3. RISK ASSESSMENT

The risk that the there could be some BSE infectivity in non SBM tissue present in cattle slaughtered for human consumption has been assessed by combining the data and assumptions presented in the previous section in a simple "event tree". Two measures of risk have been determined, both of which are based on the consumption of human oral ID_{50} units. The first measure is the total consumption per year of human oral ID_{50} units for all people in the United Kingdom. This is a measure of societal or group risk. The second measure is the individual risk, which is represented by the expected consumption per year by any one individual of human oral ID_{50} units.

For small doses, the quantity ingested provides an extremely pessimistic estimate of the risk, because of the probable existence of a safe threshold which is at present unquantified.

3.1 Event Tree

The event tree for assessing the exposure to infectivity in DRG is shown as Figure 3.1. The infectivity in the material is given on the left side of the event tree. This is simply the mass of material per animal times the infectivity density times the number of infected animals slaughtered in that year.

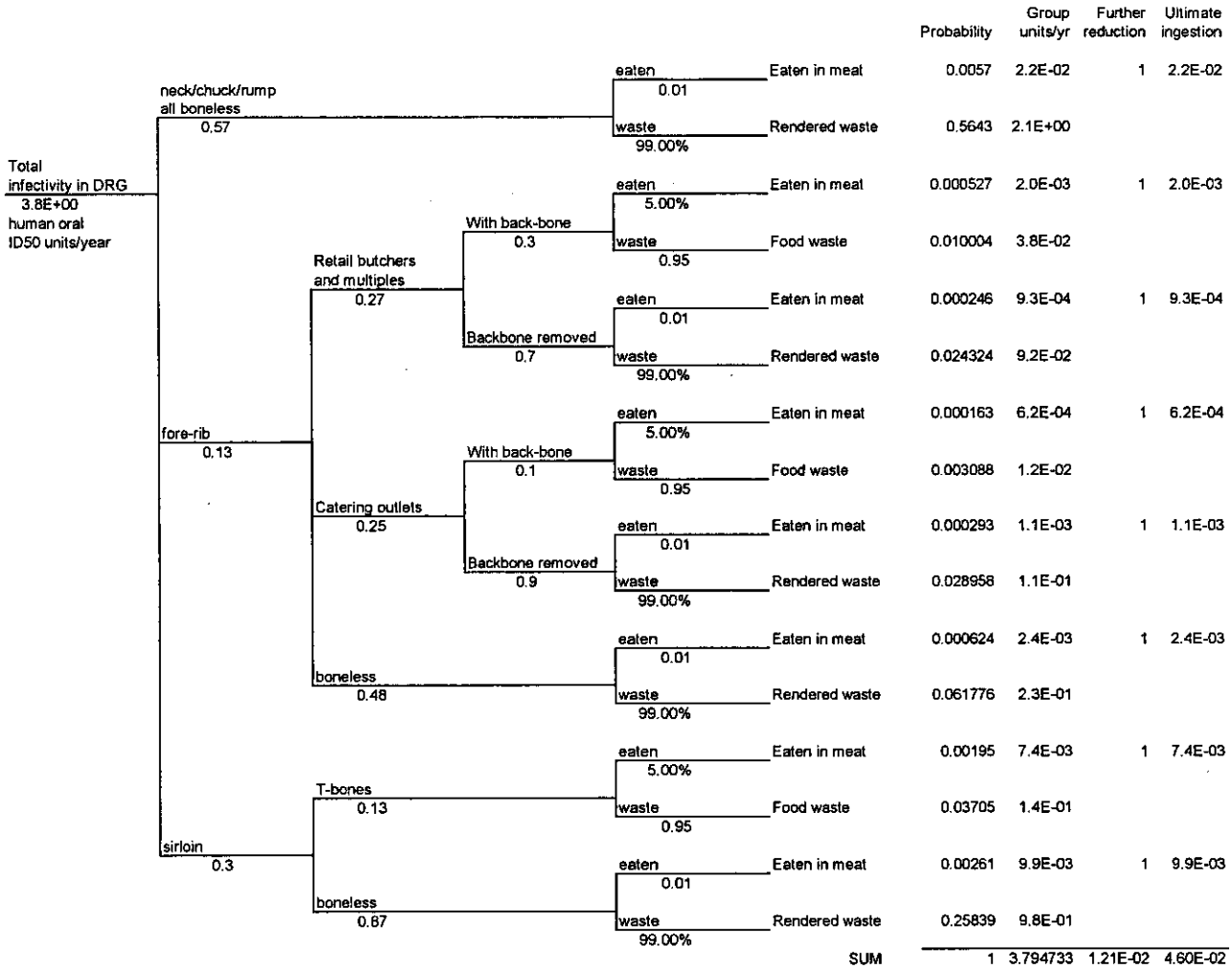
On the right side of the event tree there are four columns. The first of these gives the total probability for that pathway. This is simply the product of all the branch probabilities along the pathway. The second column gives the resulting total infectivity units for that pathway. This is the product of the probability in column 1 with the total input infectivity. The third and fourth columns only have values when that pathway can result in that infectivity being ingested. Column 3 is only used if there is further reduction of the infectivity, for example if the infectivity is input to another event tree. Column 4 gives the ultimate ingestion.

3.2 Risk Evaluation

The risk results have been evaluated using Monte Carlo simulation in order to take account of the uncertainty in the input parameters. Each variable has been defined as a distribution of values rather than as a single point value, and the result calculated many times using a simulation program.

FIGURE 3.1 : EVENT TREE FOR DORSAL ROOT GANGLIA

Year : 1997



	Probability	Group units/yr	Further reduction	Ultimate ingestion
Eaten in meat	0.0057	2.2E-02	1	2.2E-02
Rendered waste	0.5643	2.1E+00		
Eaten in meat	0.000527	2.0E-03	1	2.0E-03
Food waste	0.010004	3.8E-02		
Eaten in meat	0.000246	9.3E-04	1	9.3E-04
Rendered waste	0.024324	9.2E-02		
Eaten in meat	0.000163	6.2E-04	1	6.2E-04
Food waste	0.003088	1.2E-02		
Eaten in meat	0.000293	1.1E-03	1	1.1E-03
Rendered waste	0.028958	1.1E-01		
Eaten in meat	0.000624	2.4E-03	1	2.4E-03
Rendered waste	0.061776	2.3E-01		
Eaten in meat	0.00195	7.4E-03	1	7.4E-03
Food waste	0.03705	1.4E-01		
Eaten in meat	0.00261	9.9E-03	1	9.9E-03
Rendered waste	0.25839	9.8E-01		
SUM	1	3.794733	1.21E-02	4.60E-02
Total from bone-in products				1.0E-02
Fraction DRG in Bone-in cuts				5.28%

3.3 Input Data

The definitions of the input assumptions are summarised below.

Cattle Man Species Barrier
Probability distribution; Discrete values:

1	1%
10	24.75%
100	24.75%
1000	24.75%
10,000	24.75%

Infectivity of BSE infected brain
Log Normal Distribution; geometric mean 10, 95% ile 100, range 1 to 1000

Number of Clinical cases < 38 months old
Poisson Distribution; Rate = 4.

Weight of dorsal root ganglia in a carcase
Normal distribution; Mean = 30g, Standard Deviation = 3g.

Fraction DRGs in Fore Ribs
Normal distribution; Mean = 13%, Standard Deviation = 1.3 %.

Fraction DRGs in Sirloin
Normal distribution; Mean = 30%, Standard Deviation = 3.0 %.

Fraction Sirloin sold as T-bone
Normal distribution; Mean = 13%, Standard Deviation = 1.3 %.

Fraction Fore Rib sold by retail butchers/multiples
Normal distribution; Mean = 27%, Standard Deviation = 2.7 %.

Fraction Fore Rib sold by retail catering
Normal distribution; Mean = 25%, Standard Deviation = 2.5 %.

Fraction backbone removed by retail butchers
Normal distribution; Mean = 70%, Standard Deviation = 7.0 %.

Fraction backbone removed by catering butchers
Normal distribution; Mean = 90%, Standard Deviation = 9.0 %.

Probability Infectivity does not remain in bone
Log normal distribution; Mean = 1%, Standard Deviation = 0.5 %.

Likelihood of Infectivity being consumed from bone-in meat
Log normal distribution; Mean = 5%, Standard Deviation = 1%.

Proportion of UK population eating beef
Normal distribution; Mean = 88%, Standard Deviation = 9%.

3.4 Results

3.4.1 Total Ingestion of infectivity

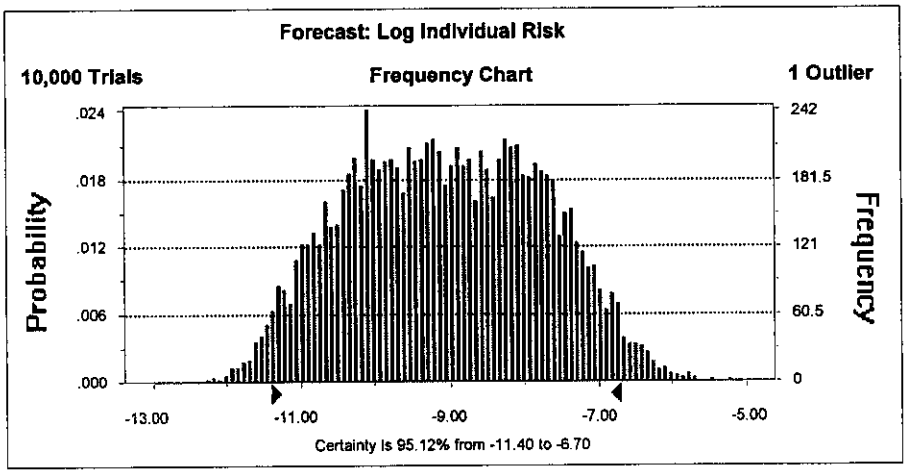
The median value of the total ingestion of infectivity due to infectivity in dorsal root ganglia of cattle with infectivity in the CNS at less than 30 months of age, has been estimated to be 0.05 ID_{50} units over the whole UK population in 1997. The 95% range is from zero to 11 ID_{50} units, and the probability of the total ingestion being less than 1 is 80%.

The results also show that 24% of this total ingestion of infectivity is due to bone in meat (range 10% - 45%). The remainder is due to the proportion of DRG left in the meat in boning out operations.

3.4.2 Individual Risk

The median value of the individual risk of ingestion has been estimated to be 9×10^{-10} ID_{50} units per person per year. The 95% range is from 5×10^{-12} to 2×10^{-7} ID_{50} units per person per year, which is some four orders of magnitude. The frequency distribution of the log of the individual risk is shown in Figure 3.2.

Figure 3.2: Frequency Distribution of the Log of Individual Risk

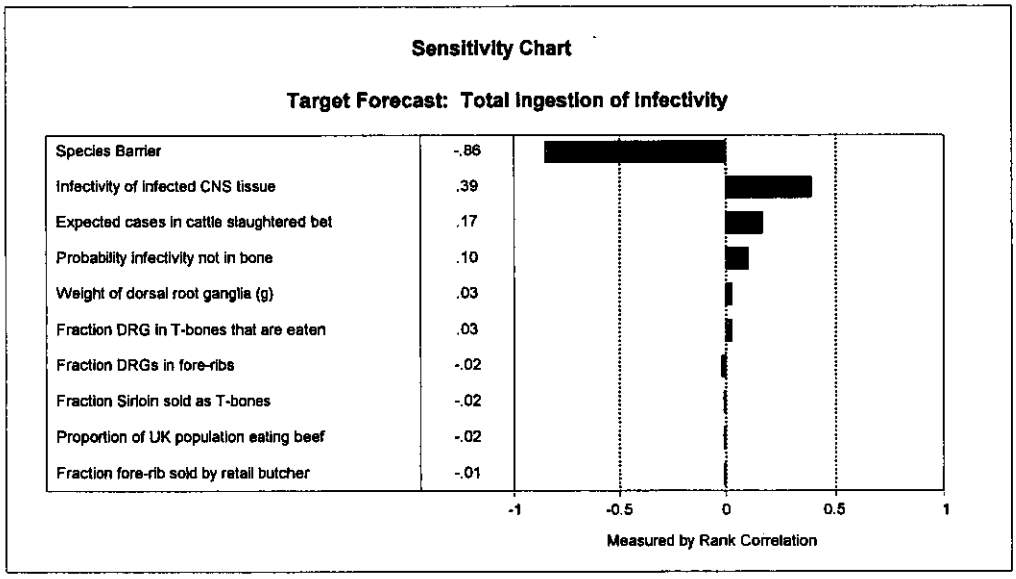


The individual risk has been estimated by dividing the total infectivity ingested by an estimate of the number of people in the UK that eat beef. This could be refined by obtaining data on the numbers of people that eat certain cuts of meat (Rib roasts, T-bone steaks, etc). However it is not expected that this would make a substantial difference to the results.

3.4.3 Sensitivity

The sensitivity of the individual risk result to the individual input assumptions is shown in Figure 3.3. This shows the contribution to the overall variance from each of the input parameters. This shows that the sensitivity is dominated by the variation in the Species Barrier, which has been defined with a uniform distribution over four orders of magnitude. The next most important parameters are the estimated infectivity in infected tissue, the number of animals with infectivity slaughtered and the proportion of infectivity that is removed from the bone into the edible portion in a boning out operation.

Figure 3.3: Sensitivity of Individual Risk to Input Uncertainties



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Addendum

Assessment of Risk from Possible BSE Infectivity in Dorsal Root Ganglia

Addendum

Philip J Comer December 8, 1997

This is an addendum to Revision 1 of the DNV report "Assessment of Risk from Possible BSE Infectivity in Dorsal Root Ganglia", dated 6th December 1997. In that report, it was estimated that about 24% of the calculated risk of total infectivity derived from bone-in meat. It also shows that with current UK practices of carcase dressing, only 5% of the meat adjacent to the vertebral column reaches the consumer still attached to the vertebral column.

The purpose of this addendum is to investigate the sensitivity of the results to some of the assumptions relevant to the proposal to remove all bone from meat. This note deals only with issues relating to dorsal root ganglia (DRG), and not to any infectivity that there may be in the bone marrow of older animals with clinical symptoms of BSE.

Results have been calculated for 5 new cases using the same assumptions in the Monte Carlo simulation for all variables apart from those noted. The cases are in three pairs, with each one showing the effect of a change in one main assumption, and then combining this with the effect of removing all meat from the bone. The results are shown together with the base case in Table 1. The results for the Total Infectivity consumed by the UK population in 1997 are also plotted on a log scale in Figure 1. This shows the median and the 95 percentile range of the results. The cases are:

1.1 Base Case: all data as for Revision 1.

1.2 As base case, but with 100% of meat sold off the bone.

2.1 As base case, but with 99.9% of the DRG removed with the bone for boneless meat rather than 99%.

2.2 Case 2.1 with 100% of meat sold off the bone.

3.1 As base case, but with 100% of the DRG in bone-in meat eaten rather than 5%.

3.2 Case 3.1 with 100% of meat sold off the bone. Not calculated, as this will be the same as 1.2.

Table 1: Comparison of Results

Case	Total Infectivity ID_{50} units in 1997		Individual Risk ID_{50} units per person/yr		% due to bone-in
	Median	95% range	Median	95% range	
1.1 Base Case	.047	2.10^{-4} - 12	9.10^{-10}	$5.10^{-12} - 2.10^{-7}$	23%
1.2 100% of meat boneless	.038	2.10^{-4} - 9	7.10^{-10}	$4.10^{-12} - 2.10^{-7}$	0%
2.1 99.9% of DRG removed with bones	.014	$8.10^{-5} - 4$	3.10^{-10}	$2.10^{-12} - 7.10^{-8}$	75%
2.2 2.1 with 100% of meat boneless	.004	$2.10^{-5} - 0.9$	7.10^{-11}	$4.10^{-13} - 2.10^{-8}$	0%
3.1 100% DRG eaten with bone-in meat	.25	$1.3.10^{-3}$ - 63	5.10^{-9}	$3.10^{-11} - 1.10^{-6}$	86%

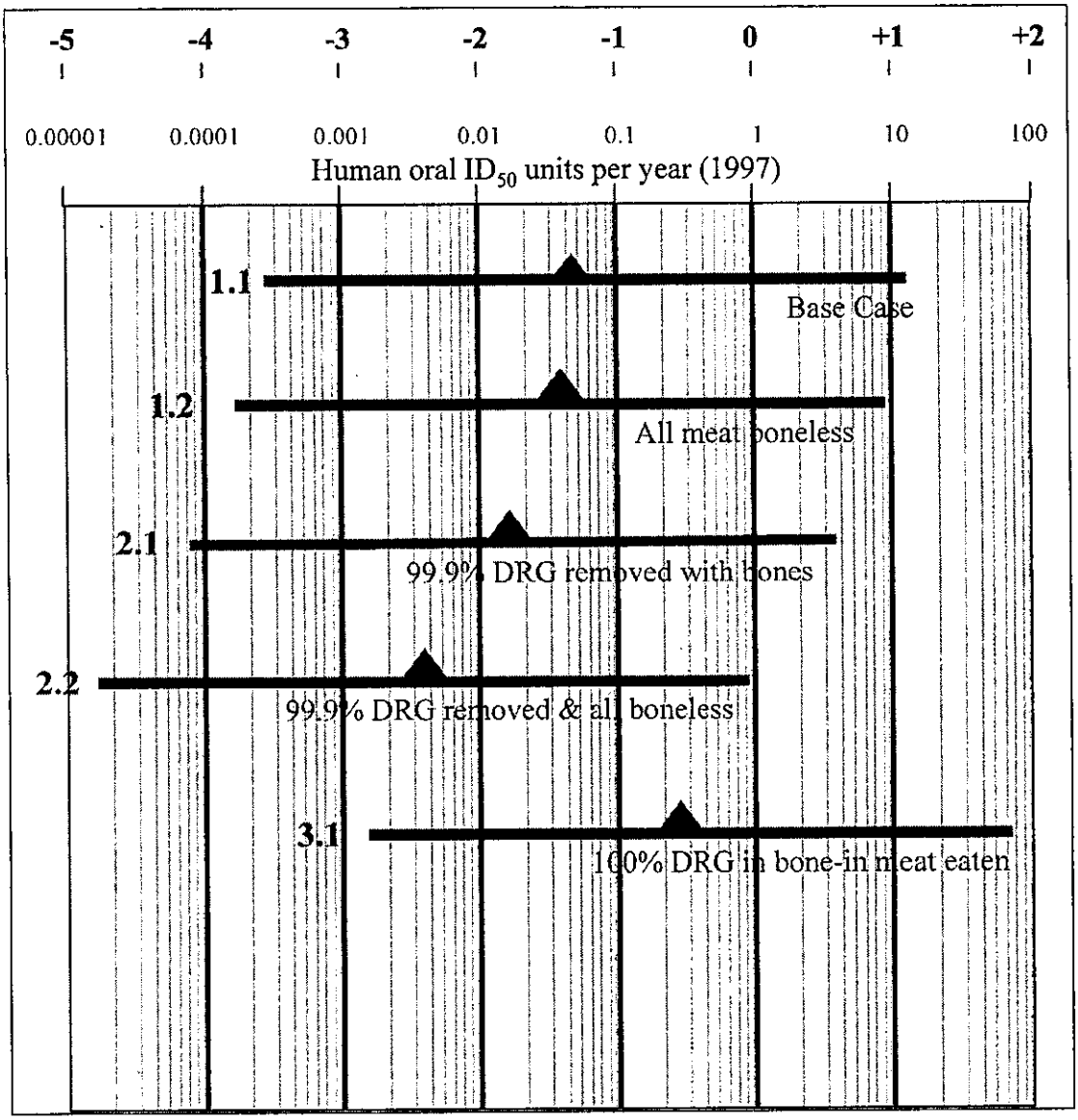
5. DISCUSSION OF RESULTS

Comparison of Case 1.2 with the Base Case shows that, with the base set of assumptions, the proposal to remove all meat from the bone would only reduce the median total infectivity consumed by the UK population from 0.047 to 0.038 ID_{50} units in 1997, a reduction of 19%. From Figure 1 it can be seen that with the range of uncertainty in the results this is a negligible reduction.

If 99.9% of the DRG are removed with the bone in boning out plants (Case 2.1.), then it can be seen that the overall risks are reduced by about a factor of 3. However, as shown by Figure 1, this does not really alter the risk profile. One significant difference is that now about 75% of the infectivity consumed is from bone-in meat. Now, adding 100% boneless meat makes a bigger reduction. The median total infectivity for Case 2.2 is reduced to 0.004 ID_{50} units in 1997, which is a 73% reduction from Case 2.1. However, the absolute reduction of 0.01 ID_{50} units remains the same. From Figure 1 it can be seen that the upper value for the 95% range has been reduced to just below 1 ID_{50} unit.

Case 3.1 has been included to give an upper estimate on the base case, reflecting uncertainty in the proportion of DRGs eaten from bone-in meat. Although the DRG is relatively unlikely to be consumed directly, if the bone was subsequently used to make stock this could result in most of the DRG going into the food chain. This would increase the overall risk by about a factor of 5, and give a high proportion of the infectivity from bone-in meat. Taking all meat off the bone would reduce this risk by 85%.

Figure 1: Risk Comparison Plot for Total Infectivity



6. CONCLUSION

The base results indicated that removing all meat from the bone would have little effect on the total infectivity consumed due to DRG. However, this sensitivity assessment has shown that this conclusion is very dependent on the assumptions made in the assessment. If more DRG are removed with the bone than was originally assumed, then taking meat off the bone becomes more effective. This is also true if more infectivity is consumed from DRG in bone-in meat, for example due to making stock.