



**EUROPEAN COMMISSION**  
HEALTH & CONSUMER PROTECTION DIRECTORATE-GENERAL

**Scientific Steering Committee**

**OPINION ON THE UK DECISION TO LIFT THE BAN ON THE  
CONSUMPTION OF MEAT ON THE BONE**

**ADOPTED BY  
THE SCIENTIFIC STEERING COMMITTEE  
AT ITS MEETING OF 13-14 APRIL 2000**

## **UK DECISION TO LIFT THE BAN ON THE CONSUMPTION OF MEAT ON THE BONE**

### **OPINION**

Following the decision of the UK to lift its national ban of bone-in beef, and the justification provided by MAFF-UK, the Commission requested the Scientific Steering Committee to address the following questions:

1. Is there new evidence or are there reasons to reconsider the validity of the various SSC opinions directly or indirectly related to the safety of bones opinions or to amend/update the listed conditions<sup>1</sup>? In particular, if and under what conditions may vertebral column and dorsal root ganglia in view of their relative risk be considered as safe for human and animal consumption? Do factors like the incidence (prevalence) of the disease and effective enforcement of general risk reduction measures such as (other) specified risk material removal rules, feed bans and age reduction at slaughter [e.g., Over Thirty Month Scheme (OTMS)] effect the level of risk associated with vertebral column and dorsal root ganglia?
2. Are the answers to the previous questions also valid for sheep and goats; if not, how should they be amended?

Scope of the present opinion: The Scientific Steering Committee established various Working Groups to prepare scientific reports on the above questions. The present opinion deals only with the UK decision to lift the ban on the consumption of meat on the bone from cattle. It deals specifically with the question of the change in relative risk from lifting the meat on the bone ban under the particular conditions existing in the UK. The report of the Working Group is attached. Two other opinions and reports deal with the *Re-assessment of the safety with respect to TSEs, of certain types of specified risk materials of small ruminants* and with the *Quantitative Risk Assessment on the Use of the Vertebral Column for the production of Gelatine and Tallow*.

---

<sup>1</sup> For example, geographical source, herd source, individual animal source (e.g., age, progeny line, ...), processing, intended end-use, risk of cross- contamination.

In December 1997, the UK authorities imposed a ban on the consumption of meat on the bone. This decision was based, amongst others, on a risk assessment estimating that the consumption in 1998 of bone-in meat in the UK would result in approximately 0.05 new cases (of vCJD) per annum (or 1 new case per 20 years) over the whole UK population of approx. 50.000.000 people. The estimated numbers of animals under 38 months with significant levels of BSE infectivity that would enter the food chain were estimated to be 5 in 1997 and 3 in 1998. The choice of 38 months for this analysis allowed for the potential presence of infectivity in nervous tissue in animals several months before the clinical phase of the disease and therefore provides a conservative estimate of possible infectivity in animals entering the food chain below 30 months.

In its opinion of 23 October 1998 on *The safety of bones produced as by-product of the Date Based Export Scheme*, the SSC stated: "*In order to address the remote risk that a clinically sound but BSE-infected animal would be slaughtered in the context of the DBES, or an equivalent scheme, it is therefore recommended to exclude the skull (including the trigeminal ganglia) and the vertebral column (including the spinal cord and the dorsal root ganglia) from further use.*" The opinion further stated that "*The other bones<sup>2</sup> should [under the DBES] be assumed to be at least as safe as bones from animals from geographical areas classified at lower-risk. When transformed into gelatine or other products, they would have to be treated as if coming from such a source.*" This implicitly implied that bones other than skull and vertebral column,

---

<sup>2</sup> The issue of the possible infectivity of bone marrow remains pending. Results of the now completed BSE pathogenesis experiment in cattle (Wells et al, 1998) have shown that tests in mice for infectivity of bone marrow were positive only in the group killed at 38 months after infection with BSE, when clinical disease was evident in the cattle, and not at an earlier (2 to 36 months) or later (40 months) time after exposure to BSE (Wells et al, 1999). The current SEAC conclusion (SEAC, 1998) is that "*the positive result at 38 months cannot be discounted and may indicate that infectivity in bone marrow occurs occasionally, when clinical signs are apparent and there are already very high levels of infectivity in the central nervous system.*" It is noted that BSE infectivity in bovine bone-marrow has been detected in only one still ongoing experiment, and only after the onset of clinical signs. Further studies of the infectivity of bone marrow at different time points in the pathogenesis experiment in cattle are being conducted by the i/c challenge of calves. There are no results as yet (Wells, unpublished observations, January 2000).

The SSC opinion of 28 October 1998 on the bone issue within the DBES context states: "*Given this age limit [of 30 months] it is possible to assume that the risk that bones and bone marrow are infective is negligible. Only nervous and CNS-tissue attached to or spilt over bones could pose a non-negligible risk if an animal would be slaughtered under the scheme which has been infected very young.*"

could be "consumed" as meat (on the bone), provided the source animals comply with the DBES criteria.

In its updated analysis of 27-28 May 1999<sup>3</sup> on the evolution of the BSE epidemic in the UK and in its opinion of 28-29 October 1999 on the UK Date Based Export Scheme<sup>4</sup>, the SSC confirms that the evolution of the epidemic and the decrease in the number of cases are conform with the scientific expectations.

In a recent paper Donnelly *et al* (2000, confidential pre-publication) assess the impact of control measures on the decline in the incidence of BSE in Great Britain from 1998 to 2001. The paper takes into account, amongst others, the following elements:

- epidemiological data until 1999.
- the effects of the offspring cull and of the selective cull programmes;
- the effect of the Over-Thirty-Months-Scheme (OTMS);
- the fact that, prior to 1 August 1996, date of the full implementation of the Feed Ban, the exposure to feed borne contamination has probably been higher than assumed in earlier models;

The paper considers feed and maternal transmission as the only possible routes of infection of cattle with BSE. It assumes that the feed ban had been fully complied with, that maternal transmission occurs at a rate of 10% and that an offspring cull is applied. The epidemiological approach involved a series of changes from the analysis originally produced by Anderson and his colleagues in 1996.

Donnelly *et al* present, for the years 2000 and 2001, predicted numbers of BSE infected cattle that may enter the human food chain under 30 months of age, in the last year of BSE incubation period, i.e. having potentially infective central nervous tissue as in clinical cases ("infective cattle"). The predicted numbers are 1.2 infective cattle in 2000. The corresponding number is 0.8 animals in 2001.

---

<sup>3</sup> *Monitoring Some Important aspects of the evolution of the Epidemic of BSE in Great-Britain (Status, April 1999)*, adopted by the SSC on 27-28 May 2000.

<sup>4</sup> *Opinion of 28-29 October 1999 of the Scientific Steering Committee on the Scientific Grounds of the Advice of 30 September 1999 of the French Food Safety Agency (the Agence Française de Sécurité Sanitaire des Aliments, AFSSA), to the French Government on the Draft Decree*

A team of epidemiologists at the Institute for Animal Neurology of the Bern University and at the Swiss Federal Veterinary Office carried out a completely independent evaluation of the evolution of the BSE epidemic in the UK and made predictions of the expected number of clinical cases in the coming years (Cohen *et al*, 2000, confidential pre-publication). Its findings support the decreasing trend in the epidemic in the UK. The team expects that under the assumption of no feed-borne infection after 1996 and no other routes of transmission, the epidemic in the UK will come to an end around 2007. This, however, does not fully exclude the possibility of isolated clinical cases being observed after 2007.

The SSC confirms that it should be clear that all central nervous tissue, including brain and spinal cord, as well as dorsal root ganglia, which could possibly contaminate bones, should still be considered as tissues that may pose a risk if obtained from potentially BSE infected animals. The risk from bone marrow is, however, considered very low indeed, if not negligible.

The Scientific Steering Committee concludes that, as compared with the end of 1997, when the ban on the consumption of bone-in meat was introduced in the UK, and on the assumption that all risk management measures, including the feed ban and the OTMS, are properly implemented, the risk associated with meat on the bone obtained, prepared and consumed as described in detail in the risk assessment carried out for the UK authorities in December 1997, has further decreased to levels 3-5 times lower than that estimated in December 1997.

The SSC further concludes that the risk from meat on the bone is negligible if the bones are not from the vertebral column or skull.

Finally, the SSC wants to underline that the hazard from dorsal root ganglia within the vertebral column remains appreciable in infective animals. In the UK, however, the risk of human exposure to BSE from this infective material is extremely small because of the small number of infective animals estimated to enter the food chain. This small

---

*amending the Decree of 28 October 1998 establishing specific measures applicable to certain products of bovine origin exported from the United Kingdom.*

number reflects the impact of the measures taken, in particular the combined effect of the OTMS, the SRM-ban and the complete feed ban of 1996. These measures explain the marked contrast between an extremely small exposure and the high incidence of BSE in the entire cattle population of the UK.

If the number of infectious animals that enter the food chain is higher than currently estimated for the UK, the risk might be different and the conclusion in this opinion cannot be extrapolated to other countries.

## **UK DECISION TO LIFT THE BAN ON THE CONSUMPTION OF MEAT ON THE BONE**

### **REPORT FROM THE WORKING GROUP**

#### **I. THE QUESTIONS AND MANDATE**

Following the decision of the UK to lift its national ban of bone-in beef, and the justification provided by MAFF-UK, the Commission requests the Scientific Steering Committee to address the following questions:

1. Is there new evidence or are there reasons to reconsider the validity of the various SSC opinions directly or indirectly related to the safety of bones opinions or to amend/update the listed conditions<sup>5</sup>? In particular, if and under what conditions may vertebral column and dorsal root ganglia in view of their relative risk be considered as safe for human and animal consumption? Do factors like the incidence (prevalence) of the disease and effective enforcement of general risk reduction measures such as (other) specified risk material removal rules, feed bans and age reduction at slaughter (Over Thirty Month Schemes) effect the level of risk associated with vertebral column and dorsal root ganglia ?
2. Are the answers to the previous questions also valid for sheep and goats; if not, how should they be amended?

The Scientific Steering Committee established various Working Groups to prepare scientific reports on the above questions. The present report deals only with the *UK decision to lift the ban on the consumption of bone-in meat*. Two other reports deal with the *Quantitative Risk Assessment on the Use of the Vertebral Column for the production of Gelatine and Tallow* and with the *Re-assessment of the safety with respect to TSEs, of certain types of specified risk materials of small ruminants* and.

---

<sup>5</sup> For example, geographical source, herd source, individual animal source (e.g., age, progeny line, ...), processing, intended end-use, risk of cross- contamination.

## II. HISTORIC AND BACKGROUND

1. In December 1997, the UK authorities imposed a ban on the consumption of bone-in meat. This decision was based, amongst others, on the risk assessment carried out by Comer (1997) who then estimated that the consumption in 1998 of bone-in meat in the UK would result in approximately 0.05 new cases (of vCJD) per annum (or 1 new case per 20 years) over the whole UK population of approx. 50.000.000 people. The estimated numbers of animals under 38 (thirty eight) months with significant levels of BSE infectivity that would enter the food chain were estimated to be 5 in 1997 and 3 in 1998. The risk assessment took into account aspects such as age of the animal at slaughter, carcass dressing and cutting practices, consumption patterns, etc., which may be specific for a given country or region.

2. The SSC opinion of 9 December 1997 *Listing of Specified Risk Materials: a scheme for assessing relative risks to man*, suggests that, amongst other tissues, the bovine vertebral column and dorsal root ganglia, should be excluded from the food and feed chains except when derived from a BSE free country with a negligible risk.

The SSC opinion of 23 October 1998 on *The safety of bones produced as by-product of the [United Kingdom] Date Based Export Scheme*, states "(...) it is therefore recommended to exclude the skull (including the trigeminal ganglia) and the vertebral column (including the spinal cord and the dorsal root ganglia) from further use." The opinion further states that "*The other bones should [under the UK-DBES] be assumed to be at least as safe as bones from animals from geographical areas classified at lower-risk. When transformed into gelatine or other products, they would have to be treated as if coming from such a source.*"

2. In its letter of 2 December 1999 the UK Government explained to the Commission its decision to lift the ban on bones in beef following a statement of the United Kingdom Chief Medical Officers (CMO) of 30 November 1999.

On 7 January 2000, the UK-MAFF provided *Supplementary information for the SSC on the background to recent decisions on bone-in beef*. The annexes include also a summary of the results of the epidemiological study on the expected evolution and predicted number of BSE cases in the United Kingdom for the period 1996-2001 (Donnelly *et al*, 2000), as well as a copy of *Bone-in beef and cattle bones: further advice to Government from the Chief Medical Officer*.

3. The current **1999 OIE Animal Health Code on BSE** recommends SRMs, including vertebral column of animals from high-incidence countries, not to be 'used' rather than 'traded for use' in edible products.

Furthermore the Animal Health Code recommends SRM removal from animals in high-incidence countries irrespective of an effective feed ban.

4. The opinions of the Scientific Steering Committee, related to the safety of the skull, the vertebral column and other bones in the United Kingdom, can be summarised as follows.

As far as their use for the production of bovine-derived products (e.g., gelatine, tallow, etc.) is concerned, all bovine materials are excluded, except if they comply with the DBES criteria. In the latter case, the conditions for lower BSE risks should apply. [This means: skull and vertebral column excluded; other bones can be processed provided they are sourced from animals that comply with the DBES criteria.]

For what concerns the consumption of meat on the bone, the SSC opinion of 23 October 1998 on *The safety of bones produced as by-product of the Date Based Export Scheme*, states "*In order to address the remote risk that a clinically sound but BSE-infected animal would be slaughtered in the context of the DBES, or an equivalent scheme, it is therefore recommended to exclude the skull (including the trigeminal ganglia) and the vertebral column (including the spinal cord and the dorsal root ganglia) from further use.*" The opinion further states that "*The other bones<sup>6</sup> should [under the DBES] be assumed to be at least as safe as bones from animals from geographical areas classified at lower-risk. When transformed into gelatine or other products, they would have to be treated as if coming from such a source.*" [Note: this means, but it is not unambiguously written in the opinion, that bones other than skull and vertebral column, could be "consumed" as (bone-in) meat, provided the source animals comply with the DBES criteria.]

---

<sup>6</sup> The issue of the possible infectivity of bone marrow remains pending. Results of the now completed BSE pathogenesis experiment in cattle (Wells et al, 1998) have shown that tests in mice for infectivity of bone marrow were positive only in the group killed at 38 months after infection with BSE, when clinical disease was evident in the cattle, and not at an earlier (2 to 36 months) or later (40 months) time after exposure to BSE (Wells et al, 1999). The current SEAC conclusion (SEAC, 1998) is that "*the positive result at 38 months cannot be discounted and may indicate that infectivity in bone marrow occurs occasionally, when clinical signs are apparent and there are already very high levels of infectivity in the central nervous system.*" It is noted that BSE infectivity in bovine bone-marrow has been detected in only one still ongoing experiment, and only after the onset of clinical signs. Further studies of the infectivity of bone marrow at different time points in the pathogenesis experiment in cattle are being conducted by the i/c challenge of calves. There are no results as yet (Wells, unpublished observations, January 2000).

The SSC opinion of 28 October 1998 on the bone issue within the DBES context states: "*Given this age limit [of 30 months] it is possible to assume that the risk that bones and bone marrow are infective is negligible. Only nervous and CNS-tissue attached to or spilt over bones could pose a non-negligible risk if an animal would be slaughtered under the scheme which has been infected very young.*"

### III. RISK ASSESSMENT

#### III.1. Bones as a risk material

Infectivity has never been detected in the bone material itself. However, it should be clear that brain, spinal cord, dorsal root ganglia, which could possibly contaminate bones, are and remain to be considered as tissues that may pose a risk if obtained from potentially BSE infected animals.

Regarding bone marrow no infectivity has been detected so far by mouse bioassay in field cases with clinical BSE. Data for BSE are based, however, on transmissions attempted from a very small number of animals<sup>7</sup>. Nevertheless, these findings are, in general, consistent with those in studies of the pathogenesis of BSE in cattle after oral challenge (Wells *et al*, 1996, 1998), with the exception of the detection of infectivity in distal ileum and, in a level close to the limit of detectability by mouse bioassay, in the sternal bone marrow from animals killed in the clinical phase of the disease at 38 months p.i. (but not before and not after) in this experimental study of BSE in orally exposed cattle (Wells *et al*, 1999). The inconsistent result of the absence of detectable infectivity in bone marrow in this study at the later time point of 40 months p.i. has raised, amongst other alternative explanations, the possibility that the finding of infectivity at 38 months p.i. may have been the result of an accidental procedural contamination. Nevertheless, there is limited evidence from previous studies of other TSEs that infection of bone marrow, although not part of the general pathogenesis pattern, could be a rare event occurring late in the incubation period.

#### III.2. Consumption of meat on the bone obtained from UK animals

In December 1997, the UK authorities imposed a ban on the consumption of meat on the bone. This decision was based, amongst others, on the risk assessment carried out by Comer (1997) who then estimated that the consumption in 1998 of meat on the bone in the UK would result in approximately 0.05 new cases (of vCJD) per annum (or 1 new case per 20 years) over the whole UK population of approx. 50.000.000 people. The estimated numbers of animals under 38 (thirty eight) months with significant levels of BSE infectivity that would enter the food chain were estimated to be 5 in 1997 and 3 in 1998.

The SSC updated its analysis of 27-28 May 1999<sup>8</sup> on the evolution of the BSE epidemic in the UK in its opinion of 28-29 October 1999 on the UK Date Based Export Scheme<sup>9</sup>. In the latter opinion, the SSC confirms that the evolution of the

---

<sup>7</sup> The experiments were limited and not all the different bone marrow bones, at different stages of incubation have been tested.

<sup>8</sup> *Monitoring Some Important aspects of the evolution of the Epidemic of BSE in Great-Britain (Status, April 1999)*, adopted by the SSC on 27-28 May 2000.

<sup>9</sup> Opinion of 28-29 October 1999 of the Scientific Steering Committee on the *Scientific Grounds of the Advice of 30 September 1999 of the French Food Safety Agency (the Agence Française de Sécurité Sanitaire des Aliments, AFSSA), to the French Government on the Draft Decree amending the Decree of 28 October 1998 establishing specific measures applicable to certain products of bovine origin exported from the United Kingdom.*

epidemic and the decrease in the number of cases are conform with the scientific expectations made in earlier years, for example by Anderson *et al* (1996).

In a recent paper Donnelly *et al* (2000, confidential pre-publication) assess the impact of control measures on the decline in the incidence of BSE in Great Britain from 1998 to 2001. The paper takes into account, amongst others, the following elements:

- epidemiological data until 1999.
- the effects of the offspring cull and of the selective cull programmes;
- the effect, on human exposure, of the Over-Thirty-Months-Scheme (OTMS);
- the fact that, prior to 1 August 1996, date of the Real Feed Ban, the exposure to feed borne contamination has probably been higher than assumed in earlier models;

The Working Group analysed the paper as well as additional information obtained on its request from the authors. It considered the paper exploitable in the context of its present mandate. The Working Group noted that the paper considers feed- and maternal transmission linked contamination as the only possible routes of infection of cattle with BSE and that the feed ban had been fully complied with.

Donnelly *et al* also present, for the years 2000 and 2001, predicted numbers of BSE infected cattle that may enter the human food chain under 30 (thirty) months of age, in the last year of BSE incubation period. They assume that there is an estimated 10% maternal transmission rate and an offspring cull is applied. The predicted numbers are approx. 1 infected animal, both in 2000 and 2001.

A team of epidemiologists at the Institute for Animal Neurology of the Bern University and at the Swiss Federal Veterinary Office carried out a completely independent evaluation of the evolution of the BSE epidemic in the UK and made predictions of the expected number of cases in the coming years (Cohen *et al*, 2000, confidential pre-publication). Its findings support the decreasing trend in the epidemic in the UK. The team expects that under the assumption of no feedborne infection after 1996 and no other routes of transmission, the epidemic in the UK will come to an end around 2007. This, however, does not fully exclude the possibility of isolated clinical cases being observed after 2007.

The Working Group concludes that, as compared with the end of 1997, when the ban on the consumption of meat on the bone was introduced in the UK, and on the assumption that all risk management measures, including the feed ban, are properly implemented, the risk associated with meat on the bone obtained, prepared and consumed as described in detail in Comer (1997), has further decreased to levels far below the one estimated in December 1997 (i.e. 0,05/50 million people/year) The risk management measures are the ones listed in the various appropriate documents related to UK beef, for example on the Over Thirty Months Scheme, culling of offspring, etc.

Whether or not a lifting of the meat on the bone ban is justified on the basis of what precedes is beyond the mandate of the Working Group. The Working Group, however, recommends that this decision should be made, taking into account the general considerations on bones as a possible risk material presented in § III.1.

#### IV. ACKNOWLEDGEMENTS:

The Working Group was composed of the following experts: Dr.M.Doherr (rapporteur), Dr.D.Taylor, Dr.Ph.Comer, Prof.Dr.M.Vanbelle, Prof.Dr.G.Piva, Prof.Dr.G.Poli, Dr.B.Urlings, Dr.B.R. Berends.

#### V. LITERATURE AND DOCUMENTATION

**Anderson, R.M., Donnelly, C.A., Ferguson, N.M., Woolhouse, M.E.J., Watt, C.J., Udy, H.J., MaWhinney, S., Dunstan, S.P., Southwood, T.R.E., Wilesmith, J.W., Ryans, J.B.M., Hoinville, L.J., Hillerton, J.E., Austin, A.R., Wells, G.A.H., 1996.** Transmission dynamics and epidemiology of BSE in British cattle. *Nature*, **382**, 779-788.

**Cohen, C., et al., 2000.** Is Bovine Spongiform Encephalopathy (BSE) disappearing from Europe? Forecasts of BSE epidemic in Switzerland differ from the United Kingdom. [Confidential pre-publication information, to be submitted for publication]

**Comer, Ph.J., 1997.** Assessment of Risk from Possible BSE Infectivity in Dorsal Root Ganglia, carried out for the UK Ministry of Agriculture, Fisheries and Food and the UK Spongiform Encephalopathy Advisory Committee. Det Norske Veritas Ltd., London, 14 pp + annex.

**Donnelly, C.A., Ferguson, N.M., Ghani, A.C., Anderson, R.M., 2000.** The impact of control measures on the decline in the incidence of BSE in Great Britain from 1998 to 2001. [Confidential pre-publication information, to be submitted for publication]

**European Commission, 1997.** Listing of Specified Risk Materials: a scheme for assessing relative risks to man. Opinion of the Scientific Steering Committee of 9 December 1997

**European Commission, 1998.** Opinion on the revised version of the UK Date Based Export Scheme and the UK proposal on compulsory slaughter of the offspring of BSE-cases, submitted on 27.01.98 by the UK Government to the European Commission. Opinion of the Scientific Steering Committee of 19-20 February 1998.

**European Commission, 1998.** Opinion on the safety of bones produced as by-product of the Date Based Export Scheme. Opinion of the Scientific Steering Committee of 22-23 October 1998

**European Commission, 1998.** Report on the UK Date Based Export Scheme and the UK proposal on Compulsory Slaughter of the Offspring of BSE Cases. Opinion of the Scientific Steering Committee of 9 December 1997

**European Commission, 1999.** Opinion on Monitoring some Important aspects of the evolution of the Epidemic of BSE in Great Britain (Status, April 1999) 18-19 March 1999. Opinion of the Scientific Steering Committee of 27-28 May 1999

**European Commission, 1999.** Opinion on the Scientific Grounds of the Advice of 30 September 1999 of the French Food Safety Agency (the *Agence Française de Sécurité Sanitaire des Aliments*, AFSSA), to the French Government on the Draft Decree amending the Decree of 28 October 1998 establishing specific measures applicable to certain products of bovine origin exported from the

United Kingdom. Opinion of the Scientific Steering Committee of 28-29 October 1999

- European Commission, 1999.** Summary Report based on the meetings of 14 and 25 October 1999 of the TSE/BSE *ad-hoc* group of the Scientific Steering Committee on the Scientific Grounds of the Advice of 30 September 1999 of the French Food Safety Agency (the *Agence Française de Sécurité Sanitaire des Aliments*, AFSSA), to the French Government on the Draft Decree amending the Decree of 28 October 1998 establishing specific measures applicable to certain products of bovine origin exported from the United Kingdom.
- Ockerman, H.W. and Hansen, C.L., 1988.** Animal By-Product Processing. Cambridge, New York, Basel, Weinheim: VCH Verlagsgesellschaft mbH; Chicester (UK): Ellis Horwood Science and Technology Publishers.
- Pearson, A.M. and Dutson, T.R., 1992.** Inedible Meat By-products. Series: Advances in Meat Research, Volume 8. London and New York: Elsevier Science Publishers, 1992.
- United Kingdom, 1999.** Bone-in beef and cattle bones: further advice of 30 July 1999 to the Government from the Chief Medical Officer Prof. L.Donaldson. 12 pp.
- Anderson, R.M., Donnelly, C.A., Ferguson, N.M., Woolhouse, M.E.J., Watt, C.J., Udy, H.J., MaWhinney, S., Dunstan, S.P., Southwood, T.R.E., Wilesmith, J.W., Ryans, J.B.M., Hoinville, L.J., Hillerton, J.E., Austin, A.R., Wells, G.A.H., 1996.** Transmission dynamics and epidemiology of BSE in British cattle. *Nature*, **382**, 779-788.
- Wells, G.A.H., Dawson, M., Hawkins, S.A.C., Austin, A.R., Green, R.B., Dexter, I., Horigan, M.W., Simmons, M.M., 1996.** Preliminary observations on the pathogenesis of experimental bovine spongiform encephalopathy. In: Bovine spongiform encephalopathy: the BSE dilemma (Ed. Gibbs CJ Jr) Springer-Verlag, New York pp. 28-44.
- Wells, G.A.H., Hawkins, S.A.C., Green, R.B., Austin, A.R., Dexter, I., Spencer, Y.I., Chaplin, M.J., Stack, M.J., Dawson, M., 1998.** Preliminary observations on the pathogenesis of experimental bovine spongiform encephalopathy (BSE): an update.. *Vet.Rec.* **142**: 103-106.
- Wells, G.A.H., Hawkins, S.A.C., Green, R.B., Spencer, Y.I., Dexter, I., Dawson, M., 1999.** Limited detection of sternal bone marrow infectivity in the clinical phase of experimental bovine spongiform encephalopathy (BSE). *Vet. Rec.* **144**: 292-294.
- Wilesmith, J.W. et al, 1988.** Bovine spongiform encephalopathy: epidemiological studies. *Veterinary Record* **123**, 638.