing ligature was placed around each uterine artery adjacent to the uterine body using 2-0 PDS suture. Attempts to locate the right ovary resulted in ~ 2 cm tear in the abaxial uterine wall of exteriorized left uterine horn, clear to white cloudy malodorous liquid leaked. Saline-soaked laparotomy sponges were packed below the left uterine horn to prevent

leakage into the abdomen. Intrauterine suction was performed with a Poole suction tip to remove remaining fluid from the uterus. Doyen forceps were placed adjacent to the defect and was closed with 0 PDS in a simple continuous pattern to prevent further spillage. Abdomen was lavaged with warm saline and suctioned. The abdominal incision was repacked with sterile saline-soaked laparotomy sponges. New gloves were used by the surgery team to minimize abdominal contamination.

The right ovary was identified, and the process was repeated for the right ovarian pedicle and right broad ligament without further contamination of the surgical site. Three Miller's knots were placed using 1 polyglactin 910 (Vicryl, Ethicon) suture around the body of the uterus ~ 1 cm apart from each other distal to the cervix. The abdomen adjacent to uterus body was packed with 2 saline-soaked laparotomy sponges. Between the 2 most proximal ligatures, an 18 G needle was inserted and suction applied to remove purulent material from the uterine body. The Ligasure was used to transect between these 2 ligatures. The uterine body stump was closed with 0 PDS in a simple continuous pattern.

After removal of uterus, the laparotomy sponges were removed, the abdominal cavity was lavaged with 5 liters of warm saline, which was then removed with suction. No hemorrhage was observed prior to closing. A new surgery pack was opened prior to closure. Peritoneum and linea alba were closed with a cruciate pattern using 0 PDS; subcutaneous layer was closed with 0 PDS using a simple continuous pattern and the skin was closed with 2-0 PDS with an intradermal pattern. An aluminum aerosol wound dressing (Aluspray, Neogen Inc, Lansing, MI) was sprayed over the incision and postanesthetic recovery was prolonged.

Postoperative management

Several hours after recovery, due to concerns of pain, an additional intravenous dose (0.2 mg/kg) of morphine was given. Postoperatively intramuscular ceftiofur crystalline-free acid (5 mg/kg; Excede for Swine, Zoetis) was given due to possible contamination from the uterine contents. For the next 3 days after surgery sow was maintained on daily intravenous balanced polyionic fluids and flunixin meglumine (decreased to 1.1 mg/kg). Appetite returned to normal 24 hours after surgery and sow was maintained on twice-daily oral amoxicillin-clavulanic acid (20.5 mg/kg; Clavamox, Zoetis). During recovery, scant manure production was noted; sow was given once 100 mg of ducosate sodium (generic) with continuation of intravenous fluids and feed was provided in mash form. Culture of the uterine fluid collected at surgery identified *Escherichia coli* (*E. coli*), *Schaalia hyovaginalis*, *Trueperella abortusuis* (Table 1). Two days after surgery, the sow had complete

resolution to normal behavior and attitude. Repeat CBC was unremarkable, with the exception of elevated fibrinogen (700 mg/dl; reference: 0-600) expected after surgery. Intravenous fluids were tapered and discontinued 4 days after surgery. Sow was discharged 6 days after surgery with instructions to complete the 10-day therapy of amoxicillin-clavulanate. Follow up on days 14, 29, and 91 after discharge suggested sow's return to normal activity with no additional health concerns.

Discussion

There is limited information on pyometra cases in pigs, although it was reported in a wild boar sow⁸ and a production sow.⁹ A previous retrospective study of complications from ovariectomy in sows described pyometra cases as least likely to survive after discharge from the hospital among groups in that study, as only 3/5 survived.⁶ An additional retrospective investigation identified 3 pigs with lesions consistent with pyometra in 24 pigs with uterine lesions observed during ovariectomy.¹⁰ With this lack of clinical reporting, it is important for clinicians to consider comparative measures for pyometra management information available in small and large animal literature. We utilized a comparative approach derived from reports on the management of pyometra in other species.

Pyometra is defined as the accumulation of purulent content within the lumen of the uterus in an intact or ovariectomized female.^{11,12} The causes of this pathology are sometimes unknown; however, there are several factors (e.g. age, parity, complicated parturition) involved. There are 2 main clinical presentations of this pathology; these are described as open or closed pyometra, depending on cervical patency.¹¹ The type of presentation depends on the presence of an active corpus luteum. Physiopathology varies depending on the species, age, reproductive status, or history. Although the accumulation of purulent material is due to a bacterial interaction, perhaps there are other causes. For example, in the mare, some common predisposing factors are failure to relax/open the cervix due to internal or external adhesions, incompetent uterine clearance, and reproductive tract position.¹³ In cattle, pyometra is most common in the postpartum stage due to an ovulation that occurred before uterine clearance is completed.¹⁴ Additionally, dystocia, fetal membrane retention, and metritis could lead to the accumulation of purulent material in the uterus.

Multiple bacterial species are associated with pyometra in veterinary medicine. In cattle the pathogen most isolated is *Trueperella pyogenes* (*T. pyogenes*),¹⁴ whereas the main organism associated with pyometra in the mare is *Streptococcus equi* ssp. *zooepidemicus*.¹³ Pyometra in dogs is strongly associated with hormone interactions.² Progesterone causes endometrial changes and in addition to the decreased immune system and closed cervix lead to an ideal environment for bacteria to proliferate and cause pyometra. Dogs tend to become systemically ill because the majority of the infections are caused by *E. coli* that release endotoxins, causing a systemic inflammatory response.¹⁵ Pigs with substantial endometrial changes had cystic endometrial hyperplasia¹⁶ leading to pyometra due to the rupture of these fluid-filled structures providing an ideal medium for bacterial growth. Additionally, accumulation of purulent material is caused by previous endometritis or metritis. Chronic endometritis led to pyometra in a sow;⁹ some of the pathogens isolated were *E. coli* and *T. pyogenes*, similar to our case (*E. coli* and a *Trueperella* species).

Table 1. Uterine fluid (collected intraoperatively) culture results

Culture Component	Identified Organisms
Aerobic	<i>Escherichia coli</i>
Aerobic	<i>Schaalia hyovaginalis</i>
Aerobic	<i>Trueperella abortusuis</i>
Anaerobic	Unidentifiable gram-negative rod
Anaerobic	Unidentifiable gram-positive coccus

Sow received multiple medications, all were extralabel, as none is labelled for pigs pyometra treatment. Although some drugs used were labelled for pigs, they were not for the indications of management of pyometra (e.g. flunixin labeled for pyrexia). Other drugs used were not labelled for pigs; however, were used before (e.g. clonazepam and maropitant for perioperative management).^{2,3} Extralabel drug use is allowed in the USA as long there is a valid veterinary-client-patient relationship and possibility of making decision as outlined in the Animal Medicinal Drug Use Clarification Act. This is common in companion miniature pig cases.¹⁷ In the USA, food animal status is determined by species, not role, and this sow was given withdrawal instructions after consultation with the Food Animal Residue Avoidance Databank (FARAD). It should be noted that when utilizing FARAD for advice, it is meant for the specific case it was requested for, and may not be accurate for other cases. Although uncommon, there are documented cases of miniature companion pigs entering the food chain in the USA.¹⁸ Ceftiofur (Excede for Swine, Zoetis) was used extralabelly in this case in a manner permitted for 3rd generation cephalosporin order of prohibition (label dose, route, and duration), and the indication was for infection determined by examination and initial diagnostics.

In small animal medicine, medical management of pyometra is possible. The ideal patients for medical management of pyometra are young and otherwise healthy cats and dogs with open cervix.¹⁹ Close monitoring is critical for these cases as severe complications, such as sepsis, is possible. It is important to note that in these small animal cases, although antimicrobials may reduce disease progression, they alone will not result in uterine healing.¹⁹ Medical management without surgical intervention was not considered as a preferential option for the sow, due to the perceived disease progression, cervix in an apparently closed state and the depressed nature at presentation indicating suspected systemic illness.

Comparative antimicrobial selection for companion miniature pigs can be challenging. For the isolates identified in this case, there are no validated Clinical and Laboratory Standards Institute (CLSI) breakpoints. For example, there are no *E. coli* breakpoints for swine, so laboratory interpretation of susceptibility data is likely extrapolated from other species, and may not be entirely accurate. Amoxicillin was used in this case based on susceptibility information for ampicillin and CLSI recommendations on the interchangeability of ampicillin and amoxicillin for antimicrobial susceptibility testing results (CLSI, VET01S, 7th edition).²⁰ Furthermore, we are unaware of any disposition data for amoxicillin or ampicillin in the uterus or uterine fluid of the pig after oral administration of the drug. This case illustrates the approach for practitioners to integrate diagnostic findings, patient information, as well as available references to extrapolate a treatment of an infection in a species where there is not enough evidence to interpret antimicrobial susceptibility testing results based solely on the susceptibility report.

Limitations of this report are its singular and retrospective nature. Although this case had a successful outcome, variation in similar cases in the future may dictate the need for alternate approaches. Future studies could evaluate less-invasive surgical procedures in pigs, such as the assisted laparoscopic surgical glove port technique for ovariohysterectomy in the female dog²¹ or the hand-assisted laparoscopic ovariohysterectomy described for resolution of chronic pyometra in

a mare.²² However, these endeavors should be considered keeping in mind the possibility of encountering a friable uterus, as in this case.

In conclusion, a comparative approach described for pyometra in other veterinary species was useful for the management of this sow. Specifically, a comparative approach was utilized in this case for diagnostic measures, intravenous fluid therapy, ovariohysterectomy, and medical management with antimicrobials and pain management. Clinicians should keep in mind the friable nature of uterus, if surgery is planned for pyometra in pigs.

Learning points

- Pyometra can account for ~ 25% of body weight
- Pyometra can be managed with surgical removal of the uterus and medical management
- Comparative species approach can be applied, with awareness to extralabel drug regulations
- Careful surgical handling of diseased uterus is necessary to prevent rupture
- Hypotension during anesthesia and ileus or constipation during recovery are possible complications

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