A Mini Review Of The Causes And Incidence Of Pericarditis In Poultry

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Introduction

In poultry, pericarditis can result from a number of aetiologies, some of which are harmful to human health. However, in the UK, the presence of pericarditis in a poultry carcass generally results in whole carcass rejection at post-mortem inspection. This is primarily because, historically, the condition has been associated with *Salmonella* infection.

The Food Standards Agency (FSA) requested that a mini review of pericarditis in poultry be carried out to establish the incidence and causes of pericarditis in UK poultry. Data has been identified by a combination of literature and web searches, together with information from appropriate experts, such as poultry pathologists and vets in the Meat Hygiene Service (MHS). Following the investigations undertaken for this mini review, methods of establishing a rationale for the revision of some of the current poultry inspection practices have been suggested, in the form of specific risk assessments.
Current legislation

The Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations 1995 state that:

“Birds shall be declared unfit for human consumption where the post-mortem health inspection reveals any of the following diseases or conditions:

- Generalised infectious disease and chronic localization in organs of pathogenic micro-organisms transmissible to humans;
- Systemic mycosis and local lesions in organs suspected of having been caused by pathogenic agents transmissible to humans or their toxins;
- Ascites\(^1\)"

The Regulations continue:

“Parts of a slaughtered bird which show localized lesions or contaminations not affecting the health of the rest of the meat shall be declared unfit for human consumption.”

These regulations are open to interpretation by individual inspectors; poultry carcasses may be condemned for conditions deemed to be indicative of generalised infection, for example pericarditis, when it may in fact only be necessary to condemn the affected part. In practice poultry carcasses with pericarditis are rejected (Norman, pers comm.)

In 1998, the Ministry of Agriculture, Fisheries and Food (MAFF, now Defra) issued a directive to poultry meat inspectors to condemn birds with pericarditis as unfit for human consumption (Rampling et al. 1989).

\(^1\) accumulation of fluid in the abdomen
Pericarditis

The pericardium is a fibroserous sac, which encloses and lubricates the heart. Pericarditis is inflammation of this sac and an accumulation of fluid or exudates within the sac. The presence of a pericarditis in a poultry carcass may or may not be indicative of systemic disease, and relies on a judgment being made by the inspector, based on guidance from the Poultry Meat, Farmed Game Bird Meat and Rabbit Meat (Hygiene and Inspection) Regulations 1995 described previously.

Figures 1 and 2 show normal poultry hearts and poultry hearts affected with pericarditis.

![Fig 1: Normal chicken heart](image1) ![Fig 2: Chicken heart with pericarditis](image2)

Post-mortem inspection (PMI) of poultry involves three stages: whole carcass inspection, inspection of viscera and final carcass inspection. It is during inspection of viscera that the heart is visualised (Wilson, 1998).

Experts from the MHS indicate that both fluid and purulent\(^2\) types of pericarditis result in carcass rejection. There are further variations in the types that occur, for example, some have floccular\(^3\) material within the pericardial fluid, in combination with other pathology. In fluid pericarditis (which may also be referred to as “hydropericardium”), there is an increase in the amount of pericardial fluid present and the fluid appears clear. Currently however, these different types are not distinguished in MHS records. An additional complication arises with fluid pericarditis, as this condition is indistinguishable grossly\(^4\) from pericardial effusion, a condition that is more likely to result from a genetic predisposition or from pathology relating to management factors such as overcrowding. A poultry heart with hydropericardium is shown in figure 3.

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\(^2\) containing pus  
\(^3\) floating  
\(^4\) visible by eye
A Mini Review Of The Causes And Incidence Of Pericarditis In Poultry

Fig. 3: Heart on the left shows hydropericardium\(^5\)

Pericarditis as a consequence of right-sided heart failure can be present in conjunction with ascites, which is another condition for which birds are rejected at PMI. The causes of ascites are attributed to management related problems (fast growth rate/ventilation) rather than to an infectious agent (Norman, pers comm.; Morris, pers comm.).

\(^5\) source: www.therange.co.uk/poultry/veterinary/vet10.htm
Incidence of pericarditis in poultry

In order to determine the incidence of pericarditis in poultry, literature searches were undertaken, and experts in the Meat Hygiene Service and Poultry Industry were consulted. UK incidence data reported in the literature was sparse and the most recent data identified was from 1992. For this reason, data from a more recent paper reporting on a study in Buenos Aires has also been included. Data provided by the MHS has been included, however data from the poultry industry is owned by private companies and is thus more difficult to obtain; that which has been included in the review is from a source that did not wish to be identified.

Table 1 shows the number of carcasses rejected at PMI for pericarditis by poultry type during the period April 2003-March 2004 in Great Britain, and the percentage of total birds rejected (Norman, pers comm.). Unfortunately, total carcass throughput by poultry type was not recorded in the raw data and hence the percentage of birds rejected by poultry type could not be calculated.
Table 1: Total poultry rejected at PMI for pericarditis in GB between April 2003 and March 2004 (MHS data, Norman, pers comm.).

<table>
<thead>
<tr>
<th>Region</th>
<th>Poultry type</th>
<th>Number rejected with pericarditis</th>
<th>Total rejected with pericarditis</th>
<th>Total carcass throughput (x 10^6)</th>
<th>% Total carcasses rejected for pericarditis</th>
</tr>
</thead>
<tbody>
<tr>
<td>North England</td>
<td>Broilers</td>
<td>71481</td>
<td>71502</td>
<td>118.3</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>Hens</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quail</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ducks</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turkeys</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central England</td>
<td>Broilers</td>
<td>12826</td>
<td>17867</td>
<td>494.5</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Hens</td>
<td>151</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quail</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ducks</td>
<td>4358</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turkeys</td>
<td>532</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South &amp; West England</td>
<td>Broilers</td>
<td>215331</td>
<td>215690</td>
<td>166.0</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Hens</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quail</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ducks</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turkeys</td>
<td>313</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wales</td>
<td>Broilers</td>
<td>21894</td>
<td>23030</td>
<td>121.0</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Hens</td>
<td>247</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quail</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ducks</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turkeys</td>
<td>889</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scotland</td>
<td>Broilers</td>
<td>16317</td>
<td>16367</td>
<td>81.5</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Hens</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quail</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ducks</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turkeys</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GB average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 2 shows the percentage of birds rejected at PMI for pericarditis at two UK poultry processing plants (A and B) between June 2003 and April 2004. The average throughput of birds processed per month was approximately 1,250,000 and 450,000 respectively (source did not wish to be identified).
Table 2: Percentage of birds rejected at PMI for pericarditis at two poultry processing plants, A and B between June 2003 and April 2004.

<table>
<thead>
<tr>
<th>Month</th>
<th>% Carcass rejection for pericarditis Plant A</th>
<th>% Carcass rejection for pericarditis Plant B</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2003</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>July 2003</td>
<td>0.01</td>
<td>0.06</td>
</tr>
<tr>
<td>August 2003</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>September 2003</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>October 2003</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>November 2003</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td>December 2003</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>January 2004</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>February 2004</td>
<td>0.05</td>
<td>0.09</td>
</tr>
<tr>
<td>March 2004</td>
<td>0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>April 2004</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Average for period June 03 – April 04</td>
<td>0.04</td>
<td>0.06</td>
</tr>
</tbody>
</table>

During the 18 months up to September 1996, 656.4 million chickens and 36 million other poultry were slaughtered in GB. During the latter 6 months of this period, 189,000 birds were recorded by the MHS as affected with pericarditis, an incidence of 0.05% (Corry & Hinton, 1997).

An analysis of poultry carcass rejection in the UK by Yogaratnam (1995) showed that, of the 33.65 million broiler carcasses studied, 1.57% were rejected for “disease conditions”, and of these, 1.1% of the diseased carcasses had a pericarditis or hydropericardium (0.02% of those rejected). A further 43.8% of diseased carcasses had pericarditis in conjunction with perihepatitis or air sacculitis (collectively these symptoms are termed “colipecticaemia”). In contrast to MHS data, this study made a distinction between pericarditis and hydropericardium, although they were counted together for recording purposes.

Twenty six years earlier, Mayor (1969) surveyed 1,000 condemned chicken carcasses and found 68 (0.07%) of these selected at random had lesions of pericarditis and/or perihepatitis6. Here the author grouped pericarditis lesions with those of perihepatitis. In these surveys, by both Yogaratnam and Mayor, the sample populations were condemned carcasses.

A survey undertaken by Gregory and Austin (1992) of 1,324 broiler chickens arriving dead at six poultry processing plants in England found that, of the 20% of carcasses exhibiting signs of disease, 5% had pericarditis (0.01% of broilers arriving dead). It is interesting to note that there was a smaller percentage of total birds affected with pericarditis arriving dead at the

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6 inflammation around the liver
processing plant in this survey (0.01%), when the presence of a pre-existing heart condition might intuitively be expected to result in an increased number of deaths following stress during transport, compared with the slightly higher percentage of birds that were rejected at PMI with pericarditis/hydropericardium (0.02% of birds) in Yogaratnam’s survey.

In 1961, Gross suggested that pericarditis was part of a complex of “air sac disease” and suggested the name “coliform pericarditis” to describe what is today referred to as “colisepticaemia”, which is used to describe a syndrome caused by *E. coli* infection. Helmsley & Harry (1965) published the results of a 3-year study of “coliform pericarditis” in 52 broiler chicken flocks. They identified two forms of the disease, one that affected baby chicks, and one that affected broilers aged between 6 and 10 weeks. Over the 3-year period, 45 flocks (87%) experienced cases of the disease, although only 8 (15%) of the flocks were considered to have outbreaks – of which 7 also exhibited symptoms of respiratory disease. A key finding was that the majority (71%) of affected birds were not detected until post-mortem. Additionally, in 20 flocks (38%) pericarditis was identified in conjunction with another disease, such as infectious bronchitis virus or *Mycoplasma gallisepticum*, or occurred secondary to infection with histomonas or coccidial parasites. This particular study made the assumption that all cases of pericarditis identified were due to infection with *E. coli*, based on the pathological lesions identified.

An epidemiological study carried out in Buenos Aires by Frandeschi et al. (2000) between March 1991 and March 1998 examined 2,840 broiler carcasses from 143 farms. The most frequently identified lesion was hydropericardium, which was found in 53.94% of birds. Lesions of pericarditis were identified in 10.03% of birds. The authors concluded that the four most frequently identified lesions (which did not include pericarditis) were the result of the intensive husbandry practices of overcrowding and confinement.
Causes of pericarditis in poultry

Literature searches conducted to date have identified 37 potential causes of pericarditis in poultry. These are listed in Appendix 1. Although data searches have focussed primarily on the aetiologies of pericarditis in UK poultry, relevant reports of experimental work undertaken in other countries have been included in this section.

UK experts indicate that in poultry, pericarditis commonly occurs as part of a polyserositis following bacteraemia or septicaemia, including infection with mycoplasmas and chlamydia, and the majority of cases seen in the UK are due to *E. coli* infections. The condition is seen frequently at post-mortem, however it is not recorded as a separate condition in VLA databases. Another common infectious cause is Enterobacter (Wood, pers comm.; Norman, pers comm.).

Reports of pericarditis in the literature also indicate that pericarditis often does not occur as an isolated lesion; In Mayor’s survey of 1000 condemned chicken carcasses (Mayor, 1969), pericarditis was grouped together with perihepatitis for recording purposes, under the classification “lesions of the respiratory tract and serous surfaces”, since the majority of the pericarditis lesions that were identified were found together with air sac and liver lesions.

A respiratory syndrome in broiler chickens described by Riddell (1987) as “air sac disease” was characterised by lesions of severe air sacculitis, pericarditis and perihepatitis; Riddell reported that *E. coli* could frequently be isolated from affected birds, however the syndrome was difficult to reproduce by administration of the organism via natural routes, although it could be reproduced with mixed infections. Riddell therefore considered *E. coli* to be a secondary invader to viral or mycoplasmal infections.

In 1980, Stuart identified septicaemia and air sacculitis as the two main reasons for condemnation of poultry carcasses in USA in 1977 as (USDA figures, 1980), both of which can be found in association with pericarditis. Table 3 shows common conditions that result in poultry carcass condemnation at PMI that are associated with pericarditis (adapted from Stuart, 1980).

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7 inflammation of the air sacs
Table 3: Common conditions resulting in poultry carcass condemnation that may be associated with pericarditis (adapted from Stuart, 1980).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Associated lesions</th>
<th>Causative organism</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septicaemia (acute)</td>
<td>Hyperaemic muscle Petechial haemorrhages Enlarged liver &amp; spleen</td>
<td><em>E. coli</em> <em>Pasteurella</em> <em>Erysipelas Staphyloccoci</em></td>
<td>Laboratory tests needed for definitive diagnosis; Carcass rejected</td>
</tr>
<tr>
<td>Septicaemia (chronic)</td>
<td>Extensive serofibrinous pericarditis Perihepatitis</td>
<td><em>E. coli</em> <em>Salmonella</em> (rarely)</td>
<td>Unable to tell if organisms in musculature without lab tests; no LNls to aid judgment; Carcass rejected</td>
</tr>
<tr>
<td>Air sacculitis</td>
<td>Pericarditis Perihepatitis</td>
<td><em>E. coli</em> Viral infection Poor housing</td>
<td>Judgement based on appearance of whole carcass; may require condemnation of affected part of carcass only</td>
</tr>
<tr>
<td>Hydropericardium</td>
<td>Excess pericardial fluid Pericardial sac thickened No pericardial adhesions</td>
<td>(Not specified)</td>
<td>Judgement based on appearance of whole carcass; may require condemnation of affected part of carcass only</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>Lesions rare; Occasionally serofibrinous pericarditis and perihepatitis</td>
<td>Various serotypes</td>
<td>When lesions are present they are indistinguishable from <em>E. coli</em> lesions</td>
</tr>
</tbody>
</table>

LN: lymph node

Much of the literature identified relating to pericarditis in poultry includes it as part of a list of lesions caused by a particular experimental infection, or associated with a particular condition. All organisms, materials or conditions that have been identified as associated with pericarditis in the literature are listed in Appendix 1. Data relating to some of the more frequently identified causes of pericarditis (according to poultry experts) are now considered further.

**Ascites**
Twenty-four 8 week old male broilers showing clinical signs of ascites at a Japanese farm were examined post-mortem. Of these, five birds (21%) had pericarditis (Sakumi et al). No microbial culture of the lesions was carried out.

**Chronic Respiratory Disease (CRD)**
Pericarditis may be the only lesion found in Chronic Respiratory Disease Syndrome (CRD). CRD lesions are commonly caused by *E. coli* and *Mycoplasma gallisepticum*, but there are other possible causes, such as
salmonellosis, chlamydiosis, pseudotuberculosis, erysipelas and staphylococcal infections (Herenda & Franco, 1996).

Investigation of an outbreak of respiratory disease in a broiler flock in the Netherlands, where the condemnation rate at slaughter was 60%, was shown to be due to infection with *Ornithobacterium rhinotracheale*. In a few of the affected birds (number not specified), pericarditis lesions were recorded (van Veen *et al.*, 2000).

Colibacillosis
Colibacillosis describes a septicaemic infection with *E. coli* occurring particularly in broiler chickens (Sundaresan *et al*). *E. coli* infection is described further below.

*E. coli*
According to the literature, *E. coli* is generally accepted as the most common cause of pericarditis in poultry, and most serotypes of *E. coli* cause pericarditis in poultry. The majority of cases of pericarditis seen at VLA Lasswade are reportedly due to *E. coli* infections (Wood, pers comm.).

Yamaguchi *et al.* (2000) designed an experiment to demonstrate the importance of *E. coli* infection in producing ascites in broiler chickens, by inoculating 50 birds with serotype 0111:H4. Eight out of the 10 birds (80%) that died of *E. coli* septicaemia before the experiment was concluded had pericarditis, perihepatitis and air sacculitis lesions, and 10 of the 40 (25%) of the surviving birds had pericarditis lesions. The authors stated that pericarditis was a common lesion in *E. coli* septicaemia, and further describe how the organism is suspected to be the cause of ascites. However, in their experiment, none of the birds were found to exhibit both ascites and pericarditis, and they concluded that their results suggested that *E. coli* septicaemia caused pericarditis in chickens but not cause ascites.

In a study by Gomis *et al.* (1997), lesions of pericarditis, air sacculitis and perihepatitis were produced in over 80% of broilers that had been inoculated with *E. coli* 078 in order to produce avian cellulitis and septicaemia. The organism could be isolated from 80-100% of pericarditis and air sacculitis lesions and spleens of birds that died 1-6 days post infection, and from 80-100% of pericarditis and air sacculitis lesions up to 5 days post infection in birds that were euthanased. However the organism was not found in any of the birds euthanased 7 days and 14 days post infection. This agrees with Herenda & Franco (1996), who suggest that pericarditis lesions more than 1 week old are often sterile, and if such lesions occurred in isolation, the poultry carcass itself may be fit for human consumption.

*Mycoplasma gallisepticum*
Thornton (1971) conducted experiments on 450 broilers to determine whether infection with *M. gallisepticum* could predispose chickens to coliform pericarditis. However, no evidence was found to show that infection with the former increased susceptibility to the latter.
Pasteurella gallinarum
Shivaprasas and Droual (2002) describe experimental infection of 21 day old broilers with an atypical strain of *P. gallinarum*, the Fresno strain. In birds that had been inoculated intramuscularly, the majority (number not specified) showed severe fibrinous pericarditis at post-mortem.

A report of severe mortality and condemnation rates in broilers in California by Droual *et al.* (1992) describe the lesions of air sacculitis, pericarditis (present in 26 out of 38 birds at post-mortem, 68%) and perihepatitis identified as being suggestive of *E. coli* septicaemia (colibaccillosis). However, *P. gallinarum* was isolated from 16 of 18 (88%) of pericardia from affected birds. The authors report that the three lesions described also occur in infections with *M. gallisepticum*, Newcastle Disease Virus and infectious bronchitis viruses, and when high ammonia levels are present in the litter.

Salmonella
The incidence of *Salmonella* in UK poultry is included in Appendix 2. Yogaratnam (1995) stated that infection of poultry with *Salmonella enteritidis* may manifest as a fluid pericarditis, which is evident during PMI, and the organism can be isolated from the pericardial fluid. In some cases the infection may manifest as a fibrinous pericarditis, which is indistinguishable from colisepticaemia. The presence of a fluid pericarditis in poultry is indicative of a possible septicaemic condition and can result from infection with a number of different bacteria, and hence it is not diagnostic of *S. enteritidis* infection. However, carcasses with hydropericardium or pericarditis are rejected at PMI in order to protect the public from possible infection with *Salmonella*.

In unpublished work undertaken by Hellig (year not specified) over the course of 1-2 years, birds from problem broiler flocks that had been bred from *Salmonella enteritidis* and *Salmonella typhimurium* negative parent flocks were examined at three unrelated poultry plants. Extensive microbiology of the pericardial contents, including culture on selective media, did not reveal the presence of *Salmonella*. The most commonly isolated organisms were in fact enterococci, and a significant number of cases (number not specified) appeared sterile. This result apparently contrasted with the situation from ten years previously, when it was not unusual to isolate *Salmonella enteritidis* from pericardial contents (Hellig, pers comm.).

Rampling *et al.* (1989) examined the pericardial fluid of 81 broiler chickens that had been condemned for pericarditis and found 41 (51%) to have *S. enteritidis* PT4. In the 6 most severely affected hearts viable organism counts were $10^4 – 10^7$ CFU/ml. During the study period, on average 0.1% of birds were condemned for pericarditis due to *S. enteritidis*. The gross appearance of the hearts was cardiac enlargement, thickened pericardial sacs and pericardial fluid exudates, and generally weighing over twice that of a non-affected heart. The authors noted that pericarditis lesions produced by *S. enteritidis* PT4 in broilers appeared to be indistinguishable grossly from that caused by *S. pullorum*. 
In the late 1980’s, “ad-hoc” tests on the pericardial fluid of several (6-12) poultry carcasses showing fluid pericarditis were undertaken by poultry inspectors at a UK poultry processing plant. Results showed the pericardial fluid to be sterile, and not to contain S. enteritidis as originally anticipated (Norman, pers comm., unpublished work).

Sepisicaemia
The term “colisepticaemia”, discussed previously in the text, has been used to collectively describe symptoms of air sacculitis, pericarditis and perihepatitis in poultry carcasses, occurring as a result of infection with E. coli.

In order to determine if the lesions of acute septicemia could be detected grossly in visceral organs at post-mortem prior to muscle changes, Fisher et al. (1997) infected 6-week old broilers with P. multocida, E. coli and S. aureus. Euthanased birds were examined between 4 and 240 hours post-inoculation for evidence of air sacculitis, perihepatitis, pericarditis and arthritis. The authors concluded that, for E. coli and P. multocida, macroscopic lesions of air sacculitis, pericarditis and perihepatitis in combination were sufficient to identify acute septicemic carcasses. They added that, although perihepatitis and pericarditis can be primary lesions, they generally occurred secondary to respiratory disease, and that when pericarditis (or perihepatitis) occurred as an isolated lesion without indications of septicemia, only the affected organ need be condemned.
Discussion

There is a limited amount of recent data on the incidence of pericarditis in UK poultry available in the literature. Additionally, data from experts in the field is difficult to obtain since in general, other than MHS data, much of this information is generated to inform private poultry producers, who keep the data confidential. Investigations to date reveal an overall low incidence (0.004% – 0.13%) of pericarditis in UK poultry, and highlight how the lesion often does not occur in isolation and is present as part of various conditions (for examples, see Table 3).

From the literature and discussions with poultry experts it appears that, within the last two decades, the incidence of *Salmonella* infection causing pericarditis in UK poultry has declined, and hence, rejection of birds with pericarditis lesions alone in order to protect public health may no longer be necessary. This may be the result of decreased overall prevalence of *Salmonella* in UK poultry flocks.

The Food Safety and Inspection Service (FSIS) of United States Department of Agriculture (USDA) has identified four categories of diseases and conditions that affect products but are not hazardous to public health; pericarditis is listed as an example of a condition that contains infectious agents that do not render foods unsafe to humans (FSIS, 1998). This decision was reached following a recommendation by the National Academy of Sciences and the General Accounting Office, that FSIS reduced its reliance on organoleptic meat inspection in favour of prevention-based systems informed by risk assessments, in order to better protect public health.

FSIS subsequently undertook a HACCP-Based Inspection Models project to study the most appropriate methods of addressing this. A key step in development of the inspection models was the differentiation of food-safety hazards from non-food safety hazards. This differentiation resulted in pericarditis falling under the category “Diseases and conditions with consumer-protection implications not related to food safety, Animal infectious conditions”, which require removal of localised lesions or condemnation if lesions are generalized. Conversely, septicaemia (which is often found in conjunction with pericarditis at PMI) was categorised under “Infectious conditions that affect food safety”, which, is defined as a generalised condition requiring whole carcass condemnation (FSIS, 1998).

The Canadian Food Inspection System (CFIS) poultry post-mortem procedures advise that the appropriate action for pericarditis, dependent on the extent of lesions and evidence of systemic effects, is carcasses condemnation if the condition is associated with systemic changes, otherwise the affected organ alone is condemned and the carcass approved (Henenda & Franco, 1996). This is because in Canada, pericarditis is not considered a food safety issue, and therefore the basis for condemnations for pericarditis

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8 using the senses
rests more on consumer acceptance/suitability rather than food safety (Teliszewsky, pers comm.).

In the UK, poultry meat inspection is undertaken to identify conditions visually, so only gross lesions are detected. The carcasses are examined on high-speed lines allowing inspectors a few seconds per bird for inspection. Such a system does not readily afford extra time to make decisions on whether potentially hazardous lesions require whole carcass or only organ condemnation. In general, it seems logical that if pericarditis is present in association with other lesions then the predisposing condition or pathogen(s) present should result in whole carcass condemnation anyway. What is more difficult to justify is where the lesion occurs in isolation, which in some circumstances may only warrant rejection of the affected part of the carcass. Risk assessments to address specific questions raised from this review are suggested in the following section.
Suggested risk assessments

1. In order to answer the question: “Is poultry carcass rejection for pericarditis justified, and do all pericarditis in poultry represent a risk to human health?” the following risk assessment is suggested:

“A qualitative assessment of the risks to human health from pericarditis in poultry at slaughter”

2. The Advisory Committee on the Microbiological Safety of Food Report (1996) strongly recommended that the practice of leaving viscera hanging in contact with carcass during inspection be discontinued; in order to answer the question: “Does the current practice of draping removed poultry viscera over the carcass during processing increase the risk to human health from poultry carcasses?” the following risk assessment is suggested:

“A qualitative risk assessment of the risks to human health from draping viscera on poultry carcasses”

3. In order to investigate the incidence of missing poultry viscera and potential hazards to human health that could ensue, a mini review of the incidence of missing poultry viscera, the predisposing causes and potential consequences is suggested.
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Appendix 1

Potential causes of poultry pericarditis identified in the literature to date:

Actinobacillus salpingitidis/avian Pasteurella haemolytica-like isolate
Adenovirus KR95
Aspergillus
Avian listeriosis
Avian pathogenic E. coli
Broiler ascites
Chlamydia sp. (pigeons)
Coronavirus-like agents
Cryptococcus
Cryptosporidia
Detoxified and non-detoxified rape seed meals
Early respiratory disease complex
Fowl Typhoid
Fumonsin in feed
Highly pathogenic parovirus (Derzsy’s disease virus) (Ducks)
Infectious serositis
Listeria monocytogenes
Marble spleen disease (Pheasants)
Marek’s disease
Mycoplasma gallisepticum
Newcastle Disease Virus
Ornithobacterium rhinotracheale
Parvovirus
Pasteurella (Moraxella) anatipestifer
Pasteurella multocida
Pasteurella gallinarum
Pseudomona aeruginosa
Pullorum disease
Reovirus
Riemerella anatipestifer
Salmonella Blockley
Salmonella Enteritidis phage types 4, 8 and 23
Salmonella Typhimurium
Spirocheatosis
Staphylococcus aureus (turkeys)
Streptococciosis
Turkey rhinotracheitis virus
Appendix 2

Incidence of *Salmonella* in UK poultry

**Live birds**
Domestic poultry can acquire *Salmonella* from the parent stock, from the environment, or from consuming contaminated feed (Barbut, 2002).

Broiler flocks that have been tested for accreditation scheme purposes show that the incidence of *Salmonella* in UK broilers is currently running at 1-4% (Allen, pers comm.); recent figures from Defra show there were 800 reported incidents of *Salmonella* in broilers in 2002 (Defra 2002 Zoonoses Report). Table A2.1 shows the incidents of *Salmonella* in layers and broilers reported by Defra in 2000 (Zoonosis Report, UK 2001).

Table A2.1: UK reported *Salmonella* incidents in layers and broilers in 2000

<table>
<thead>
<tr>
<th></th>
<th>Number of incidents</th>
<th>S. Enteritidis</th>
<th>S. Typhimurium</th>
<th>Other serotypes</th>
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<tbody>
<tr>
<td>Layers</td>
<td>12</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Broilers</td>
<td>1063</td>
<td>3</td>
<td>33</td>
<td>1027</td>
</tr>
</tbody>
</table>

**Fresh Carcasses**
A large retail survey of *Salmonella* and *Campylobacter* in UK chickens undertaken by the FSA, showed 23 of 1013 whole chicken carcasses were positive for *Salmonella*, an incidence of 2.3% (FSA, 2003).

A survey conducted by Public Health Laboratories Service (PHLS) in 1994 revealed a prevalence of *Salmonella* in raw UK produced chicken to be 33% of 281 chickens sampled (ACMSF, 1996).

Mead (2000) summarised reports from UK, USA, India, Netherlands and Germany on contamination of fresh poultry meat with *Salmonella* between 1990-1994, as having levels ranging from 4-100%.

Whereas the reports are from fresh meat (post-processing), it should be remembered that these figures include cross-contamination with organism, which can occur during transport and processing.