Management of the Barren Mare for Optimal Fertility

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In the 1970s, it was suggested that the equine species inherently achieves relatively low fertility figures and that domestication makes matters worse. Modern results with good stud and veterinary management show that this need not be the case, as demonstrated by analysis of the 1977-2017 'Returns for Mares', published by Weatherbys, keepers of the United Kingdom Thoroughbred Stud Book (Figs. 1, 2, 3 and 4). In 2017, 20,173 mares were covered by 419 stallions (average 48 mares per stallion), returning a conception rate of 94% and a live foal rate of 88% are computed (mares for whom no returns were received and those that died or were exported are excluded from the calculations). The pregnancy failure rate for those mares that conceived was 6.5%.

Occasionally, young fashionable stallions, covering young mares of high fertility potential, achieve almost 100% conception rates during a breeding season. This is the target for both equine studfarm clinicians and stud managers although we know that pregnancy losses, caused by infectious and non-infectious problems, will inevitably mean approximately 84% 'foals on the ground'. A 1970's study of Weatherbys' data demonstrated a natural linear decline in the fertility potential of mares with age. The live foal rate of 4-year-old mares was approximately 75%, whereas that of 20-year-old mares was approximately 50%. Although the live foal percentages achieved are now significantly higher than in the 1970s, this decline in fertility expectations with age is still valid today and it is vital that clinicians, stud managers and owners understand that ageing has a major limiting effect on a mare's fertility potential.

An infertile mare is incapable of conceiving when mated by a fertile stallion and is thus, by true definition, a sterile mare. The latter is uncommon, in contrast to the temporary breeding failures, which are relatively common, and these mares are more correctly termed subfertile. A barren mare is one who is not pregnant at end of the breeding season, for whatever reason.

In order to achieve maximal breeding efficiency, all barren mares should receive a thorough examination after the end of the breeding season but before they go into winter anoestrus, e.g. in September, with the aim of:

1. Making a diagnosis of genital abnormality, if one is present.
2. Making a provisional breeding prognosis based on the abnormalities diagnosed.
3. Formulating and carrying out a logical treatment programme, if indicated.
4. Assessing the response to treatment after a period of rest.
5. Making a more accurate breeding prognosis based on the abnormalities diagnosed and the response to treatment.
6. Repeating or substituting alternative examinations and treatments if the response to treatment is unsatisfactory, until improvement occurs or retirement is recommended.
7. Allowing an extended period of rest before the next breeding season.

Without this preparation, mares enter the next breeding season with persistent genital abnormalities, which then require diagnosis, treatment, re-assessment and recovery, delaying mating and wasting valuable time. The necessarily shortened recovery periods are less satisfactory.

An accurate diagnosis is, as always, a pre-requisite to prognosis, treatment and successful management. This requires a detailed logical investigatory approach, which may include a variety of tests to examine the mare's ovaries, uterus, cervix, vagina, vulva and perineum. Diagnoses are then made and specific treatments are performed. The next step is to provide prognoses and logical management plans for the next season and for the longer-term future. These are given in 2 stages:

1. After the first complete diagnostic evaluation.

2. After treatment and follow-up examinations, assessing the ability of the mare to respond to treatment and/or compensate for the abnormalities diagnosed.

The autumn barren mare examination

With the mare restrained in stocks, the following examinations are performed:

1. Vulva and perineum

The conformation of the mare's perineum, the integrity, shape and angle of slope of her vulva, in relation to her anus is evaluated, to determine if she is suffering or likely to suffer from pneumovagina (vaginal wind sucking), i.e. she requires Caslick's vulval surgery to be performed. Sometimes, small fistulas (holes) are found in the scar from a previous surgery, and these need to be repaired. If the mare's shape is very poor to the extent that Caslick's operation is insufficient to prevent pneumovagina, Pouret's perineal reconstruction operation may be recommended.

Swabs are collected from the urethral opening, clitoral fossa and sinuses for screening by culture and/or qPCR tests for the equine venereal disease organisms *Taylorella equigenitalis*, *Klebsiella pneumoniae* (capsule types 1, 2 and 5) and *Pseudomonas aeruginosa*, which may persist in these sites, producing carrier status.

2. Vaginascopic (speculum) examination

The cervix and vagina are examined for their appearance in relation to cyclic state (moist, pink and relaxed in oestrus, dry, pale and tight in dioestrus), and for signs of injury, incompetence and/or discharge.

If the mare is in oestrus, swabs are collected from the endometrium (uterine lining), through the open cervix, for screening for inflammation (the presence of polymorphonuclear leucocytes, i.e. pmns in a smear test), for the equine venereal disease organisms *T. equigenitalis*, *K. pneumoniae* (capsule types 1, 2 and 5) and *P. aeruginosa*, and for any of the multitude of opportunist pathogens (most commonly *Streptococcus zooepidemicus*, i.e. beta-haemolytic streptococci (BHS), *Escherichia coli* and *Staphylococcus aureus* and the anaerobe *Bacteroides fragilis*). These opportunist organisms are only considered to be of significance, i.e. causing endometritis (inflammation of the uterine lining), if there is cytological evidence of inflammation (more than +/- pmns) on the smear sample.

If the mare is not in oestrus, a swab sample is taken from the endometrial biopsy sample after it has been collected (see later) or, if indicated following uterine palpation and ultrasound scan (below) a uterine flush may be performed to provide washings for cytological and bacteriological examinations.

If visual examination via the speculum suggests injury or incompetence, a digital examination is performed with a hand passed via the vagina.

3. Rectal palpation and ultrasound scan examination

During oestrus, the uterus has minimal palpable tone and endometrial oedema delineates the endometrial folds on scan examination. During dioestrus, the normal uterus should have uniformly palpable tone and no palpable enlargements. Ventral dilatations (areas of fold atrophy and myometrial, i.e. uterine muscular, stretching) may contain lumenal fluid accumulations that may be either dark or light-coloured on scan, the latter more likely to be inflammatory fluids. With pyometritis (pus in the uterus) the uterus may be uniformly enlarged, palpably distended or 'doughy' and contains particulate fluid, sometimes giving a 'scintillating' scan appearance. If fluid, urine or pus is detected in the uterus, a uterine flush may be performed and the washings examined (above).

The ovaries are also highly variable in size and activity depending on cyclic state. During oestrus, they may be large and contain follicles in varying stages of development, in addition to old, non-functional corpora lutea. During dioestrus there will be at least one functional corpus luteum in addition to follicles in varying stages of development. During anoestrus, the ovaries will be small and inactive, containing neither active follicles nor corpora lutea. The most commonly diagnosed ovarian abnormality is the granulosa cell tumour. This benign tumour causes one ovary to enlarge, sometimes enormously, and appear full of cysts on ultrasound examination, whilst the other ovary is characteristically inhibited (by abnormal hormone production), it becomes small, hard and inactive and the mare fails to cycle. The cancerous ovary needs to be removed surgically (by 'keyhole' laparoscopic surgery), allowing the inhibited ovary to regain normal function and the mare to cycle again and regain her fertility. True cystic ovarian disease is rare in mares, although persistent anovulatory follicles, containing slowly resolving haemorrhage and fibrin, diagnosed by ultrasound scan, are sometimes a nuisance during the season. Occasionally, mares haemorrhage excessively into an ovary after ovulation, causing enlargement and pain. A typical homogeneous scan appearance of the blood clot (haematoma) allows the diagnosis to be confirmed. Most cases resolve with time but rarely pain cannot be controlled without removing the affected ovary surgically.

4. Endometrial biopsy

Special long forceps are essential to provide interpretable biopsy specimens of the uterine lining. Non-pregnancy must be confirmed by uterine palpation and ultrasound scan, per rectum, prior to taking a biopsy. One biopsy taken from a mid-horn region is diagnostically representative unless there are palpable uterine abnormalities, when more than one sample should be taken. A mid-dioestral biopsy is recommended as a routine, as the endometrium is more easily interpretable during this stage of the cycle. The sample is placed into special (Bouin's) fixative and then processed for microscopic examination at an experienced laboratory.

a. Cyclic histology: the microscopic architecture of the endometrium reflects the hormonal status of the mare and normal changes that occur during oestrus, dioestrus and anoestrus may be classified accordingly.

b. Histopathology: microscopic pathological abnormalities are usually mixed so specific individual changes are classified and their significance is assessed in terms of the mare's age and her gynaecological history. They can be conveniently classified as inflammatory (endometritis) and non-inflammatory conditions, the latter including endometrial hypoplasia (gland underdevelopment), hyperplasia (gland overdevelopment) and chronic degenerative conditions (gland nests and cysts, with fibrosis, i.e. scarring), also sometimes called endometrosis (no similarity with human endometriosis).

i. Acute endometritis: is diagnosed by the presence of pmns in endometrial biopsy samples taken at any stage of the non-pregnant mare's cycle. This means active inflammation of the mare's uterine lining, most commonly caused by infection. Because the mare's cervix naturally opens during oestrus to allow the stallion to pass his glans penis into her cervix at covering and then to ejaculate into her uterus, allowing direct contamination of the uterus with environmental, penile and mare perineal microorganisms, acute endometritis is a natural temporary sequel to natural cover. As mares' vulval, cervical and uterine anatomy change with ageing and the effects of multiple pregnancies, foalings and recovery issues, persistent acute endometritis becomes a relatively common significant gynaecological problem that discourages conception, increases the chances for early pregnancy failure and requires appropriate treatment.

Ultrasound scan may help to demonstrate the severity of inflammation by the degree of endometrial oedema and the volume and scan appearance of retained lumenal fluid. After cytological (smear) diagnosis of endometritis, the associated infectious organism(s) is/are determined by bacteriological culture examinations of swabs or flushings, as discussed above.

Endometritis is treated, with infusions of appropriate non-irritant, soluble antibiotics, to which the pathogen(s) is/are confirmed sensitive, after hygienic preparation of the perineum and vulva, via a sterile plastic insemination pipette, inserted through the vagina with a gloved hand. The catheter is inserted through the cervix into the uterus along the index finger. Where there are signs of uterine fluid accumulation or pyometra, large volume (3 litres) sterile saline irrigation, with 3% hydrogen peroxide added for cases of pyometritis or excessive fluid accumulation, is recommended prior to starting antibiotic treatment. Irrigation may be performed via an egg-flushing catheter. Uterine fluid clearance is then stimulated with oxytocin, given intravenously. Large volume flushing and oxytocin treatment may be repeated daily or, if indicated, twice daily until ultrasound scan examinations suggest improvement. The successful treatment of acute endometritis is confirmed by cytological (scan) re-examination at next oestrous period.
In addition to local treatment with antibiotics, systemic treatment may, on occasions, be indicated. In the experience of most clinicians involved in this type of work, systemic (by mouth or by intravenous or intramuscular injection) antibiotic treatment alone is of little value in the treatment of uterine infection in the mare. In most cases the infecting organism is in the uterine lumen rather than the endometrial tissues and thus local uterine lumenal treatment is likely to be the most successful, coupled with oxytocin injections to promote clearance of uterine fluid and inflammatory mediators. The suitability of the preparation used for intra-uterine irrigation is very important and many cases of acute endometritis that have been treated unsuccessfully by the systemic route alone have been encountered.

Fungal infections of the uterus may produce clinical signs that vary from none, in which the infection is lumenal and there is no tissue invasion, to severe purulent endometritis, demonstrable by ultrasound scan. If persistent, fungal infections can lead to conception failure or, if infection occurs during pregnancy, to placentitis and abortion. They are treated by correcting predisposing gynaecological abnormalities (e.g. vulval surgery) and large volume (3 l daily or twice daily) uterine irrigation with sterile saline solution

with added 3% hydrogen peroxide solution. Irrigations with dilute (0.5%) povidone iodine solutions are sometimes used but care must be taken to avoid severe genital inflammation and uterine and/or cervical adhesion formation in individual mares. Specific antimycotic agents, as used in human genital fungal infections, have not been critically evaluated in mares but subjective experience suggests that although expensive, they do help resolution. Concurrent oral ketoconazole treatment has been used for mares with fungal endometritis, with useful results.

The success or failure of treatment for endometritis is monitored by 'follow-up' endometrial smear/swab, ultrasound scan and/or biopsy examinations, taken 3–4 weeks after the end of the course of treatment, during oestrus.

ii. Chronic infiltrative endometritis: is diagnosed by the presence of mononuclear cells (histiocytes/lymphocytes and plasma cells) in biopsy specimens. The presence of these cells indicates a local immune response and therefore previous or on-going challenge by infectious agents, inevitably associated with the mare's response to covering (see above) and pregnancy. A normal equine uterine immune response is a natural and good thing and, if uncomplicated by other abnormalities, no specific treatment is indicated. Excessive mononuclear cell infiltration, constituting granulomatous endometritis, is rare and a poor prognostic sign, usually a sign of chronic infection and an excessive but ineffectual immune response.

iii. Chronic degenerative endometritis (CDE or endometrosis): is diagnosed by the presence of glandular degenerative changes in biopsy specimens in the form of 'nests', surrounded by lamellae of fibrous (scar) tissue or, less commonly, 'cysts', lined by glandular epithelial cells. Peri-glandular (around glands), peri-vascular (around blood vessels) or, less commonly, diffuse stromal fibrosis is seen in varying degrees. Diffuse stromal fibrosis is considered to be a poor prognostic sign for the maintenance of future pregnancies. Perivascular fibrosis ('angiosis') is occasionally seen in older mares and may be a sign of an excessively ageing and malfunctional endometrium. Pools of tissue fluid (lymphatic 'lacunae') of varying sizes may be seen scattered in the stroma. As they develop they become larger and migrate into the uterine lumen, attached to the endometrium by a 'stalk' of lymphatic endothelial cells. These endometrial cysts, when large enough, can be seen by ultrasound scan. It is unusual to sample a lymphatic cyst, using biopsy techniques. CDE should be looked upon as a form of chronic, progressive uterine lining 'wear and tear' pathology.

These chronic degenerative changes are progressive and are associated, most importantly, with the normal ageing process and its cyclic hormonal effects. The repeated stimulatory challenges of semen, micro-organisms, external genital and environmental debris, and foetoplacental antigens, and the repeated physical challenges of pregnancy, parturition and involution may accelerate the progression of these changes and it is believed that they may, to a large extent, account for the apparently inevitable linear decline in fertility seen in the Thoroughbred mare population and are frequently seen is mares who suffer repeated pregnancy failure or prolonged gestation with foetal dysmaturity. Degenerative changes are inevitable to a degree and thus each biopsy specimen must be assessed in terms of the mare's age and parity (the number of foals that she has produced). The severity of these changes is correlated with age to an extent which suggests that, in general terms, mares up to 9 years of age should have no signs of CDE, mares from 10 to 13 years of age should have no more than mild signs, mares from 14 to 15 years of age should have no more than moderate signs and mares of 17 years and older are likely to have advanced signs. Paradoxically, repeated healthy and atraumatic pregnancies appear to slow the development of these changes because it is well recognised that older maiden mares frequently have degenerative changes in their biopsy specimens to a degree that are markedly in excess of what would be considered acceptable for their age and that these mares often find difficulty in achieving a first successful pregnancy. Conversely, old Thoroughbred mares that have produced a foal year after year since 4 years of age, managing to avoid obstetrical difficulties, have endometrial biopsy changes that suggest a much younger age. The aim for broodmares is therefore good gynaecological and obstetric management to encourage them to enjoy pregnancy, year after year, and to try to avoid difficult and traumatic foalings.

Where a mare's degree of endometrial degenerative change is considered excessive for age, treatment with endometrial curettage may be attempted. Improvements in histopathological appearance and fertility can be expected in some mares, more reliably in those who are less than 17 years old.

iv. Endometrial atrophy: is diagnosed by loss of glands from the endometrium. This is a form of uterine wall senility. Temporary diffuse glandular 'atrophy' is seen following prolonged ovarian inactivity and is

therefore a normal temporary feature during winter anoestrus (glands become inactive and 'shrink' in size rather than are lost) and is similarly seen in some mares with ovarian functional depression associated with ovarian granulosa cell tumours. True endometrial atrophy, with true loss of glands, may be seen in aged mares, usually in association with senile ovarian malfunction and is an 'end-stage' process of great significance to fertility. Rarely, true endometrial atrophy has been seen in younger mares following severe recurrent acute endometritis with *P. aeruginosa* infection. No treatment for true endometrial atrophy is successful and retirement from breeding is the most practical option.

iv. Endometrial hypoplasia: is diagnosed by signs of diffuse glandular under-development and has been seen in young barren maiden mares, sometimes in association with ovarian cyclic irregularities. It appears to be a feature of relative sexual immaturity and usually resolves, without treatment, with time. In a young maiden mare, where the degree of hypoplasia is marked and ovarian size is minimal, or where the condition persists, the possibility that fundamental genetic/ovarian abnormality is involved should be considered and chromosome analysis (karyotype) of a blood sample should be performed.

v. Endometrial hyperplasia: is diagnosed by signs of endometrial glandular over-activity. A degree of glandular hyperplasia with hypersecretion is a normal feature of oestrus and the post-partum or post-pregnancy failure period and normal glandular architecture and secretory activity is usually achieved by dioestrus and 10 to 12 days postpartum and post-pregnancy failure/abortion but occasionally may persist for weeks if not months, when this delay is considered pathological. Acute endometritis is often a complicating feature. Treatment with oxytocin by intravenous drip has been used with good results in most cases.

In some cases, recurrent acute endometritis appears to produce diffuse glandular hyperplasia, probably associated with short cycling and hyperoestrogenism. Successful treatment of the acute endometritis will reduce the signs of diffuse glandular hyperplasia.

5 Other uterine abnormalities

a. Endometrial (lymphatic) cysts: These have been discussed above and are commonly seen during ultrasound scan examinations in multiparous mares over 14 years old. They can be seen on ultrasound scan examination because the lymphatic fluid that they contain is clear (free of cells and debris) and appears dark on the screen. The cysts may be unilocular or multilocular. They are frequently inconvenient in that they may confuse pregnancy examinations, but otherwise, unless very large where they may prevent the normal intrauterine mobility of the pre-fixed embryo, essential for early maternal recognition of pregnancy and/or they are widespread throughout the uterus to the extent that they may result in poor placentation, they appear to have no specific effect on fertility. They can, if considered necessary, be visualised and removed with laser or wire-loop thermocautery or may be punctured with a biopsy instrument, via a videohysteroscope.

c. Trans-lumenal fibrous adhesions: These may follow obstetrical injuries or the injudicious intrauterine use of irritant chemicals in the uterus. If widespread, severe and diffuse, these are untreatable and the mare is most sensibly retired. If focal and discrete, they may be removed or their effects lessened with laser, thermocautery or biopsy attachment, via a videohysteroscope.

d. Intra-uterine foreign bodies: Use of the videohysteroscope in mares with recurrent non-responsive endometritis has revealed, in rare cases, lumenal foreign bodies consisting of placental remnants, cotton wool (presumably swab tip fragments) and amorphous debris with a central core of multiplying bacteria or unidentifiable degenerate debris. Once removed with a biopsy attachment, via a videohysteroscope, these cases respond to treatment for acute endometritis. Glass marbles are sometimes placed in the uterus of race and performance fillies to prevent them from (oestrous) cycling. If these are not removed before mares retire to stud, they usually act as a contraceptive and in occasional cases have been known to cause serious uterine damage.

e. Uterine wall haematomas: Small areas of bleeding into the uterine wall are not uncommonly diagnosed by ultrasound scan at 'foal heat' examinations. These usually resolve naturally given time but sometimes delay the mare's ability to conceive and should always be given adequate time for complete resolution before covering. Rarely, a significant obstetric (occurring at foaling) bleed produces a cavernous uterine wall 'cyst' which, on ultrasound scan, appears to contain swirling blood. These lesions are worrying in that if they were to burst, the haemorrhagic consequences might be serious and experience suggests that

they may take up to two years to resolve, before the mare is safe to cover again with a realistic chance of safe and successful pregnancy.

f. ***Endometrial neoplasia:*** Uterine cancer is rarely seen in mares. Leiomyomas or fibroleiomyomas (benign) and their leiomyosarcomatous forms (malignant), while rare, are the most frequently diagnosed neoplasm in the uterus of mares. These tumours are usually small and the solitary benign form is most common. They have no primary effect on fertility and treatment, by laser surgery, via a videohysteroscope or surgical removal via hysterotomy, is only indicated where the tumour is large (when it may be pedunculated, i.e. attached by a stalk) and may cause persistent endometrial haemorrhage (which kills sperm) and secondary endometritis. Malignant endometrial adenocarcinoma has been only rarely recorded. In one case the mare presented with respiratory signs and necropsy examination confirmed pulmonary metastases (secondary spread) from a primary uterine tumour.

6. Hysteroscopy

Examinations (involving passing a sterile videohysteroscope through the vagina and cervix) are made, where indicated. Examinations are useful for mares with persistent acute endometritis, to rule out the rare possibility of retained intrauterine foreign bodies (see above). Endometrial cysts, fluid accumulations, fibrous adhesions and endometrial tumours (see above) may be studied and, where necessary, removed either by laser surgery or hot-wire thermocautery. Biopsy specimens obtained with instruments supplied for passage through the endoscope are too small to be diagnostically useful. In some cases, it may be helpful to pass conventional basket-jawed endometrial biopsy forceps alongside the endoscope to obtain visually directed samples.

7. Laparoscopy

This technique (involving passing a laparoscope through the abdominal peritoneal cavity) has been historically used to study ovulation in mares and more recently to treat blocked fallopian tubes with external applications of prostaglandins (PGE_2). Fallopian tube blockage is a rare condition in mares and when it occurs it is usually unilateral and therefore not usually a limiting factor unless the mare only has one ovary and this is on the side with the blocked fallopian tube. Nevertheless, the occasional mare has been genuinely and successfully treated by this technique. Candidates will have repeatedly failed to conceive to different stallions while showing no other signs of significant gynaecological abnormality, including uterine infection. Expertise and experience with laparoscopic surgery has improved markedly during recent years and ovaries damaged by tumours or haemorrhage are now usually removed with the laparoscope, with the mare standing under sedation and local anaesthetic. The technique may be used for intra-pelvic exploration of the genitalia in specific cases.

8. Laparotomy

Rarely, mid-line or flank laparotomy, i.e. surgically opening the abdomen with the mare under general anaesthesia, may be indicated for the investigation and/or treatment of uterine abnormality. A laparoscopic surgical technique of 'uteropexy' is used to help mares with significantly pendulous uteri, causing excessive uterine fluid pooling. Encouraging results have resulted in a few carefully selected mares but time will tell if this highly invasive and technically demanding procedure is safe to recommend with more confidence.

9. Extra-uterine abnormalities

Organising broad ligament haematomas or pelvic adhesions may be detected by their site, palpably hard consistency and their homogeneous appearance on ultrasound scan examination. These require time to heal before covering can be confidently recommended. Peri-uterine abscesses occasionally follow covering and obstetric injuries and these require intensive medical treatment with antibiotics and resolution may take significant time.

Prognosis for future breeding

The horse breeding industry aims for maximum efficiency, owners would like mares to produce single foals annually throughout their lives and (without obstetric trauma) this appears to be best state to maintain endometrial gland structure and function (see above). However, transient endometritis is an unavoidable consequence of mating or insemination and the natural ageing process, paradoxically accelerated both by reproductive inactivity and more understandably by the repeated challenges of mating, endometritis and parturition followed by involution and by obstetric injuries, are associated with progressive endometrial degenerative changes. These factors all result in progressive characteristic mixed endometrial pathology, which is believed to be a major factor in producing the linear fall in Thoroughbred fertility with age that has been demonstrated by Weatherbys' data.

However, statistics mean little for the individual mare, where age, gynaecologic and obstetric history, diagnosed gynaecological abnormalities (type, severity and complexity) and their ability to correct or compensate with

specific treatments, must all be taken into consideration. Individual variation, stallion and management factors then all add to an already complex picture that means that many prognostications may prove to be inaccurate. Nevertheless, a better knowledge of the pathogenesis of progressive endometrial disease, its treatment and the application of modern managerial and veterinary preventive measures are believed to be at least in part responsible for the comparatively high degree of efficiency now seen in the more intensive areas of the Thoroughbred horse breeding industry. Breeding prognoses are most usefully made, in 2 stages, on the following basis:-

Table 1: **Prognosis 1** - after the first examination, before treatment:-

Category 1	Mares who have no significant gynaecological abnormalities.	Good prognosis
Category 2	Mares who have gynaecological abnormalities that are unlikely to significantly affect their reproductive performance.	Satisfactory prognosis
Category 3	Mares who have gynaecological abnormalities that are likely to significantly affect their reproductive performance.	Guarded prognosis
Category 4	Mares who have gynaecological abnormalities that will not or are unlikely to respond to treatment	Poor/hopeless* prognosis

*Aged mares with true endometrial atrophy, i.e. in effect, senility, and young maiden mares with fundamental chromosome abnormalities (gonadal dysgenesis) are appropriately retired at this stage.

Table 2: **Prognosis 2** - after treatment and the second examination:-

Category 1	Mares who have no significant gynaecological abnormalities or whose abnormalities have recovered, apparently completely, following treatment.	Good prognosis
Category 2	Mares who have gynaecological abnormalities that are unlikely to significantly affect their reproductive performance or whose abnormalities have recovered, following treatment, to a degree which should allow adequate compensation.	Satisfactory prognosis (try again)
Category 3	Mares who have gynaecological abnormalities that are likely to significantly and irreparably affect their reproductive performance or whose abnormalities have not recovered, or have become worse, following treatment, to a degree which will not allow adequate compensation.	Poor prognosis (consider retirement from breeding)

Subsequent management

After a satisfactory follow-up examination, a management plan is formulated to help, if necessary, the individual mare compensate for the residual abnormalities that she has. In appropriate cases, the aim is to reduce uterine challenge at mating to a minimum and to aid early resolution of inevitable post mating uterine infection. This can be achieved, in populations of horses where registration authorities allow, by the use of artificial insemination (AI) with washed and antibiotic-extended semen. Where AI is not applicable, i.e. in Thoroughbred horses, 'minimal contamination breeding techniques' may be used. These consist of:-

1. Satisfactory endometrial swab and smear test results are obtained at the current oestrous period.
2. An apparently normal, on-going, mature ovarian follicle is palpable.
3. Mating is arranged as close as possible to the estimated time of likely ovulation.
4. Pre-breeding semen extender, containing antibiotics, may be instilled into the mare's uterus as close as possible prior to mating, if considered appropriate.
5. LH in the form of HCG, or GnRH is used to hasten ovulation.
6 The uterus is flushed with 3L sterile saline and then treated with a water-soluble, non-irritant, broad-spectrum antibiotic solution to which the common equine uterine aerobic and anaerobic pathogens are sensitive, 12–24 h after mating, followed by intravenous oxytocin therapy to aid uterine fluid clearance.
7. A second mating during that oestrous period is not recommended or this will make resolution of post-mating uterine infection even more difficult.

Pregnancies achieved from such mares should be identified as 'high risk' and should be monitored throughout by watching the mare's udder for premature development and secretion of milk (a sign of impending abortion in some cases) and by serial ultrasound scan examinations. Unnecessary maternal stress (e.g. transportation and social group changes) should be avoided throughout pregnancy. Prolonged gestation (significantly over 340 days) sometimes occurs in mares with advanced chronic endometrial degenerative disease and this identifies the foetus

as ‘high risk’. Neonatal critical care facilities should be prepared for use, if required. For such mares, it may be unwise to try to shorten gestation, as these foeti require longer in an unsatisfactory uterine environment to prevent the birth of an ‘at risk’ ‘dysmature’ foal.

Has progress been made?

Weatherbys report annual fertility returns made by owners of Thoroughbred mares in the United Kingdom and Ireland. This data is supplied by owners themselves and so may be subject to some inaccuracy. There have been some changes in data collection methods during the last 40 years but overall trends are interesting and some are encouraging. Advances in veterinary technology, particularly ultrasound scanning, have increased the accuracy of early pregnancy diagnosis, making the interpretation of these data more accurate since 1990. Nevertheless, the numbers of mares involved and the relative consistency of the exercise over these years provide a very useful comparative guide to the fertility of the UK and Irish Thoroughbred horse industry.

Weatherbys’ data shows that during the 40 years from 1977 to 2017, the number of mares at stud in UK and Ireland ranged from a low of 15,612 in 1979 to a high of 31,805 in 2004 (23,449 in 2017) and the number of live foals ranged from a low of 7,774 in 1978 to a high of 18,191 in 2007 (13,847 in 2017). When these data are expressed in terms of the percentage of mares mated by registered Thoroughbred stallions (minus ‘no returns’ and ‘mares dead and exported’, for whom accurate data is not available), encouraging trends emerge. Conception rate (%) ranged from a low of 76.60% in 1978 to a high of 97.13% in 2006 (93.79 in 2017) (Fig.1). Similarly, live foal rate (%) ranged from a low of 67.37% in 1978 to a high of 89.02% in 2005 (87.71% in 2017) (Fig.1). It appears from the graphs that ‘outlying’ high rates seen during 1997 and 2005-2008 may have been associated with differences in data recording but the overall trends in conception and live foal rates continue upwards. Barren mare rate (%) ranged from a high of 23.40% in 1978 to the lowest rate of 8.64% achieved in 2017 (Fig.2). Overall gestational (pregnancy) failure rate (%), as a percentage of mares who conceived, ranged from a high of 12.36% in 1996 to the lowest rate of 6.49% achieved in 2017 (Fig.3). Closer examination of this latter data shows a downward trend from 1977 (12.13%) to 1989 (8.92%), followed by a rise which is believed to be associated with the widespread use of ultrasound scanning, making possible the accurate diagnosis of early gestational failure, which has since been reflected in mare owners’ returns. Since 1996, it appears that progress has been made in decreasing pregnancy losses associated with early foetal deaths and later abortions. Progress has been made with stillbirths (Fig.4), from a high of 5.73% in 1979 to the lowest rate of 2.90% in 2017. If we ignore the ‘quirky’ data seen from the ultrasound scanning ‘settling in’ decade from 1990 to 2000, the overall trends in the pregnancy failure statistics remain downwards. We must remember that this data is based upon owners’ returns rather than detailed scientific study but nevertheless, the system has worked similarly during this 40-year period and it may be the closest that the equine breeding industry is likely to get to ‘big data’.

The progressive fall in the barren mare rate by more than 50% over the last 40 years (Fig.2) appears particularly encouraging. The data for 1998 to 2016 suggested that a ‘steady state’ might have been achieved but the 2017 figures (assuming that this is not a ‘quirk’) are encouraging and may suggest that even more progress may be achievable. The overall improvement is probably associated with multifactorial causes, but one must assume that progress in studfarm and equine gynaecological management, with close cooperation between owners, managers and their veterinary surgeons, have played a significant part.

Conclusions

Few mares are truly infertile. With an accurate diagnosis of specific gynaecological abnormality, rational treatment and careful management, most mares can be encouraged to breed successfully. Those that are proven to have major gynaecological problems that fail to respond to logical attempts at treatment should be retired. Preparing the barren mare individually and specifically for the new breeding season early is essential to maximise chances for an early successful pregnancy and to help prolong the mare’s long-term breeding career. This is best achieved if the attending veterinary surgeon is given the opportunity to develop a detailed knowledge of each individual mare’s gynaecological and obstetrical history, over time, by repeated, consistent examinations.

Whilst giving a mare a ‘year off’, particularly when she has had obstetric difficulties or when she foals late, may be unavoidable, mares should be encouraged to breed annually, to help maintain the integrity of their uterine lining and the optimal function of their uterine glands.

Stud management ‘teamwork’ is a vital factor and sufficient commitment is required from the owner, in terms of interest and finance, from the studfarm manager, in terms of interest and staff time and facilities, and from the veterinarian, in terms of interest, time, knowledge, expertise, experience and provision of the necessary equipment.