Could BSE be introduced in semen or embryos?

An assessment of the scientific information leads to the conclusion that cattle semen and embryos can be imported safely without risking the introduction of BSE. This opinion is held widely by experts who have researched BSE. The basis for this conclusion that semen and embryos do not constitute a BSE risk is based on:

1. What is known about the distribution of BSE infectivity in cattle; and

2. What has been observed of the epidemiology of BSE.

BSE is a feedborne disease. It has been spread throughout the European cattle population through the practice of feeding cattle meat and bone meal, made from those parts of the slaughtered animal not used for other purposes. One of the main hypotheses for the origin of BSE is that it arose from feeding cattle meat and bone meal made from sheep infected with the related disease scrapie. Although this hypothesis is not proven or universally accepted, it is one of the mainstream hypotheses.

However, whatever the origin, there is no doubt that it was the feeding of meat and bone meal which spread BSE so widely. It was mainly the **effective** banning of the practice of feeding meat and bone meal which finally brought the epidemic under control in the United Kingdom.

In the 15 or so years since BSE was first recognised, an enormous research effort has gone into the disease. One of the things learned is that the distribution of infectivity in naturally occurring cases of BSE is almost entirely confined to the central nervous system (the brain, spinal cord and eye). A wide range of other tissues has been studied without detecting any BSE infectivity (but see below). These tissues have been tested by intracerebral inoculation in mice and, in some instances, calves. Inoculation directly into the brain is much more sensitive than inoculation by mouth. The oral dose is perhaps 10,000 times greater than the intracerebral dose.

The popular press commonly state that human vCJD is attributable to eating "beef". However, it is now believed that the "villain" was mechanically recovered meat. Because it is difficult to trim all the meat from the vertebral column of the cow, mechanical techniques were developed to maximise meat recovery. However, at each segment of the spinal column there are two dorsal root ganglia, extensions of the spinal cord which are outside the bony vertebral column. It was realised in 1995 that these ganglia were being stripped off into the mechanically recovered meat. It has been estimated that as much as 2% of meat recovered mechanically from the vertebral column was thus central nervous tissue.

Mechanically recovered meat went into a range of foods including sausages, burgers, canned soups, baby foods etc.

Table I below lists all the tissues from cattle clinically affected with BSE which have been tested with negative results. In no instance has BSE infectivity been found outside the central nervous system (including the eye) of naturally occurring cases of BSE.

Table I: Tissues from clinically affected cattle with no detectable infectivity by parenteral inoculation of mice grouped by anatomical system

Cerebrospinal fluid	Spleen	Oesophagus
Cauda equina (of spinal cord)	Tonsil	Reticulum
Peripheral nerves:	Lymph nodes:	Rumen (pillar)
N. sciaticus (proximal)	Prefemoral	Rumen (oesophageal groove)
N. tibialis	Mesenteric	Omasum
N. splanchnic	Retropharyngeal	Abomasum
N. opticus		Proximal small intestine
		Distal small intestine
		Proximal colon
		Distal colon
		Rectum
Clotted blood	Testis	
Buffy coat	Prostate	Ovary
	Seminal vesicle	Uterine caruncle (pregnant cow)
	Epididymis	Placental cotyledon
Foetal calf blood	Semen	Placental fluids:
Serum		Amniotic fluid
		Allantoic fluid
Midrum fat	Liver	Embryos
Musculus (M.)	Kidney	
Semitendinosus	Heart	
M. longissimus	Pancreas	Udder
M. diaphragma	Lung	Milk
M. masseter	Trachea	
Bone marrow		
Skin		

A word of caution is needed here. In some experimental infections where calves were dosed with very large dose [100 grams] of infected cattle brain, infectivity has also been detected in the terminal ileum for some weeks after infection. It has also been reported that late in the clinical phase of the disease infectivity may sometimes be detected in bone marrow (hence the ban on bone-in beef).

Anyway, it can be seen that BSE infectivity has not been found in any of the bovine reproductive tissues studied.

The second piece of evidence for the safety of semen comes from a study of the epidemiology of BSE. There are three areas here from where one can draw inferences:

1. The incidence of BSE amongst cattle born to cows with the disease.

   In this case, there is some evidence suggesting that a calf born to a cow which develops BSE during pregnancy is, perhaps, as much as 10% more likely to develop BSE that a calf whose mother did not have the disease.

However, to keep this in perspective, the relationship between a calf carried to term and the dam is a prolonged and intimate one. There is even, sometimes, passage of white blood cells across the placenta into the calf. The exposure of the calf is thus much, much greater than the exposure of embryos.

2. Cattle embryos are collected by non-surgical means four to five days after conception. At this stage they are surrounded by a hard *zona pellucida*.

   Many thousands of experiments with other viral and bacterial diseases have shown that such embryos can be washed free of conventional viruses and bacteria, frozen, transported, thawed and implanted into recipient cows without transmission of disease.

   Evidence that this applies also in the case of BSE is only just to hand. Several years ago the British imported 350 cattle from New Zealand to use in an experiment to test whether or not BSE could be transmitted by embryo transfer. Embryos were collected from British cows with BSE.

   Embryos not suitable for implantation were inoculated intracerebrally in mice. No BSE infectivity was detected in 800 embryos inoculated this way.

   Embryos suitable for implantation were washed according to international guidelines and were implanted into the BSE-free New Zealand cattle. These New Zealand cattle and the calves they bore were then kept in isolation until the youngest of the embryo-derived calves was 7 years old.

   All the New Zealand cattle and the embryo-derived offspring remained healthy. The last of the offspring were slaughtered late in 2000 and a range of tissues were tested for BSE by inoculation into mice and by the newer immunological tests which look for accumulation of an abnormal form of a protein called PrP which is associated with BSE.

   So, while this experiment is not quite finished (the final report is expected to be published later this year) it looks as if one can be confident that BSE is not transmitted by embryo transfer.

3. The third piece of epidemiological evidence deals with semen. A study was carried out in the United Kingdom of the incidence of BSE amongst the offspring of bulls having the disease compared with the offspring of bulls which did not have the disease. (The offspring were the result of artificial insemination, the bulls were those belonging to the former Milk Marketing Board's artificial insemination service).

   The BSE incidence is shown below:

Table II: Incidence of BSE amongst AI-derived offspring of bulls affected with BSE compared to the incidence amongst offspring of bulls not affected with BSE.

		BSE STATUS OF BULL	
		+	-
BSE STATUS OF OFFSPRING	+	25	185
	-	3,889	23,319

> The incidence of BSE amongst the offspring of the bulls affected with BSE was 0.0064 while that amongst the offspring of the control bulls was 0.0079. As no one is proposing that the presence of BSE in the bull actually reduces the incidence of BSE in his progeny, the conclusion drawn from the data in Table II is that there is no enhanced risk of developing BSE for offspring whose sires developed BSE.
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> MAF's assessments that semen does not constitute a BSE risk were discussed and endorsed by the Agricultural Security Consultative Committee and by the Government's independent BSE Expert Science Panel.
>
> Internationally, the *Office International des Epizooties*, the world organisation for animal health, considers semen to be safe, so far as BSE is concerned.

So, because various New Zealand farmers wanted access to cattle semen from the United Kingdom MAF decided to permit the resumption of imports late in 1999. The policy has always been that any citizen can import a commodity so long as there is no demonstrable risk to human, animal or plant health. In the case of British cattle semen, there is no technical justification for refusing to allow its importation.

Embryo imports from the United Kingdom have **not** resumed. While it looks as if one can be confident that they would be safe it would not be proper to resume imports until the results of the large British experiment are published and subject to critical review by other scientists.