This is the accepted version of the article published in the Veterinary Record (2014) 174(1):16.
https://doi.org/10.1136/vr.101846

Assessing the expenditure distribution of animal health surveillance: the case of Great Britain

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Abstract

Animal health surveillance in Great Britain (GB) is conducted through public and private initiatives, yet there is no consolidated information on these activities and their outcomes. We developed an inventory of livestock health surveillance programmes in GB to identify gaps in resource use and potential synergies that could be exploited. The inventory contained details of 36 livestock surveillance activities active in 2011. Data were collected by questionnaire and interviews. Livestock health surveillance funding was found to be unevenly distributed between species: the vast majority (approximately 94%) was spent on cattle diseases (tuberculosis surveillance accounted for most of this expenditure), with 2% on pigs, 2% on sheep/goats, 1% on poultry, and 1% on antimicrobial resistance surveillance across all species. Consequently, surveillance effort in GB appears heavily skewed towards regions with high cattle densities, particularly high-prevalence tuberculosis areas such as the south-west. The contribution of private schemes to surveillance funding was hard to quantify due to limited access to data, but was estimated to be about 10%. There is scope to better understand the benefits of surveillance, enhance data sharing, clarify costs and identify who pays and who gains. Health surveillance should be considered within the sharing of responsibilities for disease control.

Introduction

Animal health surveillance is undertaken in combination with intervention to mitigate the impact of animal disease on public health, animal welfare and the rural economy, by provision of evidence to optimise decisions on disease control (Häsler and others 2011). The delivery of veterinary surveillance in Great Britain (GB) has recently been subject to detailed scrutiny and review. Recent reports have highlighted the need to ensure that animal health surveillance provides sufficient evidence to meet the purposes of decision-makers effectively and efficiently (SAG 2012, Scottish Government 2011). However, animal health surveillance in GB is conducted through a range of public and private initiatives, yet there is no consolidated information on these activities and their outcomes. This lack of an overview of surveillance activities means that there may be opportunities to get added value from existing surveillance programmes, as well as identify gaps in knowledge or overlaps if similar schemes exist which are duplicating the collection of surveillance information.

The aims of this study were to (i) develop an inventory of existing livestock health surveillance programmes in GB and (ii) explore this information to identify gaps in resource use and potential synergies of current livestock health surveillance programmes. The intention was to highlight links to

improve resource allocation that may impact on performance. Although occasional reports exist that include estimates of surveillance costs for one hazard in one country (e.g., Probst and others 2013), the authors are not aware of any published integrated studies which compare surveillance costs for multiple diseases across different surveillance systems and therefore comparisons are not possible from the literature. Given the importance of surveillance and the need to ensure its cost-effectiveness this appears to be a major gap in research and publications.

In the present study, overlaps and synergies were identified in order to make suggestions on possible redundancies and where some additional collaboration could add value. The current distribution of financial resources between programmes was considered as part of this objective. The inventory developed included key characteristics of each programme as used previously (Stärk and Nevel 2009) and other characteristics identified at an international workshop to discuss the standardisation of surveillance terminology (Hoinville, 2011).

Materials and methods

Data collection

An inventory of all known surveillance components (activities) of livestock in GB was developed by contacting staff (in person, by email and by telephone) working at the following institutions for lists of any known extant surveillance activities in March 2011: (1) the Animal Health and Veterinary Laboratories Agency (AHVLA) Centre for Epidemiology and Risk Analysis; (2) the AHVLA Veterinary Surveillance Department; (3) the Department for Environment, Food and Rural Affairs (Defra) Surveillance, Zoonoses, Epidemiology and Risk, Food and Farming Group; (4) the Royal Veterinary College (RVC) Veterinary Epidemiology, Economics and Public Health Group; and (5) the Scottish Agricultural College (SAC) Veterinary Epidemiology Group. The surveillance components identified were organised by disease and species in one document which was circulated, reviewed and revised by the authors and colleagues at AHVLA to ensure it was complete to the best of our knowledge.

Four criteria were used for inclusion of current surveillance activities in the inventory:

1. Surveillance components (rather than full surveillance programmes) each constituted an individual record in the inventory.
2. Surveillance components that were current in GB as of June 2011 or were active in the preceding 12 months were included (i.e. a cross-sectional inventory).

3. Focus for the inventory was restricted to schemes of domesticated food producing animals (excluding horses).
4. A broad spectrum of study designs was included: ongoing or repeated, descriptive and action linked activities plus others which may not fit the usual definition of a surveillance activity (for example, herd health schemes that aim to reduce disease incidence) that provide information which contributes to achieving surveillance objectives.

Fifty-one surveillance characteristics, each capturing an item of surveillance information (for example: surveillance purpose, target population, funding source) were identified. A full list of surveillance characteristics and surveillance components can be found in the supplementary Appendix. Data on each characteristic of each surveillance component were collected using detailed questionnaires accompanied by guidance notes which were sent to surveillance programme managers (for AHVLA/Defra schemes) or filled in by a member of the team (JD) using publically available information from the internet (for industry schemes). Follow-up emails were sent to industry scheme managers to request any additional information. Data were inputted from paper forms onto computer database and error-checked. The end result was a comprehensive database of 36 livestock disease surveillance components each described by 51 surveillance characteristics. Early warning surveillance was included as part of each hazard and not as a single separate entity.

Data analysis

A spreadsheet of information from the database was summarised by species and by disease. The information was used to perform a visual mapping exercise to identify overlaps and potential synergies between schemes. This was done by grouping surveillance components together wherever they shared one or more of the 51 characteristics. For example, two surveillance systems for different diseases that utilised the same operator to collect data (such as a private veterinary surgeon collecting blood and milk samples from a dairy farm) would be linked because this commonality represents a possible source of efficiency that might not have been currently exploited. A potential gap was identified when available resources were not utilised. For example, a milk tanker driver might regularly visit a dairy farm but rarely collect samples for disease surveillance. This approach relied on the quality of the information provided in the spreadsheet and thus was limited where data were missing (for example, some financial data were not available: see later). The overlaps and synergies that were identified enabled suggestions to be made on possible redundancies and where some additional collaboration could add value. The current distribution of financial resources between programmes was considered as part of this objective. Whilst data were

collected on individual components of disease surveillance (e.g. a serological test for brucellosis in sheep would be one component; screening of abortion samples for *Brucella* spp. would be another), for the purposes of the analyses presented here, data were combined to the surveillance programme level (i.e. all components relating to that disease in that species).

Surveillance expenditure for each livestock sector was standardised by expressing it in livestock units (a comparative measure based on metabolic weight, with one unit usually representing a mature 'black and white' dairy cow weighing approximately 550kg: Defra 2010a). Livestock units for each sector were calculated based on UK population sizes in 2011 (Defra and others 2013). Surveillance expenditure by species was compared to the economic value of each livestock sector, defined as the "value of production at market price" (Defra 2010a), to determine if surveillance expenditure was in proportion to the economic contribution of each species to the UK economy.

The costs quoted in this report are estimates of surveillance expenditure generated from the surveillance managers' responses to the questionnaires, publically-available data from websites, reports and personal communications. Figures quoted exclude specific disease control costs.

Results

A total of 36 surveillance components covering 21 diseases in four livestock sectors (cattle, sheep and goats, pigs, and poultry) were identified for the inventory and included in the subsequent economic analysis. Of these 36 surveillance components, 28 were programmes operated by AHVLA/Defra and eight were industry-led schemes.

Surveillance expenditure by species

Spending was found to be very unevenly distributed across species. The vast majority (94%) of livestock surveillance expenditure in GB in 2011 was spent on diseases of cattle (mainly bovine tuberculosis), 2% was spent on pigs, 2% on sheep and goats, and 1% on poultry (Figure 1). The remaining 1% was spent on surveillance for antimicrobial resistance across all species.

When data were standardised by expressing it using livestock units, the variation in spending between species remained although it became slightly less pronounced (Figure 2). The average annual spending on livestock surveillance in GB in 2011 was £4.00 per livestock unit (equivalent to 1 cow, or 3.1 pigs, or 12.5 sheep or goats, or 588 chickens) (Figure 2). Surveillance funding was least

for sheep and goats, with spending on these species being an order of magnitude less than the mean spending across all species. Spending on surveillance of pig diseases was also well below average (Figure 2). However, if spending on bovine tuberculosis surveillance were excluded from the calculation, then cattle disease surveillance would receive markedly less funding, at a spend of just 10p per animal (compared to £5.78 per animal when current tuberculosis spending is included).

Table 1 shows that that surveillance spending by species remained unevenly distributed even when the economic value of each livestock sector was taken into account.

Surveillance expenditure by disease

Figure 3 shows the distribution of surveillance spending by disease across each species. In pigs, surveillance was conducted for six health conditions, with just over half of this funding coming from the private sector. After Salmonella, Trichinella surveillance was the biggest funded pathogen. Comparatively, very little was spent on surveillance for Aujeszky's disease and influenza. Financial information on public spending on Salmonella surveillance was unavailable.

Surveillance was reported to be conducted for just three health conditions in poultry (Figure 3). Salmonella surveillance appeared to take the bulk of the funding, spread approximately evenly between layers, broilers, breeders and turkeys. However, financial information on public sector spending on influenza and private sector spending on Salmonella surveillance was unavailable, and it is therefore expected that the total spend on poultry surveillance is likely to be higher than that shown here. Data from the private sector on their surveillance activities were not available leaving an unfortunate gap in the overview.

Surveillance in sheep and goats was conducted for seven health conditions (Figure 3). Of the financial data that were publically available, two-thirds of the money spent on sheep and goat disease surveillance in GB was spent on scrapie surveillance. However, financial information was unavailable for Salmonella and Maedi Visna surveillance, and it is therefore expected that the total spend on sheep and goat surveillance is likely to be higher than that shown here. Very little appears to be spent on contagious agalactia surveillance. Only a small portion of the surveillance funding quantified in this study (around 2%) came from the private sector (compare with over 50% for pigs).

The species with the highest surveillance funding and the greatest number of surveillance programmes was cattle (£44.4m for surveillance of 12 health conditions: Figure 3). It should be

noted that up to five of these may be combined within herd health schemes: Johne's disease, Infectious Bovine Rhinotracheitis, Bovine Viral Diarrhoea, Leptospirosis and mastitis. The vast majority of surveillance money (98%) was spent on tuberculosis, with very little going towards other diseases, particularly Enzootic Bovine Leukosis on which only £21,000 (or 0.0005% of the cattle surveillance budget) was spent. No herd health scheme administrators were willing to disclose financial information on either dairy or beef cattle schemes. Approximately 11% of declared funding came from the private sector; the majority of this is pre-movement skin testing of cattle for tuberculosis.

Synergies and opportunities

Mapping of surveillance components common to several diseases or species revealed that there were several areas of opportunity which could be better exploited. For example, for surveillance of pig diseases, samples were shared between only two of the six surveillance programmes. Risk-based sampling was rarely used and incorporating more risk-based sampling into surveillance may be beneficial. Blood samples and clinical samples were collected in a minority of the surveillance programmes and perhaps could be utilised more. The potential for more farmers and laboratory staff to collect samples should be explored.

Some shared resources were noted. For example, there was sharing of samples, sample collectors and laboratories between surveillance for salmonellosis and antimicrobial resistance in poultry. Also, sharing of some resources was evident in surveillance for sheep and goat diseases. Samples were shared between several surveillance programmes and the AHVLA-Weybridge laboratory was used by many of the surveillance programmes. Although private vets collected samples for most of the diseases analysed, it was not clear whether this collection of samples is coordinated for several diseases at once: if not, this is an area to improve efficiency.

In general, however, there was little sharing of samples between surveillance programmes and this represents an opportunity where potential overlap is being missed. Health information collected by private herd health schemes is not currently made publically available and this represents a missed opportunity, as well as a waste of resources through repetition of similar data collection by different schemes. For example, at least four private schemes collect information on Johne's disease in cattle but they do not share data with each other or with other institutions. The majority of benefits of such surveillance are therefore unnecessarily limited to the cattle owner.

Discussion

A high-level inventory of existing surveillance programmes was established and used to obtain an overview of current efforts, to identify gaps in resource use, and to highlight potential synergies of current livestock health surveillance programmes. Such a compilation of surveillance systems across species was provided for the first time and revealed that information on surveillance costs, particularly for private herd health schemes, were often unavailable or inaccessible. As a consequence of this, economic assessments of disease mitigation – including cost-benefit analyses – will remain biased and incomplete. Our findings are therefore biased due to data gaps, but nevertheless provide an impression of general funding patterns.

The results of this work suggest that surveillance funding in GB is heavily focused on cattle, with the vast majority of this being spent on bovine tuberculosis. This surveillance is part of the UK national control programme required by legislation, of which infection control is an integral part and a large cost. As a result, surveillance in GB is heavily skewed towards regions of the country with high cattle densities, namely the south-west UK. Other diseases, other species and other regions of the country would appear relatively under-funded in comparison.

Surveillance expenditure distribution was most evenly spread across diseases in pigs. Whilst this might suggest a balanced approach to surveillance, this might not appear to be fully justified. For example, the second most funded surveillance programme of pigs was for Trichinella, a disease that has not been detected in GB in this species for over fifty years. Comparatively, very little was spent on surveillance for Aujeszky's disease and influenza, the latter being important from a zoonotic viewpoint. Financial information on public spending on Salmonella surveillance (another zoonosis) was unavailable. It would be beneficial if the methods used for prioritising health conditions for surveillance in animals were made clear, as well as the conditions under surveillance being regularly reviewed (e.g., Defra 2011) to ensure their continued importance and justification for ongoing funding.

The estimate of private sector expenditure made a small contribution to total estimated surveillance spend (approximately 10% across all species, although the exact figure is likely to be a little higher because not all private funding was disclosed). This finding may partly be due to gaps in the data we were able to obtain, particularly from the poultry sector and from the herd health schemes for all species. In addition we take no account of the costs in time and resources of the farmers in taking samples and regularly monitoring the health of their animals. For this reason we have not examined

whether the current ratio of public: private funding (approximately 9:1) is in proportion to the amount of benefit gained by various parties from the surveillance. Since surveillance essentially delivers evidence to inform action, there is scope to increase work in this area to understand the value and benefits of investment in surveillance and in particular to enhance data sharing, clarify costs and identify who pays and who gains.

Information on the benefits of surveillance (which parties benefit and by how much) were described vaguely in the reports used to populate the inventory. This is likely to be because benefits resulting from surveillance are difficult to quantify, or indirect, or both. Surveillance may result in private or public good. The former might result in better profit for a farmer in an assurance scheme, the latter in cases where everybody benefits whether or not they pay for it. For example, surveillance for a zoonotic disease at an international border – and effective intervention in case of disease occurrence – will benefit the whole human population, i.e. everybody will be protected even though they may not be taxpayers and therefore not pay for it. When thinking about diseases like avian influenza, the idea of public good becomes global and therefore any investment into (early warning) surveillance, control and standards, will benefit the global community. It would be useful to be able to describe the type of benefit or beneficiaries with at least a qualitative estimate. For example: medium benefit to farming community through reduction of a production disease, or very large benefit to society through avoidance of human illness and death. This absence of even basic estimates of benefit data is a strong message in itself.

It was not possible to accurately determine costs for all surveillance activities because they were often block funded and costs for each programme were not always separated. The proportion of spending on passive and active surveillance was not clear in some cases. We suggest that funders and deliverers of surveillance need to start characterising how money is spent in order to be able to estimate if each surveillance programme is providing value for money.

None of the industry-led cattle herd health schemes were willing to disclose financial information, sample sizes or geographical locations of farms sampled. The reason given was that this would give their competitors an advantage. As a result, this source of surveillance information is not publically available and the benefits of such schemes are limited to the industry. This represents a potentially significant lost opportunity because of the similar nature of several of these schemes conducting surveillance on the same diseases. An idea of the scale of this 'missing' data can be obtained from a recent estimate of the coverage of herd health schemes in GB. It has been estimated that

290 approximately 14,000 cattle herds (around 14% of UK holdings) have some form of disease
291 surveillance within a herd health scheme, with the likely dairy:beef split being around 40:60
292 (Brigstocke 2012). Limited epidemiological data from these schemes appears to be publically
293 available.
294
295 Facilitating access to both technical and economic data on surveillance would help researchers and
296 decision makers increase the validity of their estimations and decisions. This gap has been identified
297 and made a specific activity in the RISKSUR project (http://www.fp7-risksur.eu/). Therefore such
298 information is likely to be forthcoming in the near future. The recent development of such
299 integrated surveillance frameworks should provide decision-makers and research funders with a
300 better idea of what the data needs for surveillance are, therefore enabling appropriate data
301 collection structures and dialogue with the private industry to share data and costs.
302 Several resources were well utilised across surveillance programmes in many species, for example
303 private veterinary surgeons commonly collect samples which are sent to the AHVLA-Weybridge
304 laboratory for testing. There were some common gaps across species, for example multiple utility of
305 surveillance programmes (sharing of samples) was not commonplace. Where the same sample
306 collectors are used, it is not clear whether animals are sampled once and the resultant samples
307 analysed for several diseases, or whether multiple farm visits and sampling sessions are made (which
308 would represent an overlap and therefore a potential waste of resources). Risk-based sampling is
309 currently used in a minority of cases and its wider use could usefully be explored.
310
311 In conclusion, we note that economic information on private and public sector surveillance activities
312 in GB is very limited at the moment and basically consists of rough estimates. As a consequence of
313 this, economic assessments of disease mitigation – including cost-benefit analyses – will remain
314 biased and incomplete. Decisions taken with regard to disease mitigation will continue to lack this
315 substantial component in its evidence-base until economic information is systematically collected
316 and analysed. In times of increasingly limited resources, this gap should be addressed with urgent
317 priority.
318
319 **Acknowledgements**
320 We thank Toby Floyd, Andy Mitchell and other AHVLA staff contributed to data collection and
321 management. Staff working for the individual surveillance schemes provided some of the data. Linda
322 Hoinville and Jane Gibbens provided constructive comments on drafts of this manuscript. This

project was funded by the UK Department for Food, Environment and Rural Affairs (project code SE4302).

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Table 1. The relationship between animal health surveillance budgets in 2011 and the economic value of each livestock species.

Livestock sector	UK population size in 2011[1]	Animal health surveillance budget in 2011 (£ million)[2]	Economic value of livestock sector in 2011 (£ million)[1]	Amount spent on surveillance per £1000 value of livestock sector to the UK economy
Cattle	9,933,000	44.4	6,322	£7.02
Sheep and goats	31,722,000	0.979	1,149	£0.85*
Pigs	4,441,000	1.01	1,070	£0.94
Poultry	162,551,000	0.571	1,904	£0.30

1. Values from Defra and others (2013)

2. Values from data collected in the present study

*only the economic value of sheep included (figure for goats unavailable)

Figure 1. Estimate of annual public and private expenditure on livestock health surveillance in GB in 2011. Areas of circles are proportional to amount spent on that species. Spending on antimicrobial resistance surveillance (£352k) is not shown because it is spread across several species.

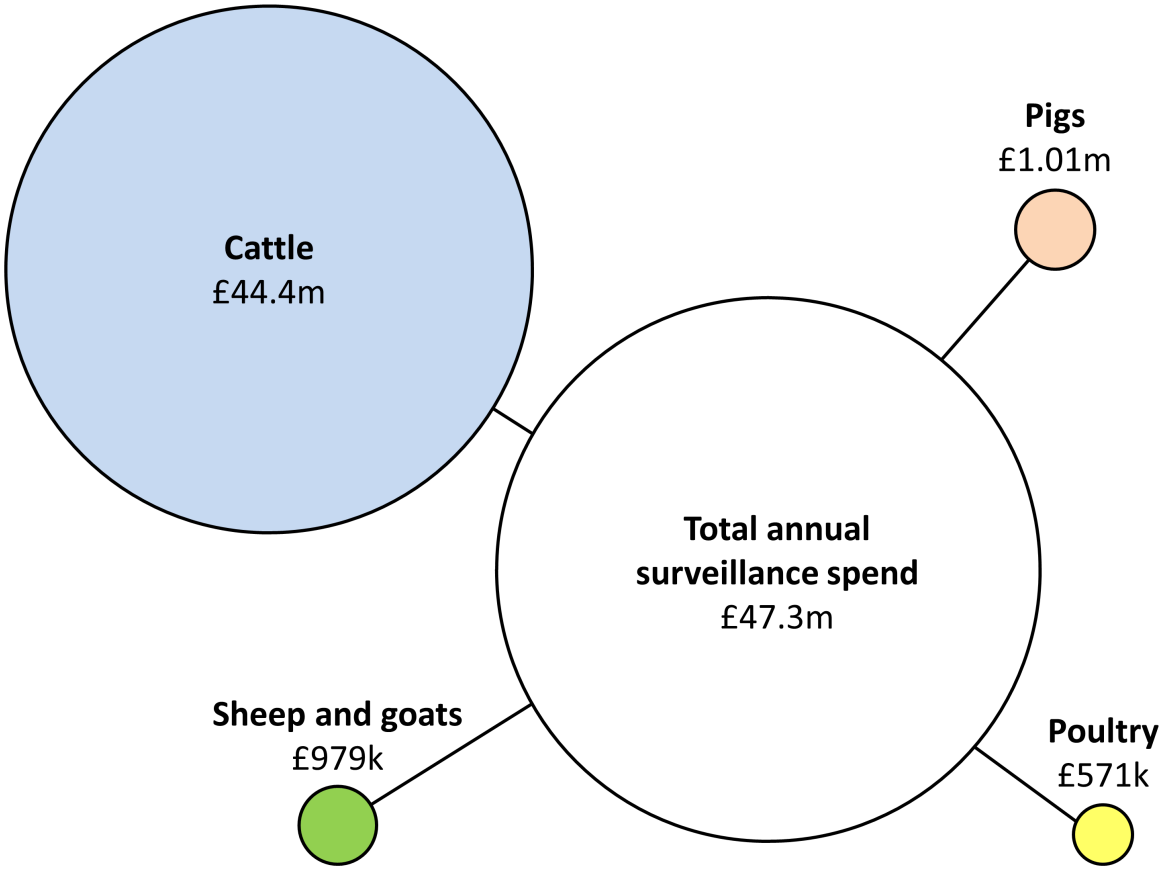

Figure 2. Public and private surveillance expenditure in GB per standardised livestock unit. Livestock Units are based on metabolic weight for each species. Standard ratios are used for converting animals of different species and ages into Livestock Units with one unit usually representing a mature 'black and white' dairy cow weighing approximately 550kg (Defra 2010a). In the diagram below, the expenditure of £0.76 for pigs indicates that 76p is spent each year per livestock unit of pigs (3.3 pigs: the metabolic equivalent of one cow) on disease surveillance in GB. Conversion figures for the other species shown are indicated below. Areas of circles are proportional to amount spent per standardised livestock unit for that species. Livestock unit (LU) coefficients used were: cattle (1.0 LU [adults], 0.65 LU [youngstock]); pig (0.3 LU); sheep or goat (0.08 LU); chicken (0.0017 LU). Source for Livestock Unit Coefficients: Defra (2010a). Sources for livestock population sizes: pigs, cattle, sheep, poultry (Defra and others 2013); goats (Defra 2010b).

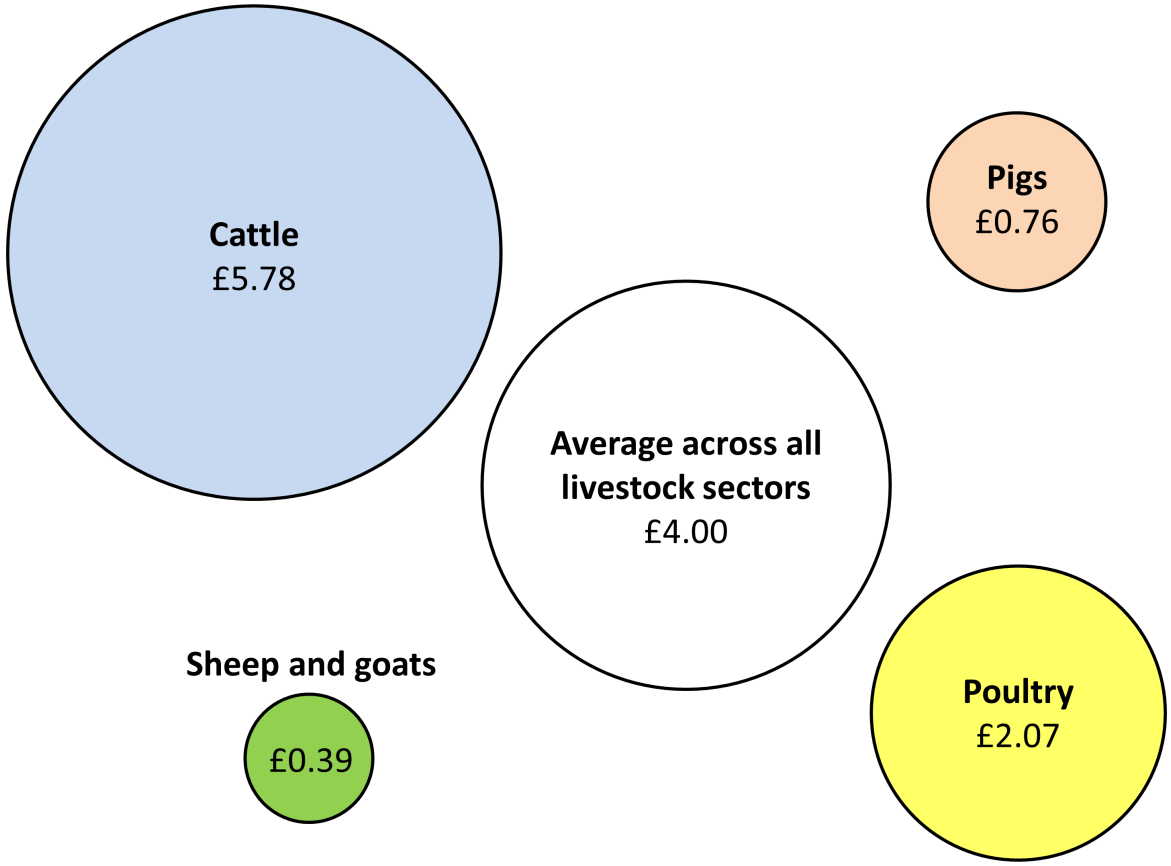

Figure 3. Distribution of surveillance expenditure across pig, poultry, small ruminant and cattle diseases in GB. The proportion of funding from the public and private sectors is shown overall for each species (at centre of each box, with total spend per species indicated) and for each disease separately. Coloured shading = public funding. Black shading = private funding. NK = not known. Areas of circles are proportional to amount spent on that disease. *Tuberculosis and antimicrobial resistance surveillance are not species specific and the funding indicated for these components is spread across several species. #Financial information on public sector spending on influenza and private sector spending on Salmonella surveillance was unavailable, and it is therefore expected that the total spend on poultry surveillance is likely to be higher than that shown.