Infertility in the Mare

Mary A. Ebert, BS, DVM,*
Richard L. Riese, DVM, DACT**

INTRODUCTION

Infertility in the mare results in a significant loss of dollars in the horse industry every year. It is defined as the absence of the ability to conceive.[13] There are many causes of infertility that are recognized, including infectious, inflammatory, a faulty uterine immune system, trauma and scarring, hormonal, twinning, neoplasia, and congenital abnormalities.

CAUSES OF INFERTILITY

Infectious endometritis is probably the number one cause of infertility in the mare, and contributes significantly to fetal death.[6,9] A large variety of organisms have been cultured in both the mare and stallion, but much disagreement exists as to the clinical significance of these positive cultures.[6] A large number of bacteria normally enter the uterus at breeding when the cervix is relaxed.[3,25] If these are not eliminated by about five days post-ovulation when the embryo descends to the uterus, infertility may result.[3] Mares can conceive while infected, but many will abort, resorb, or produce infected foals.[9] Pyometra occasionally occurs, but does not show systemic manifestations as in the canine.[20]

The mare has a highly efficient defense mechanism that clears the uterus of bacterial contamination, so inflammation is a normal response in fertile mares.[3] This mechanism involves phagocytosis by neutrophils, primarily, which respond to a massive invasion of the uterine lumen by debris and bacteria within 6 hours.[1,27] Opsonins from the circulation are vital for efficient phagocytosis, and complement is a component of opsonization.[1] The uterine defense system, in addition to the leukocyte function, includes ovarian hormones, non-cellular bactericidal factors, and immune responses.[28] Local synthesis of antibodies, mainly IgA, occurs in the secrectory epithelium, and a transport mechanism moves the polymeric Ig across into the uterus, cervix, and vagina.[32] Six of the ten known equine immunoglobulins have been found in uterine flushings. Some investigators report that these are in higher concentrations in fertile mares, while others dispute these findings.[25,27] When bacteria penetrate the mucosal barrier, the higher protein level stimulates the defense mechanism.[25,27] Mares with a decreased resistance to infection undergo rapid complement inactivation, possibly of enzymatic origin.[1] A failure of the uterine defense mechanism leads to a prolonged inflammation and an endometritis.[3]

Ovarian hormones greatly influence the inflammatory and immune responses of the uterus. These defense systems have the greatest ability at estrus when the vascular system is the most permeable.[32] Progesterone inhibits the immune response.[28] Many mares become anestrus after embryonic loss, delaying the next estrus for a significant period of time.[23] Infrequent, irregular estrus due to embryonic loss and decreased ovarian activity is common in the least productive mares.[21] Embryonic losses occur because of nutritional deficiencies, endometrial disease, stress, twinning, paternal influences, chromosomal aberrations, failure of maternal recognition of pregnancy, and several other causes. Mares may have lower conception rates when bred on the foal heat.[28] The highest percent of pregnancy loss occurs at days 15–20, when maternal recognition occurs, or at days 30–35, just prior to when the endometrial cups form.[23]

*Dr. Ebert is a 1985 graduate of the College of Veterinary Medicine at Iowa State University.
**Dr. Riese is a professor of Veterinary Clinical Sciences at Iowa State University.

There are a variety of anatomical and congenital conditions in mares that contribute to infertility. Pneumovaginitis, and subsequently pneumo-uterus, result from poor conformation which allows an inadequate vulvo-vestibular closure and urine pooling.[20,28] Occasionally, maiden mares have a persistant hymen.[20] Chromosomal abnormalities may be related to bilaterally small, smooth, soft or firm, ovaries with no palpable structures.[8] Pathologic cystic follicles, like those in cattle, have not been documented in mares.[8] Cervical lesions prevent conceptions in some mares, and are frequently a result of trauma from breeding or foaling.[20]

Ovarian neoplasm can cause infertility. Three recognized categories of tumors are sex cord-stromal tumors (granulosa cell tumors), primary eptithelial tumors (cystadenomas), and germ cell tumors (teratomas and dysgerminoma). Of these, the granulosa cell tumors are the most common.[8,24] The embryologic origin is uncertain. They produce hormones and cause anestrous, intermittant or frequent estrus, nymphomania, stallion-like behavior or masculine physical characteristics in mares because of the increased testosterone concentration.[24]

The serous cystadenoma is rare. Mares will cycle normally, and can become pregnant due to the normal function of the opposite ovary. The multiple cysts eventually destroy the affected ovary.[20] They do not secrete hormone.

Teratomas are relatively rare and are non-hormone secreting. They can be quite large and contain bone, cartilage, hair, teeth and nerves. They are usually unilateral and the opposite ovary will cycle and pregnancy is possible.[20]

Dysgerminomas are rare but are the one malignant form of ovarian neoplasms. They metastasize to the abdomen and thorax and can cause colic or rapid weight loss.[20]

Endometrial cysts develop from obstructed lymphatics in the reproductive tract. These cysts, if large enough, make the endometrial lining unsuitable for implantation.[20]

Infertility can be recognized by anestrus behavior during the breeding season in unbred mares, continuous or intermittant estrus, aggressive behavior, uterine discharges, or a history of unproductiveness.[8,24]

DIAGNOSING INFERTILITY

A diagnosis of infertility and its underlying etiology is based on a complete and careful evaluation that may require several clinical and laboratory procedures. Uterine cultures, uterine cytology, endometrial biopsies, serology, endoscopy, ultrasound, and rectal palpation are common techniques available to the practitioner.[20]

A general physical appraisal should be the first procedure when evaluating the reproductive status of a mare.[26] The overall condition of the mare in terms of her body fat can have a direct effect on her reproductive efficiency. Mares are most fertile when they are lean and gaining weight.[7] Any masculinity should be noted.

The reproductive exam should begin with a visual appraisal of the vulva, vagina and cervix.[26] Conformational and traumatic defects are common. Recto-vaginal tears, pneumovagina (windsucking), cervical lacerations, muscle separation, abscesses, diverticulae, and abnormal dilatation of the cervix can be found by visual inspection with a speculum or digitally.[7] A rectal exam is the most important step in reproductive evaluations. The uterus can be palpated to determine its tone, size, and texture. The ventral wall at the junction of the horns is the most frequent location for grossly palpable uterine pathology[7]. Atrophy of myometrium, mucosal atrophy, endome-

TABLE 1. Differential Diagnosis of Ovarian Enlargement[8]

	Granulosa Cell Tumor	Persistant Follicular Structures (Functional)	Ovarian Hematoma
Age	Breeding Age	Usually Breeding Age	Us. Br. Age
Site	Unilateral	Us. Unilateral	Us. Unilat.
Season	All Year	Breeding Season	Peak Br. Sn.
Estrous Cycle Charact.	Anestrus, Irregular Cycles, Nymphomania, Infertile.	Anestrus, Nymphomania, Infertility.	Normal, Fertile.
Behavior	Normal to Abnormal— Virilistic, Viscious.	–	–
Ovarian Charact.	Varying size, Solid, cystic, Indistinct Fossa. Serous Fluid.	Large cystic struct. Fossa palpable. Cyst fluid serous.	Large cystic structure. Architecture destroyed. Bloody fld.
Response to Hormones	0	Fair	0
Treatment	Hemi-ovariectomy	Hemi-ovariectomy. Ovariocentesis. LH/HCG, Progesterone.	Hemi-ovariectomy. Recovery.
Prognosis	Good Wk-months	Good Days to weeks	Good A few days

trial cysts, and lymphatic lacunae can be detected, as can atrophy of endometrial folds. Oviducts cannot be consistently palpated. The ovaries should be examined for hypo- or hyperplasia. The normal size is 6-7.5 cm in length, but vary greatly in size due to the season.[7] Their consistency, and a comparison with the opposite ovary are important to note. An enlargement of one ovary can indicate one of several disease conditions. Differentials to consider include tumors, hematoma, or an enlarged lobulated ovary of older mares developing at the beginning of the transition period.[5] Granulosa cell tumors produce hormones that can be detected in the serum and may be used for differentiation (See Table 1).[8]

Ovarian hypoplasia is caused by several conditions. Seasonal anestrous causes a regression of ovarian size, as does severe malnutrition, stress, or obesity. Chromosomal abnormalities are seen occasionally and 63,X0 (Turner's Syndrome) is the most common. Reproductive endocrinopathies can cause hypoplasia, and can be detected by injecting exogenous GnRH.[7] If the mare shows normal estrus behavior, forms a corpus luteum, and returns to estrus 15 days after the last day of the previous estrus, it is reasonable to assume that the endocrine system is functioning adequately.[7]

Before any contaminating intra-uterine procedures are done, a uterine culture should be collected for identification and antibiotic sensitivity of uterine organisms. It is no longer applicable to culture the cervix. The significance of positive cultures is not always clear.[7] Healthy mares harbor bacteria in their reproductive tracts, and these organisms make the recognition of disease difficult.[28] Up to 80% of mares culture positive 72 hours after breeding and from one to thirty days after foaling.[7] Generally, only mares with a questionable breeding record should have a culture performed. The sample should be taken from the uterus during mid-estrus.[9] Cytology should be done to evaluate the uterine response to any bacterial contamination. Bacteria associated with a significant inflammatory reaction (neutrophilia) indicate a positive culture.[7,9] Sometimes positive cultures are not associated with significant histopathologic evidence of endometritis.[12] A positive bacterial culture without inflammation is not significant, and antibiotics are not needed.[10] A single positive culture is insignificant unless there is evidence of infection visually or biopsy indicates active inflammation.[7] Discharges should be noted, although only contagious equine metritis can be diagnoised by the type of discharge (grey).[9] Pure cultures on successive days are more meaningful.[7] Significant bacterial infections include colonies of *Streptococcus spp., E. coli, Klebsiella spp., Staphylococcus spp., Proteus vulgaris, Pseudomonas aeruginosa, Corynebacterium pyogenes, Shigella equuli, Bacillus subtilis, Acinetobacter spp., Citrobacter spp.,* and *Enterobacter spp.*[26] *Aspergillus spp.* and *Candida spp.* are the primary fungal and yeast organisms encountered.[20] The incidence of endometritis increases with age and affected mares have an increasing difficulty in carrying a pregnancy to term.[11]

Endometrial biopsies are used to evaluate inflammatory changes in the endometrium, but do not necessarily identify the etiology.[6] The correlation between finding bacteria and inflammatory changes is not high, usually because of a failure to recover bacteria.[2,9] With an increase in endometrial fibrosis, the foaling percentage drops because of a high percentage of embryonic death (3–4 times normal).[12] Four categories have been established as indicators of periglandular fibrosis in biopsy samples. Expected foaling percentages are related to the severity of periglandular fibrosis (See Table 2).[20] Seasonal changes influence the quantitative assessment of fibrosis, and the changes may not be uniform throughout the uterus.[15] Biopsies are indicated when:

- —mares have abnormalities of the genital tract.
- —pyometra or mucometra is present.
- —barren mares are bred 3 or more times with good sperm at 48 hours pre-ovulation.
- —there is evidence of early embryonic or fetal death.
- —non-pregnant mares are anestrus during the breeding season.

TABLE 2. The Relationship Between Foaling Rates and Endometrial Degeneration[20]

Neely Categories	Doig Categories	Degree of Periglandular Fibrosis	Percentage of Glandular Degeneration	Expected Foaling Rate
I	A	Absent	<10%	70–90%
II high	B	Mild (<2 layers)	10–35%	50–70%
II low	C	Moderate (2–4 layers)	35–60%	10–50%
III	D	Severe (>4 layers)	>60%	<10%

—genital surgery is required.
—examining for a fertilty evaluation.
—mares are barren due to unknown causes.[18,20]

The results are used to predict the future reproductive performance of the mare.[7]

An internal exam of the reproductive tract is accomplished by endoscopy using a fiberoptic scope. This instrument is useful in visualizing various abnormalities such as transluminal adhesions, atrophy or endometrial folds, lymphatic cysts and foreign bodies.[7] Many conditions are visualized that cannot be detected by palpation. Small flat embedded fibroses, synechiae, mucus membranes, septa, polyps, sacculations, ulcerations, and cysts fall into this category.[29,31] Endoscopy allows the clinician to observe the entire uterine cavity, including the horns, and thus increases the accuracy of diagnosis.[30] Biopsies should be done concurrently. Endoscopy is indicated in the following situations.

1. When evacuating abnormal discharges from postpartum mares.
2. In infertile mares with a history of abortion or resorption.
3. In severe purulent endometritis.
4. When there is uterine pathology.
5. During tubal cannulation.
6. When there is a suspected foreign body.
7. For direct cultures.
8. For direct biopsy.[29]

Ultrasound, as a tool in the diagnosis of reproductive conditions, is a fairly new development. The interpretation of readings requires that one's knowledge of anatomy be adapted to cross-sectional readouts. Ultrasonic anatomy of the uterus is influenced by the stage of the estrous cycle and is dependent on prevailing circulating levels of ovarian steroids.[14] Ultrasound is most frequently used for early pregnancy diagnosis, and is highly accurate at 15 days, although best at 20–24 days.[34] False negatives are rare and no false positives are observed.[23] It is useful for the detection of twins, false pregnancies, and open mares.[34]

Serology can be used for pregnancy detection by detecting PMSG (EgCG). It appears in the blood on day 35–40, peaks between days 65–75, and disappears around day 120.[22] Two tests are commercially available for the practitioner, D-Tec* MP and MIP-Test®.[35,36]

Adequate diagnosis and treatment of infertility in the mare is based on a sound knowledge of the seasonal variations and estrous cycle in the mare, and its effects on the physical changes at the gross, histological, and endocrine levels.

THERAPY FOR INFERTILITY

The choice of therapy for uterine disease depends on the diagnosed etiology, the uterine size and tone, the character of the endometrium, the duration of the problem, economics, and how available the animal is for treatment. Uterine disease is categorized into a non-infectious inflammation, pyometra, metritis, and endometritis.[26] Irrigation and infusion of the uterus is used extensively since it assists in controlling infection, debriding necrotic tissue, regulating estrous cycles, and inducing estrus.[11] Pressure infusion can be used to introduce antibiotics, correct a pneumouterus associated with prolonged estrus, increase uterine tone, induce estrus, and is often used with chronically affected mares.[28]

Non-infectious inflammation is generally treated by physical or chemical curettage, especially in animals with normal estrus/ovaries, and with early abortion.[26,33]

Pyometra therapy must initiate estrous. To accomplish this, the uterus is flushed with a dilute antiseptic (1% Lugol's) by infusing and siphoning 500–2000 mls at a time. This stimulates the release of luteolytic factor and CL regression. Prostaglandin can also be used exogenously. The uterus decreases in size and increases in tone. Two to four treatments are usually required. Once the uterus has returned to a more normal size, antibiotics are infused.[26] Cervical adhesions are often a complication of pyometra, and even with rigorous, conscientious therapy, the prognosis remains poor for future reproductive capabilities.

Metritis therapy is similar to treatment for pyometra except that prostaglandins are used to evacuate the uterus and shorten the cycle. Antibiotics and/or antiseptics are then used.[26] Alternative therapy includes estrogens plus oxytocin in place of the prostaglandins.

Endometritis therapy is aimed at eliminating any predisposing factors, employing local and systemic antibiotics, and utilizing chemical antiseptics, plasma or colostrum, and hormones.[20,26] Chemical curettage is employed in non-infected endometritis.[26] Treatment of infectious endometritis is aimed at a specific

spectrum of bacteria or fungi according to the culture sensitivity (C/S) results. In the absence of C/S, a broad spectrum antibiotic should be used. Systemic dosage rates and frequencies are used as guidelines for infusing the medication.[7] The antibiotic is diluted in at least 120 mls of water or saline, and repeated daily for 3–5 days, up to 14 days. An indwelling catheter is helpful when prolonged therapy is indicated.[7] Intra-uterine infusions of the mare's own plasma (collected at estrus) help to bring about a clinical improvement of endometritis, due to serum-derived opsonins (complement) that enhance the phagocytic rate of bacteria.[3,4] Colostrum can also be used for intra-uterine therapy. Colostral contact with the uterus favorably influences the hormonal control of the estrous cycle. Mare colostrum contains 6g/dl of IgG, which can compensate for a deficiency of IgA at the uterine secretory surface. The effects of colostral treatment persist through one estrous cycle to early pregnancy or even longer.[11] It has been recommended that 120 ml of mare's colostrum in 380 mls of saline be infused during mating estrus.[11] However, the uterine size should be determined by rectal palpation to avoid over-infusion of the uterus and to insure an adequate dosage. An undistended maiden mare's uterus has a capacity of about 35 mls, while an older mare may hold 60–150 mls.[20] The mare should be cultured 30 days after treatment.[7]

When considering therapy, it is important to remember that a genital infection is rarely localized only to the uterine cavity, but usually affects other associated tissues such as myometrium, serosa, vagina, cervix, oviducts, etc.[16] The pharmacological agents used in the therapy of uterine disease are antiseptics, antibiotics, and antimycotics (See Table 3).[26] A popular antiseptic is Lugol's 1–2%. It is vital that it be diluted or severe damage to the uterus, cervix, and vagina may result. Clinical signs of chemical damage look like colic: straining, increased heart and respiratory rate, sweating and trembling.[26]

A number of antibiotics are available for use. Of these, penicillin K, 2 million units, for 3 days is perhaps the most effective. It is readily absorbed from the uterus, but its duration of action is only a few hours. The mare's hormonal status does not influence the plasma levels of penicillin, but mechanical irritation of the uterus before infusion results in greater

TABLE 3. Guidelines for the Administration of Intrauterine Drugs[20]

Drug	Dosage	Comments
Penicillin K+	5×10^6 U	Very effective for *Strept.* Economical. Commonly used.
Gentamicin SO4	500–1000mg	Very effective, non-irritating when diluted.
Ampicillin	1–3 g	Irritating if not diluted.
Carbenicillin	2–5 g	Used for persistant *Pseudomonas*. Slightly irritating.
Ticarcillin	1–3 g	Used for *Pseudomonas*. Do not use for *Klebsiella*.
Amikacin SO4	2 g	Used for persistant *Pseudomonas, Klebsiella,* and persistant gram negative organisms.
Kanamycin SO4	1 g	Toxic to sperm.
Polymyxin B	1×10^6 U	Used for *Pseudomonas*.
Neomycin SO4	3–4 g	Used for sensitive *E. coli*.
Chloramphenicol	2–3 g	Irritating, especially orally.
Nitrofurazones	50–60ml	Questionable effectiveness.
Povodone-I_2 (1-2% of stock)	250ml	Good irrigation for nonspecific inflammation, and for yeast. Irritating if >10%.
Chlorhexidine	250ml	Irrigation for nonspecific inflammation. Irritating if >5% or in suspension form.
Nystatin	500,000 U	For yeast. Dilute in 100–250ml water.
Amphotericin B	200mg	For fungi. Dilute in 100–250ml water.
Dimethylsulfoxide (5% of stock)	50–100ml	Penetrating agent to carry drugs. Effectiveness and safety unknown.
EDTA-TRIS (1.2g NaEDTA + 6.05g TRIS/L water, to pH 8 glacial acetic acid)	250 ml, 3 hours later use IU antibiotic	Theory: EDTA binds Ca++ in bacterial cell walls, making more permeable to antibiotic.

absorption.[16] It is active against *Strep. spp.* which is involved in 50–65% of infections. Chloramphenicol is bacteriostatic against *Staph. spp., Strep. spp., E. coli, Proteus spp.,* and *Klebsiella spp.* It is rapidly absorbed after intrauterine infusion, blood levels peak in less than 1 hour, and it lasts 12 hours.[16] Oxytetracycline is useful in only a limited number of infections, and it is poorly absorbed from the uterus to the bloodstream.[16] Gentamycin is an expensive drug, but causes no uterine inflammation and is effective against *Staph. spp., Pseudomonas spp., Klebsiella spp., Proteus spp., E. coli, Step. spp.* and *Hemophilus equigenitalis* (CEM). Ampicillin is similar in action to penicillin. Intravenous administration (7–10 mg/kg) is effective for treatment of B-hemolyzing streptococci.[16] Dihydrostreptomycin is not effective against any organisms found in the uterus. Nitrofurazone is effective towards some uterine pathogens, as is amikacin. When a fungal infection is suspected, antibiotic treatment should be stopped, and any other underlying causes corrected (e.g. pneumovagina). Antimycotic agents such as iodine or nystatin may result in successful treatment.[26] Iodine 1–4% solution is the cheapest and mostly widely used treatment, but is not always satisfactory. Nystatin

(500,000 IU, 4–5 days), amphotericin B, and clotrimazole (400–600 mg every third day for 3–4 treatments) may be the best treatments available. Clotrimazole is a human drug used as a suppository.[17]

Hormones can be used in combination with antibiotics or alone to treat several disease conditions. A sensitive antibiotic + estradiol in solution (e.g. ethinyl estradiol + nitrofurathiazide) stimulates the expulsion of exudate from the uterus.[10] Prostaglandins cause a longer follicular phase. Prostaglandin F2a, 10–15 mg, once subcutaneously, is used, when a mare is having a prolonged luteal function, to cause ovulation. The mare will not always respond to teasing, even if ovulation occurs.[7] This same drug can be used to shorten the estrous cycle. Commonly it is given 5–6 days after the ovulation of the first foal heat, after which the mare will have a new heat in 2–5 days. This is useful for late foalers whose conception rate on the foal heat would be 10–15% lower. Progesterone has been advocated for chronic aborters, although its effectiveness is not documented, nor has the loss of pregnancy due to a true progesterone deficiency been established. If used, a dosage of 150 mg in oil daily or 2000 mg repository weekly is recommended, for the first 100 days of pregnancy until the placenta takes over the production of this hormone from the CL of the ovary.[7,20]

Environmental factors can cause infertility in mares, one of which is seasonal day length. For mares that will be bred early in the season, artificial lighting can help to improve the pregnancy rate. Fifteen to 16 hours per day by the onset of the breeding season, and allowing 6 weeks to respond, starting in December, is necessary.[7]

Surgery is the treatment of choice for ovarian neoplasms. Normal behavior patterns usually return in a few days.[5,8,24] Caslicks procedure is done on mares that are windsuckers as soon as possible after foaling.[7] Surgeries can also be performed for cervical lacerations, urine pooling, and rectovaginal fistulas.[7,10]

Treatment failures stem from many factors. The use of an incorrect antibiotic (resistance), or the use of antibiotics where there is no infection is common. Antibiotics in combination with another incompatible antibiotic or drug causes unsatisfactory results. Treatment after permanent severe degenerative changes also is useless.[26]

Several disadvantages result from uterine antibiotic therapy. The estrous cycle may be lengthened or shortened. Fungal infections may develop. A low dose or the incorrect antibiotic may cause resistance. Systemic effects can result from absorption. Some antibiotics are irritating and can cause endometrial damage. A post-breeding infusion may decrease the foaling rate.[26]

CONCLUSIONS

The causes of infertility in the mare are many and varied, and result in considerable economic loss for the breeder. The more common factors contributing to reproductive losses, and methods available to the practitioner for their diagnosis and treatment have been outlined here.

REFERENCES

1. Asbury, AC: Practical Application of Intrauterine Plasma as a Treatment for Equine Endometritis. January 1984 (Personal communication)
2. Asbury, AC: Some Observations on the Relationship of Histologic Inflammation in the Endometrium of Mares to Fertility. *Proceedings of the 28th Annual Convention of AAEP* December 1982.
3. Asbury, AC; Gorman, NT; Foster, GW: "Uterine Defense Mechanisms in the Mare: Serum Opsonins Affecting Phagocytosis of Streptococcus zooepidemicus by Equine Neutrophils." *Theriogenology* 21(2) 375–385, Feb. 1984.
4. Asbury, AC: Uterine Defense Mechanisms in the Mare; The Use of Intrauterine Plasma in the Management of Endometritis. *Theriogenology* 21(2) 387–393, Feb 1984.
5. Bergeron, Helene; Crouch, GM; Bowen, JM: Granulosa Theca Cell Tumor in a Mare *The Compendium on Continuing Education* 5(3) S141–S144, Mar 1983.
6. Blanchard, TL; Garcia, MC; Hurtgen, JP; Kenney, RM: Comparison of Two Techniques for Obtaining Endometrial Bacteriologic Cultures in the Mare. *Theriogenology* 16(1) 85–93, July 1981.
7. Blanchard, TL; Woods, GL: Reproductive Management of the Barren Mare. *The Compendium on Continuing Education* (9) S141–S147, Sept 1980.
8. Bosu, WTK; Van Camp, SC; Miller, RB; Owen, R ap R: Ovarian Disorders: Clinical and Morphological Observations in 30 Mares. *Canadian Veterinary Journal* 23: 6–14, 1982.
9. Brook, Derek: The Diagnosis of Equine Bacterial Endometritis. *The Compendium on Continuing Education* 6(5) S300–S307, May 1984.
10. deGannes, RVG: Old and New Uterine Treatments for Broodmares. *Proceedings of the 28th Annual Convention of AAEP* December 1982.
11. Dewes, HF: Preliminary Observations on the Use of Colostrum as an Uterine Infusion in Thoroughbred Mares. *New Zealand Veterinary Journal* 28: 7–8.
12. Doig, PA; McKnight, JD; Miller, RB: The Use of Endometrial Biopsy in the Infertile Mare. *Canadian Veterinary Journal* 22: 72–76, 1981.
13. *Dorland's Illustrated Medical Dictionary,* 24th edition, W.B. Saunders Co., Philadelphia and London, 1965.

14. Ginther, OJ and Pierson, RA: Ultrasonic Anatomy and Pathology of the Equine Uterus. *Theriogenology* 21(3) 505–516, Mar 1984.
15. Gross, TL and LeBlanc, MM: Seasonal Variation of Histomorphologic Features of Equine Endometrium. *JAVMA* 184(11) 1379–1382, June 1, 1984.
16. Gustafsson, BK: New Aspects on Antibiotic Treatment of Genital Infections. *Proceedings of the Annual Meeting of the Society for Theriogenology.* pp. 219–224, 1980.
17. Hurtgen, JP; Cummings, MR: Diagnosis and Treatment of Fungal Endometritis in Mares. *Proceedings of the Annual Meeting of the Society for Theriogenology,* pp. 18–22, 1982.
18. Kenney, RM: Cyclic and Pathologic Changes of the Mare Endometrium as Detected by Biopsy, With a Note on Early Embryonic Death. *JAVMA* 172(3) 241–262, Feb 1, 1978.
19. Maher, JM; Squires, EL; Voss, JL; Shideler, RK: Effect of Anabolic Steroids on Reproductive Function of Young Mares. *JAVMA* 183(Sept 1, 1983)5: 519–524.
20. Neely, DP; Liu, IKM; Hillman, RB: *Equine Reproduction.* Veterinary Learning Systems Co., Inc. 1983.
21. Solomon, WJ; Schultz, RH; Fahning, ML: A Study of Chronic Infertility in the Mare Utilizing Uterine Biopsy, Cytology and Cultural Methods. *Proceedings of the 18th Annual Convention of the AAEP. 1972.*
22. Squires, EL; Voss, JL; Villahoz, MD: Immunological Methods for Pregnancy Detection in Mares. *Proceedings of the 29th Annual Convention of the AAEP* December 1983.
23. Squires, EL; Voss, JL; Villahoz, MD; Shideler, RK: Use of Ultrasound in Broodmare Reproduction. *Proceedings of the 29th Annual Convention of the AAEP.* December 1983.
24. Stabenfeldt, GH; Hughes, JP; Kennedy, PC; Meagher, DM; Neely, DP: Clinical Findings, Pathological Changes and Endocrinological Secretory Patterns in Mares With Ovarian Tumors. *J. Reproduction and Fertility, Suppl.* 27: 277–285, 1979.
25. Strzemienski, PJ; Kenney, RM: Effect of Stage of Cycle, Sampling Frequency, and Recovery of Microorganisms on Total Protein Content of Mare Uterine Flushings. *J. Reproduction and Fertility* 70(1) 327–332, 1984.
26. Threlfall, WR: Broodmare Uterine Therapy. *The Compendium on Continuing Education* 2(11) S246, 1980.
27. Williamson, P; Dunning, A; O'Connor, J; Penhale, WJ: Immunoglobulin Levels, Protein Concentrations and Alkaline Phosphatase Activity in Uterine Flushings From Mares With Endometritis. *Theriogenology* 19(3) 441–448, Mar 1983.
28. Wilson, GL: A Modified Treatment of the Equine Uterus. *VM/SAC* 76: 493–502, Apr 1981.
29. Wilson, GL: Equine Hysteroscopy: A Window to the Tract. VM/SAC 78(4) 568–578, 1983.
30. Wilson, GL: Equine Hysteroscopy: Normal Intrauterine Anatomy. *VM/SAC* pp. 1388–1393, Nov 1984.
31. Wilson, GL: Laparoscopic Examination of Mares. *VM/SAC* 78(10) 1629–1633, Oct 1983.
32. Winter, AJ: Microbial Immunity in the Reproductive Tract. *JAVMA* 181(10) 1069–1073, Nov 15, 1982.
33. Witherspoon, DM: Technique and Evaluation of Uterine Curettage. *Proceedings of the Annual Convention of the AAEP.* pp. 51–53, 1972.
34. Zent, WW: Use of Ultrasound in Broodmare Practice. *Proceedings of the 29th Annual Convention of the AAEP.* December 1983.
35. D-Tec* MP, Pitman-Moore, Inc. Washington Crossing, NJ 08560.
36. MIP-Test®, Diamond Laboratories, Inc. Des Moines, IA 50304.