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Resource setting impacts neonatal but not maternal survival in bitches treated for dystocia: 243 cases (2015–2020)

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OBJECTIVE
To compare maternal and fetal outcomes of dystocia managed surgically and nonsurgically at referral hospitals (RHs) versus community medicine clinics (CMCs), determine the rate of C-section, and evaluate the incidence of hypoglycemia and hypocalcemia in bitches presented with dystocia.

ANIMALS
Bitches presented with dystocia at 2 RHs and 2 CMCs.

METHODS
Information on signalment, presence of hypoglycemia and/or hypocalcemia, diagnostic imaging performed, nonsurgical and surgical interventions performed, maternal and fetal outcomes, and total cost of care was obtained from the electronic medical records of bitches presenting for dystocia between October 2015 and October 2020. Descriptive statistics were performed and outcome compared between RHs and CMCs using a Fisher exact test, with a $P < .05$ considered significant.

RESULTS
230 bitches were evaluated with 243 separate episodes of dystocia, with 183 (75%) episodes treated at an RH and 60 (25%) at a CMC. There was a low incidence of hypoglycemia (5% [9/178]) and ionized hypocalcemia (1% [2/164]). Seventy-three percent (177/243) of bitches underwent surgical intervention, 25% (61/243) received nonsurgical management, and 2% (5/243) transferred to their primary veterinarian. There was no difference in survival for bitches operated at an RH compared with a CMC. However, bitches operated at an RH were more likely ($P = .04$) to be discharged with at least 1 live neonate.

CLINICAL RELEVANCE
In bitches diagnosed with dystocia, hypoglycemia and hypocalcemia were rare. The majority of bitches underwent a C-section. The setting where the C-section was performed did not impact maternal survival.

Keywords: calcium, glucose, canine dystocia, cesarean section, neonate

Dystocia is defined as the disturbance of parturition resulting in the abnormal delivery of a fetus through the uterus or birth canal.[1–4] Dystocia may be due to maternal factors, such as primary or secondary uterine inertia, narrow pelvic dimensions, and uterine abnormalities, or fetal factors, such as fetal malposition, oversize, and developmental abnormalities.[1] Ideally, pregnancy and parturition would always be planned and monitored with serial health screening, progesterone level testing, imaging studies, and monitoring of uterine activity if available.[5] Unfortunately, from the authors' clinical experience, numerous canine pregnancies are unplanned, with many of these dogs receiving little to no preparturient care, and the availability of affordable after-hours emergency veterinary services is often limited.

Dystocia is reported to affect about 5% of all canine pregnancies, with brachycephalic breeds and singleton litters overrepresented.[2] The emergency clinician must consider signalment, clinical signs, and stage of labor as well as litter size when determining whether medical or surgical intervention is warranted. Medical management for dystocia may be considered for bitches in which labor has not been prolonged, the cervix is dilated, obstructive causes have been ruled out or manually removed,

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and there is no evidence of fetal death or distress.[1] Veterinarians should consider owner priorities as well as progression of labor when attempting medical management. When medical management is attempted, it is important to monitor closely for contraindications that would prompt conversion to surgical therapy, such as fetal distress noted by bradycardia on ultrasonography, aberrant patterns on tocodynamometry, or stillbirths of previously viable fetuses.[5]

Initial diagnostic tests routinely recommended for dogs presented with possible dystocia include assessment of blood glucose and ionized calcium levels as well as abdominal imaging. Hypoglycemia and hypocalcemia reportedly may contribute to the incidence of dystocia and may need to be supplemented separately or in conjunction.[1,4] Abdominal radiographs can provide an accurate fetal count and evidence of obstruction (malpositioned puppy, oversized fetus, etc) but unless clear fetal demise or lack of skeletal calcification is evident, offer limited utility in identifying fetal viability. Ultrasound assessment of fetal heart rate, body movement, and intestinal peristalsis is a much better modality for detecting fetal stress and viability.[2]

Medical management for dystocia may include glucose and calcium infusion, either empirically or based on laboratory evidence of hypoglycemia and hypocalcemia. Parenteral calcium is often given SC in dystocia patients and may improve myometrial contractions in eucalcemic bitches; it can be given alone or in conjunction with oxytocin.[5] While calcium improves the strength of uterine contractions, oxytocin increases their frequency. Oxytocin dosing is dictated by labor pattern and best assessed with the aid of tocodynamometry, which detects changes in intrauterine and intra-amniotic pressures. Much smaller doses of oxytocin have been recently recommended to progress labor while minimizing uterine tetany and side effects.[5] Additionally, digital manipulation alone may facilitate vaginal delivery in some bitches or may be combined with oxytocin when obstructive dystocia and other contraindications have been excluded. Unsuccessful medical management is associated with increased fetal and maternal morbidity and mortality and necessitates the need for surgical intervention.[3,6] Surgical management may include C-section with or without ovariohysterectomy and is associated with good maternal and fetal survival.[7–9]

The challenges of managing dystocia patients are amplified when owners lack the financial resources to proceed with an unplanned C-section. As such, the lives of the bitch and any viable puppies frequently rely on the veterinarian finding a lower-cost solution, which can further delay the time to surgical intervention. To the authors' knowledge, outcomes associated with canine C-sections performed at community medicine clinics (CMCs) by trainees with limited surgical experience have not been evaluated.

Previous studies have indicated low mortality (0.03% in 10,000 surgeries including both cat and dog spays and neuters) of patients presenting for elective reproductive surgery at high-volume shelter medicine clinics, as well as a decrease in canine and feline ovariohysterectomy surgical time when surgical experience of fourth-year veterinary students increased.[10,11] Good outcomes are possible with trainee surgeons, which is also noted in a similar study[12] of dogs treated for pyometra with ovariohysterectomy by trainees at the same 4 hospital locations as the current dystocia study. There was no difference in survival to hospital discharge or 1 week after surgery for dogs operated on at CMCs by trainee surgeons.[12]

The authors hypothesized that there would be improved maternal and fetal survival in dogs with dystocia managed with surgical intervention at referral hospitals (RHs) as compared to CMCs. The first aim of this study was to compare maternal and fetal outcomes for dogs treated for dystocia both surgically and nonsurgically in RH settings compared to those managed in CMC settings. The second aim was to describe the incidence of hypoglycemia and ionized hypocalcemia in dystocia patients.

Methods

Electronic medical records were queried from 2 veterinary RHs, (1) Foster Hospital for Small Animals at Tufts University (FHSA) and (2) Tufts Veterinary Emergency Treatment and Specialties, and 2 CMCs, (3) Luke and Lily Lerner Spay/Neuter Clinic (Lerner) and (4) Tufts at Tech Community Veterinary Clinic (Tufts at Tech). All 4 clinics are located in Massachusetts. Referral hospitals are defined as a high-resource setting with 24-hour access to specialty and emergency care, while CMCs are low-resource settings without specialty services. Community medicine clinics aim to serve the underserved pet owner and pet population of the nearby greater Worcester area of Massachusetts primarily in an outpatient manner. The total client cost for subsidized anesthesia and surgery at the Luke and Lily Lerner Spay/Neuter Clinic was $200 USD. Cases in this study that were operated on at a CMC either presented to Tufts at Tech for an urgent appointment or were presented to an RH but operated on at the Lerner Clinic.

An existing protocol at the study institution allows bitches that were diagnosed with dystocia necessitating emergency C-section at FHSA and whose owners lacked financial resources or approval for a medical credit card (eg, CareCredit) to have a C-section performed 24 hours a day at the Luke and Lily Lerner Spay/Neuter Clinic by a trainee surgeon, such as a fourth-year veterinary student, rotating intern, or critical care resident with oversight from either a surgical or critical care faculty member. For this study, patients that presented to FHSA but were operated on at Lerner were categorized as CMC patients. Tufts at Tech Community Veterinary Clinic is a community medicine clinic that can take urgent appointments such as dystocia. Surgeries performed there were also performed by trainees with experienced nonspecialty faculty oversight.

The search terms dystocia, difficult labor, pregnancy, cesarean section, and C-section were searched to identify bitches presented for dystocia between October 2015 and October 2020. Inclusion of any of the above search terms prompted review of the record and determination of study inclusion by a single reviewer. Only patients diagnosed with dystocia by the attending emergency clinician were included in this study population. Exclusion criteria included patients that were diagnosed as not being in labor or identified as being in stage 1 labor. Data extracted from the veterinary medical record included age and

breed. Brachycephalic breeds were defined to include French, American, and English Bulldogs; Pug; Cavalier King Charles Spaniel; Boxer; Shih Tzu; Boston Terrier; Mastiff; Brussels Griffon; and Lhasa Apso. Data extracted also included time of initial presentation (day, 07:00 to 18:00; and night, 18:00 to 07:00), parity, presence of hypoglycemia (< 75 mg/dL; reference range, 76 to 120 mg/dL), presence of ionized hypocalcemia (< 0.9 mmol/L; reference range, 1.18 to 1.37 mmol/L), frequency and type of diagnostic imaging obtained (radiography and ultrasonography), intervention performed (surgical and nonsurgical), maternal and fetal outcomes, and, when applicable, the surgical setting (RH vs CMC) and related expense.

In this study, surgical management included both C-section and C-section with ovariohysterectomy. Medical management included administration of any of the following medications, either alone or in combination: dextrose, calcium, and oxytocin. Manual manipulation refers to digital repositioning of the fetus and/or application of gentle traction that resulted in fetal delivery and does not include manual stimulation of Ferguson reflex via vaginal exam. Supportive care included placing the bitch in a quiet, darkened room or administration of medications not listed under pharmacologic management (such as antiemetics, analgesics, and IV fluids). Transfer included transfer of care to another hospital not included in the study prior to completion of parturition.

Statistical analysis

Descriptive statistics were used to describe the population of bitches. Data distributions were evaluated visually and using Shapiro-Wilk tests. Since most data were not normally distributed, continuous variables are represented as median (range) and categorical variables as frequency (percentage). Fisher exact tests were used to compare outcomes between the 2 different hospital settings (RH and CMC) for (1) survival of the bitch and (2) survival of the bitch and at least 1 puppy. *P* values < .05 were considered significant. All data analyses were performed with commercial statistical software (SPSS, version 25.0; IBM Corp). A post hoc power analysis was not performed.

Results

A summary of the patient signalment, visit characteristics, and diagnostics performed at both the RH and CMC are provided **(Table 1)**.

Table 1—Summary of signalment characteristics including age and breed, time of presentation, parity, identification of ionized hypocalcemia and hypoglycemia, and performance of abdominal radiography and point-of-care abdominal ultrasonography in dogs treated for dystocia at 2 referral hospitals, the Foster Hospital for Small Animals at Tufts University (FHSA) and Tufts Veterinary Emergency Treatment and Specialties (TVETS), and 2 community medicine clinics, Luke and Lily Lerner Spay/Neuter Clinic (Lerner) and Tufts at Tech Community Veterinary Clinic (Tufts at Tech), between October 2015 and October 2020.

Variable	FHSA	TVETS	Lerner	Tufts at Tech	Total
Age (y)					
< 5	85	40	32	11	**168**
5–10	33	23	13	2	**71**
> 10	2	0	1	0	**3**
Unknown	0	0	1	0	**1**
Total cases	**120**	**63**	**47**	**13**	**243**
Breed					
Brachycephalic	32	13	3	2	**50**
Nonbrachycephalic	87	50	44	11	**192**
Unknown	1	0	0	0	**1**
Total cases	**120**	**63**	**47**	**13**	**243**
Time of presentation					
Day (07:00–18:00)	57	31	25	9	**122**
Night (18:00–07:00)	63	32	22	4	**121**
Total cases	**120**	**63**	**47**	**13**	**243**
Parity					
Primiparous	30	16	12	1	**59**
Multiparous	55	25	16	2	**98**
Unknown	35	22	19	10	**86**
Total cases	**120**	**63**	**47**	**13**	**243**
Laboratory testing performed					
Hypoglycemia < 75 mg/dL	3	3	2	1	**9**
Total cases with glucose measured	**104**	**45**	**22**	**7**	**178**
Ionized hypocalcemia < 0.9 mmol/L	1	1	0	0	**2**
Total cases with ionized calcium measured	**103**	**41**	**20**	**0**	**164**
Imaging performed					
Radiographs only	14	18	2	2	**36**
Ultrasonography only	67	11	22	5	**105**
Radiographs and ultrasonography	29	22	9	5	**65**
Total cases with imaging performed	**110**	**51**	**33**	**12**	**206**

There were 243 separate occurrences of dystocia in 230 individual bitches analyzed over the 5-year study period. Thirteen bitches had dystocia with > 1 litter. One hundred eighty-three bitches were managed primarily at an RH and 60 managed primarily at a CMC, with 46 bitches having been initially presented to the FHSA and then operated in the Lerner clinic. The most common breeds were Chihuahuas (18% [43/242]) and pit bull–type dogs (15% [37/242]). Brachycephalic dogs made up 21% (50/242) of the study population, with 1 dog breed being unknown. The median age at time of presentation was 3.5 years (range, < 1 to 11 years). Time of presentation was evenly split between the daytime (50% [122/243]) and nighttime hours (50% [121/243]). Of the 156 cases in which parity was known, more dogs were multiparous (63% [98/156]) than primiparous (38% [59/156]).

Laboratory testing

One hundred seventy-eight bitches had some laboratory testing documented as part of their evaluation of dystocia that included measurement of glucose and 164 measurements of ionized calcium. Hypoglycemia (< 75 mg/dL) was documented in 9 of 178 (5%) dogs, with a median of 59 mg/dL and range of 39 to 74 mg/dL. Two dogs had severe hypoglycemia (< 50 mg/dL). Eight of the hypoglycemic dogs were supplemented with IV dextrose (1 with blood glucose of 74 mg/dL was not supplemented with dextrose). Eight of the 9 hypoglycemic bitches survived to discharge, and 5 required surgical intervention. Ionized hypocalcemia (< 0.9 mmol/L) was documented in 2 of 164 (1%) dogs, with individual measured values of 0.65 and 0.76 mmol/L. Both dogs were treated with parenteral calcium gluconate, required surgical intervention, and survived to discharge.

Diagnostic imaging

Two hundred six (85% [206/243]) bitches had results of diagnostic imaging recorded in the medical record. Thirty-six (17.4% [36/206]) bitches underwent abdominal radiography alone, 105 (51% [105/206]) bitches had only point-of-care ultrasonography, and 65 (31.6% [65/206]) bitches experienced both imaging modalities.

Medical and surgical intervention

A summary of the interventions performed at both the RH and CMC is provided **(Table 2)**. A total of 243 cases of dystocia were treated between all 4 hospitals. Over half of all bitches (56% [137/243]) received immediate surgical intervention alone and in one-third (33% [80/243]), pharmacologic treatment was initially attempted. Fifteen bitches underwent manual manipulation (6% [15/243]) and successfully whelped. Five (2% [5/243]) dams received supportive care alone, and all were able to whelp remaining puppies. Five (2% [5/243]) remaining bitches were transferred to another facility prior to any therapies and completion of parturition, and 1 dog was euthanized prior to any treatment (1/243).

Of the initial one-third (33% [80/243]) that received pharmacologic treatment described above, 46% (37/80) finished whelping successfully, 50% (40/80) required surgical intervention, and 4% (3/80) were transferred to another facility.

Of the surgical group, 67% (118/177) underwent surgery at an RH and 33% (59/177) underwent surgery at a CMC. For dogs that received surgical intervention at an RH, 45% (53/118) had a C-section and 55% (65/118) had C-section with ovariohysterectomy. Ninety-six percent (57/59) of dogs that underwent C-section at a CMC were also spayed.

Maternal and fetal mortality

Two percent (4/243) of the bitches died prior to discharge. One was euthanized before any treatment was administered due to poor maternal condition (0.4% [1/243]). The other 3 deaths occurred in dogs that underwent surgical intervention (2% [3/177]), 2 at RH and 1 at CMC; however, there was no significant difference in maternal survival in either setting (98%), RH (116/118) or CMC (58/59; P = .99). The 3 surgical deaths all had concurrent ovariohysterectomies (2.5% [3/122]) compared to C-section only (0% [0/55]). There was no significant difference between surgical maternal survival in those that received ovariohysterectomy versus C-section (P = .55).

In the dogs that received surgical intervention, there was significant difference in the number of

Table 2—Summary of veterinary interventions performed in both hospital settings (referral hospital and community medicine clinic) in the population described in Table 1.

Interventions performed	FHSA	TVETS	Lerner	Tufts at Tech	Total
Surgical	75	16	37	9	**137**
Medical then surgical	14	13	9	4	**40**
Total surgical	**89**	**29**	**46**	**13**	**177**
Medical	18	18	1	0	**37**
Manual manipulation	4	11	0	0	**15**
Supportive care	4	1	0	0	**5**
Total nonsurgical	**26**	**30**	**1**	**0**	**57**
Medical then transfer	1	2	0	0	**3**
No treatment and transfer	3	2	0	0	**5**
Total with unknown outcome due to transfer	**4**	**4**	**0**	**0**	**8**
Total euthanasia prior to any therapies	**1**	**0**	**0**	**0**	**1**

Surgical included both C-section and C-section with ovariohysterectomy. Medical included administration of dextrose, calcium, and/or oxytocin. Manual manipulation was performed when a fetus was able to be maneuvered into a position for delivery or manual removal. Supportive care included placing the bitch in a quiet darkened room and receipt of other medications not listed under pharmacologic management (such as antiemetics, analgesics, and IV fluids). Transfer included transfer of care to another hospital not included in the study prior to completion of parturition.

dams discharged with at least 1 live puppy between the 2 types of hospitals (P = .04).

Of the bitches that underwent surgery at an RH, 80% (93/116) were discharged with at least 1 live puppy, 20% (23/116) had no surviving puppies, and 2 had an unknown neonatal outcome. Of the bitches that underwent surgery at a CMC, 65% (37/57) were discharged with at least 1 live neonate, 35% (20/57) had no surviving puppies, and 2 had unknown neonatal outcome.

Cost

The median cost of the RH surgical visits including emergency room assessment, stabilization, surgery, and hospitalization was $2,292 (range, $969 to $7,695). A review of the medical record for the surgical case with a total cost of $969 revealed that the anesthesia and surgical charges were inadvertently not applied to the invoice. The median cost of the CMC surgical visits was $295 (range, $116 to $855), which in some cases included the initial assessment fees at FHSA.

Discussion

This study population consisted of mostly Chihuahuas and pit bull–type dogs, with brachycephalic dogs making up 21% (50/242) of the total population. The incidence of brachycephalic dystocia in this study was comparable to the 19.3% (129/668) reported in the 2019 UK retrospective by O'Neill et al.[13] Breed association with dystocia is highly varied in different studies, with most noting small breeds being more predisposed (Chihuahuas, Miniature Poodles, Dachshunds, Pomeranians) and some noting brachycephalic breeds (French Bulldogs, Boston Terriers, Pugs).[13–15] The median age at time of presentation in this study was 3.5 years (range, < 1 to 11 years). This is consistent with the O'Neill et al study, which noted a median age of 3 years.[13] Age has been shown to play a role in dystocia, with primiparous dams over the age of 6 years being more at risk of dystocia in 1 large retrospective study.[16] In this population, of the 156 cases in which parity was known, more dogs were multiparous (63% [98/156]) than primiparous (37% [59/156]).

Biochemical changes such as hypoglycemia and ionized hypocalcemia in the parturient bitch are theorized to play a potential role in development of dystocia due to uterine inertia, though the exact mechanisms have not been fully elucidated.[6,7,17] Recent research evaluating biochemical markers in blood and uterine biopsy samples (ionized calcium, uterine oxytocin receptor mRNA, progesterone, and PGF2 α metabolite) found that uterine oxytocin receptors are downregulated in bitches with obstructive dystocia and not in those diagnosed with primary uterine inertia. Additionally, the authors did not find a difference in blood ionized calcium levels across any group within the study population. It remains unclear whether parturition ceases due to uterine inertia or uterine inertia develops due to parturition.[18] In the current study population, hypoglycemia and ionized hypocalcemia were rare at 5% (9/178) and 1% (2/164), respectively. These results vary from a previously reported 2018 study describing biochemical and hematological profiles of parturient bitches with various causes of dystocia.[19] In that 2018 study, where hypoglycemia was defined as a blood glucose < 70.2 mg/dL and ionized hypocalcemia < 1.23 mmol/L, the incidence of hypoglycemia was 7.6% (2/26) and ionized hypocalcemia was 52% (11/26).[19] The study population was a lot larger than that of the 2018 study, which could account for the large difference in biochemical abnormalities, with other possibilities being a less sick population or a population seeking earlier care prior to onset of biochemical abnormalities. To the authors' knowledge, there are no other reports documenting the frequency of hypoglycemia and ionized hypocalcemia in parturient dogs, and the value where hypoglycemia and hypocalcemia are clinically relevant is unknown.

Similar to that of a previous report (80.1% in 70 Boxer breed dogs with dystocia), 73% (177/243) of the bitches emergently presented for dystocia in this population of dogs received surgical intervention.[20] It is unknown which dogs might have successfully whelped naturally if given more time, but protracted labor increases the risk of fetal demise and a worse outcome for the bitch. In the current population, nonsurgical management was successful 58% (57/97) of the time, which is higher than that previously reported by Darvelid et al[21] in 1994 (30% [56/181]). This finding could be due to chance alone or better case selection (selection of appropriate medical management candidates). Better case selection can be due to veterinarians having better access and training in point-of-care ultrasound, thereby enabling better detection of fetal distress and viability and/or a lower incidence of obstructive dystocia not amenable to manual manipulation, where medical management is appropriate.

The authors acknowledge that there is also debate surrounding the decision for concurrent ovariohysterectomy at time of C-section due to increased risk of perioperative hemorrhage contributing to patient morbidity. It is not uncommon in community medicine practice to encourage ovariohysterectomy at the same time as dystocia surgery (C-section) for population control purposes and often, due to owner preference, unplanned pregnancies, or in older bitches or patients with other comorbidities. Recent literature suggests that ovariohysterectomy at time of C-section did not result in an increase in risk of mortality, intra- or postoperative complications, or decreased mothering of the bitch.[22] Overall, it is a multifaceted decision and one that is made with patient and owner considerations.

There were 3 nonsurvivors in 177 (1.7% [3/177]) surgical patients. One Great Dane had septic peritonitis due to gastric perforation from a concurrent gastric dilation volvulus (surgery included ovariohysterectomy for a retained fetus, gastric derotation, repair, and gastropexy, as well as splenectomy for devitalized spleen). This patient had unknown blood glucose on presentation but developed hypoglycemia postoperatively and no ionized hypocalcemia. One Siberian Husky was diagnosed with a septic abdomen (diagnosed with cytology of abdominal effusion) from devitalized fetuses

and uterine rupture, and cardiopulmonary arrest occurred shortly postoperatively. This patient had normal blood glucose and ionized calcium on presentation. One Chihuahua was dull on presentation and had hypoglycemia and unknown ionized calcium. She was suspected to be septic due to devitalized fetuses from prolonged labor and experienced cardiopulmonary arrest intraoperatively. All 3 patients had concurrent ovariohysterectomy.

No necropsies were performed on the 3 patients, so the definitive cause of death cannot be determined. Cause of death in these 3 patients was likely multifactorial but likely to include biochemical derangements, anesthetic drugs and protocols, surgical time, type of surgery performed (ovariohysterectomy or C-section), and sepsis or septic shock. The study surgical mortality rate of 1.7% (3/177) is similar to that of previous reports (between 0% and 4.19%).[22–24]

The strengths of this study included having a large diverse study population including 24-hour emergency presentation to a teaching hospital and specialty hospital, as well as daytime regular hour presentation to lower cost community practice for sickness appointments. The inclusion of 2 separate hospital settings should represent a broad variety of patients and owners, as well as differing hospital practices. To the authors' knowledge, this study was the first to compare management strategies, patient outcomes, and surgical costs for dogs with dystocia treated in financially diverse settings. The survival rate for bitches treated surgically was high in both the RH and CMC practice settings, despite the expectation of a much higher level of surgical expertise at the RH, indicating that good maternal outcomes are possible for emergent obstetric surgery despite lower resource availability of the clinic. In the dogs that received surgical intervention, there was a significant difference in the number of dams discharged with at least 1 live puppy between the 2 types of hospitals (P = .04), with those at RHs being greater.

While primary surgeons at CMCs were always trainees, we were unable to quantify from the medical record their level of surgery experience. An assumption was made that these individuals had less experience than most veterinarians at nonacademic community medicine clinics and referral centers. A prospective study with stratification based on surgical experience would be a useful area of further study to better understand the exact relationship between surgical experience and outcomes in various types of emergency surgery.

Limitations of this study included the retrospective nature and lack of consistent recording of oxytocin, dextrose, and calcium doses and effects on progression of parturition, precluding assessment of dosages or routes of administration playing a role in the success or failure of medical management. The practice of ovariohysterectomies or C-sections in canine dystocia contributing to possible maternal morbidity and mortality is also an important consideration that this study was not primed to fully evaluate due to its retrospective nature. The choice of ovariohysterectomy or C-section should be determined on a patient-to-patient basis and with input from both the owner and clinician. Another limitation was that fetal viability was not consistently documented prior to and following therapies. For example, a patient with 5 viable fetuses prior to surgery that resulted in 1 live neonate after surgery would be a better outcome by this study design as compared to a patient with no live fetuses prior to interventions. Unfortunately, these were the best extracted data from a retrospective evaluation and available documentation. Lack of recorded fetal data also precluded definitive answers as to why the neonatal survival rates may have been lower in the CMC setting. However, the authors speculate that these dogs may have had longer labors, additional delay to surgical intervention, less experienced surgeons necessitating longer surgeries, and minimal support staff with reduced resources for neonatal resuscitation.

Lastly, some owners with financial limitations may have delayed presentation to the veterinary hospital due to concern for cost, lack of transportation, or lack of knowledge of normal whelping, which could have increased the number of fetuses that died in utero. Other limitations of this study included dogs that were discharged prior to completion of parturition and subsequently lost to follow-up, as well as the general difficulty in assessing fetal survival, as puppies that were prior to presentation and individual neonate outcomes were not specified in the medical record.

This study supports that veterinarians with minimal surgical experience can achieve successful outcomes in the management of reproductive emergencies. While fetal survival was lower at the CMCs in this study from the available extracted data, there was no difference found in maternal surgical outcomes regardless of setting. While this study demonstrated low incidence of hypoglycemia and ionized hypocalcemia, it was not designed to evaluate various types of medical management. Further research to assess the efficacy of different medical interventions in patient morbidity and mortality is warranted.

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