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Evidence Project Final Report

Department for Environment Food & Rural Affairs

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Project identification

1. Defra Project code: AW1028

2. Project title:
   Identification of Ante- and Post-mortem inspection indicators of ruminant welfare and how they can be applied for welfare monitoring, audit and surveillance

3. Contractor organisation(s):
   University of Warwick
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4. Total Defra project costs (agreed fixed price): £ 365773

5. Project: start date 01/01/2014

   end date 31/12/2015

6. It is Defra's intention to publish this form.

   Please confirm your agreement to do so..... **YES** ☒ **NO** ☐

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   In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

   (b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

The objective for this research was to investigate whether abattoirs, where the majority of ruminants are slaughtered at end of life, are a place where welfare on farm of origin, market and in transit can be measured and if so, could it be used by farmers, for benchmarking prevalence of welfare nationally and to trigger welfare inspections by Defra.

It was agreed that the current rare and severe events recorded at abattoirs should continue to be recorded and would not be part of the data collection for the research because of the rarity of these events.

Measurable objective welfare indicators for six classes of ruminant, calves, prime cattle, cull dairy and beef cattle, lambs and ewes were developed from literature and compared with the five Freedoms. Objective definable welfare indicators were identified for all areas except freedom from prior thirst and fear and distress.

Stakeholders, including research scientists, veterinarians and farmers were asked to complete a questionnaire to consider the indicators identified and whether there were other indicators not proposed. There were no new indicators identified. Stakeholders were also asked who should collect such data in an abattoir and how it should be used. Meat hygiene inspectors were identified as the group already in abattoirs and so potentially able to collect these data. Abattoir owners stated that they did not have staff to collect new data and that it was not a priority for them to do more than currently obliged to do. In addition, some were concerned about data being used negatively to trigger farm inspections because of the relationship with their clients, others felt they managed poor welfare confidentially but rigorously with suppliers. All thought that the data were private, owned by the owner of the animal, and so could not be used by government.

Farmers and those in the farming industry were keen to receive more data from abattoirs to help inform on herd health decisions and stated that this was an under used potential resource. They were also interested in the idea of using data to benchmark welfare nationally. They were negative about such data triggering welfare inspections on farm.

From approximately 60 indicators for cattle and sheep pilot tested in 3 abattoirs, 11 were taken forward for the main study. These were low body condition, body cleanliness, skin irritation/parasites, fresh injury, healing injury, diarrhoea/dirty perineum, docked/broken tail (cattle only), mild or moderate lameness, severe lameness, respiratory distress, dull demeanour, eye condition, fleece condition (sheep only), wool pull (sheep only) and bruising (stick marks and other bruising separately).

There were 6500 cattle, 950 calves and 15000 sheep observed over 18 months. Animals originated from England, Scotland and Wales. The prevalence of most welfare indicators was <1%. The most prevalent welfare indicator was bruising (defined as any bruise >2cm in diameter), observed in >50% cattle and 10 - 15% calves and sheep. Lameness, injuries and poor body condition were the next most prevalent abnormalities (<3%) in cattle and sheep. Dull demeanour was present in 2.1% calves from collection centres.

In cattle, bruising was associated with increasing age, dairy breeds, lameness and poor body condition. Empirical observation by the research team linked this to very thin dairy cows ante-mortem and large, apparently deep, chronic bruises around the pelvis post-mortem. This condition has been reported in other countries and warrants further investigation in GB to reduce the occurrence of this injury, which is most likely to occur on farm.

A pilot study was designed and run to investigate the reliability and repeatability of training observers to detect and score bruises on cattle. This was run in a compliant, medium sized abattoir slaughtering prime beef cattle. Moderate agreement in scoring occurred between three observers (a research team member, meat hygiene inspector and abattoir employee) and further training would be necessary before scoring was sufficiently consistent to be repeatable and reliable. There was discussion about the minimum size of bruises that warranted further investigation with all three assessors only in agreement that bruises >16cm fell into this category.

The Food Standards Agency (FSA) receive data from the official veterinarians' (OV) ante-mortem inspection and from meat hygiene inspectors' (MHI) post mortem inspections. Data are returned by day and are coded for cattle by County Parish Holding (CPH) number since 2013 and for sheep by day without subclasses. In the abattoirs that participated in the current study MHI data were recorded electronically on the line, manually on the line, or by memory and then transferred onto paper at the start of a break. There is no validation or retraining of OVs or MHIs' scoring of abnormalities to ensure consistency and repeatability of scoring or recording which means that the uniformity of data within and between abattoirs is not known. This limits its use currently for individual farmers, benchmarking the national herd / flock, as an early warning for national welfare or health concerns, or to trigger Defra welfare inspections. Yet these data are the data required for these activities. The most efficient improvement in use of data from abattoirs would be to ensure objective definitions are used and that reliable, repeatable data are recorded by OVs and MHIs and returned to FSA.

Our research indicates that most animals presented for slaughter are generally in good welfare. This is good news for the industry and the high welfare standards in GB are reflected in this information. Whilst there are individual abattoirs where data recording is robust and returned to farmers in a timely way, the technology used in many abattoirs and the lack of calibration of scoring by FSA OVs and MHIs make current data insufficiently real-time and uniformly robust for use at a national level to monitor the population welfare of ruminants. Rare and severe events are important in abattoirs and these should be recorded by OVs and should trigger welfare inspections consistently, again re-training and calibration are necessary to give the industry confidence in this activity.

The levels of bruising detected are a concern and further work is needed both to define the size and location of bruises that should trigger investigation, and the age of bruises for likely origin of damage e.g. for those on the spine - where damage could occur on farm, at market or in transit. Bruising around the pelvis in adult dairy cattle warrants particular study so that guidelines can be given to minimise the occurrence of this chronic damage.

Results from this project indicate that further work to define the appropriate time to cull adults at the end of productive life is required to prevent unnecessary suffering from being very thin. Body condition of adult cattle can be assessed ante-mortem without handling cattle and very thin adult cattle should be recorded. Abattoirs are reluctant to handle sheep ante-mortem because of the risk of bruising and so thin adult sheep cannot be detected easily ante-mortem. There is currently no post-mortem assessment that detects very thin adult sheep, unless an animal is so emaciated that the carcase does not set.

In conclusion, there is a wealth of data from abattoirs that could potentially be used to monitor and improve welfare (including health) of ruminants. To be used nationally OVs and MHIs would need to be regularly retrained using objective definitions for abnormalities recorded and calibrated to ensure reliable and repeatable data were recorded. In addition, data recording at all abattoirs would need to be electronic and linked to farm of origin real time so that farmers can act on the data as received.

Most stakeholders were positive about the potential for data to be used directly by farmers to improve welfare and health in particular and for national bench marking but were negative about using the data to trigger welfare inspections, in particular there was concern about who owned the data and therefore the feasibility of its use by Defra.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the objectives as set out in the contract;
   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Exchange).

Objectives as set out in the contract

Objective 1. Identification of welfare indicators We will target six classes of animal at slaughter: calves, prime beef and finished lambs and cull suckler cows, cull dairy cattle, and cull ewes. We will use published indicators for measurement of welfare in ruminants on farm, ante-mortem and post-mortem to identify which indicators correlate with at least one of the five freedoms as an indicator of welfare.

Objective 2. Defra meetings and stakeholder engagement for aims of project and current practice Ideally, industry would self regulate on animal welfare and work together to improve welfare on farms through feedback and information to farmers, either directly from the abattoir or via quality assurance schemes. We aim to identify indicators that are most likely to be acceptable and adopted by industry or, if unacceptable, we understand why.

Objective 3. Development and testing of new welfare indicators We will work with our industry partners with abattoirs convenient to York / Warwick with each of the six classes of ruminant to facilitate testing of the newly designed indicators for animal welfare in both large and medium sized slaughter houses.

Objective 4. Summary of semi-structured interviews from stakeholders We will transcribe and summarise the semi-structured interviews to produce qualitative attitudes towards current and potential recording of welfare indicators at slaughter. We will use this to inform on Objective 5.

Objective 5. Estimating prevalence of welfare indicators The main aim of Objective 5 is to identify the prevalence of each welfare indicator by class of animal, geographical location and time of year to inform on its use to audit on farm and in transit welfare and regional or national surveillance.

Objective 6. Presentation of results to stakeholders We will revisit stakeholders, present results from the pilot testing and discuss a final list of indicators for each class of ruminant to determine acceptability and feasibility.

Objective 7. Summary of semi-structured interviews from stakeholders We will produce stakeholder attitudes towards the use of proposed welfare indicators for audit and surveillance.

Objective 8. Testing of novel welfare indicators in a commercial setting We will work with personnel from large and medium abattoirs to test the practicality and usefulness of the novel welfare indicators.

Objective 9. Reporting of project We will report back results to stakeholders at group meetings and complete the final report, papers for peer review publication and lay press articles. We will present the results at interested stakeholder professional meetings.

All the objectives were met

Objective 1. Identification of welfare indicators

A systematic review of peer-reviewed scientific literature was conducted on published material from January 1995 to 15 December 2012. Four search engines Sciencedirect, Web of Knowledge, Scopus and Pubmed were used and searched using the same search terms. The initial search gave 349 references for sheep and 1,259 for cattle. After excluding papers not written in English, duplicates and papers that did not include animal-based welfare indicators, 226 welfare indicators for sheep and 286 indicators for cattle were identified, many overlapped e.g. several types of techniques to measure locomotion score. Each indicator was classified according to the Five Freedoms (freedom from hunger and thirst, discomfort, pain, injury or disease, to behave normally and free from fear or distress). A paper was written on the

systematic review of sheep welfare indicators (Llonch et al., 2015). The indicators identified were carefully defined using measurable criteria and agreed after discussion with Defra. There were no welfare indicators identified for sheep to measure historical Freedom from thirst or fear and distress. Indicators for cattle and sheep will be made publically available together with a peer reviewed paper from the project.

Online Questionnaire

Although not in the original project plan, an online questionnaire was incorporated as a method to capture the views of stakeholders. The questionnaire was divided into three sections according to whether respondents were answering questions on sheep only, cattle only, or both sheep and cattle. Questions covered the abattoir as a place to assess animal welfare; current and potential uses of health and welfare data; the importance, percentage affected that would be of concern and likely origin of welfare insult (on-farm; at-market; in-transit; or don't know). All the welfare indicators and definitions were listed and respondents were asked to identify any other indicators that they thought were important. Stakeholders agreed with the list of rare and severe indicators currently used by FSA and considered the welfare indicators listed important. No new indicators were proposed. The online survey was run in January 2014.

Objectives 2 and 4. Defra meetings and stakeholder engagement for aims of project and current practice

A list of industry stakeholder groups was drawn up. Stakeholder groups and individual industry representatives were invited to participate in semi-structured interviews. The interviews were divided into 7 sections and covered: background information; thoughts on the aims of the WISER project; data collection, recording and reporting; uses of current health and welfare assessments at the abattoir, and the abattoir as a place to assess previous animal welfare. There were 4 face-to-face and 28 telephone interviews. A soft (i.e. the interviewee was guided through the interview without interrogation or pressure), semi-structured, unstandardized (i.e. consisted of open questions only) and focused approach was taken when the interviews were conducted. Interviews were recorded with consent from the interviewee using a small digital recording device (Olympus WS-811). Interviews lasted 30-60 minutes. Non-directive probes were used to encourage interviewees to expand short, partial or unclear responses (Sarantakos, 2005; Rubin and Rubin, 2005). Stakeholders were encouraged to talk freely, openly and honestly throughout and were told that their opinions were extremely valuable and important. Analysis was driven by the data and focused on comments relevant to the study. Coding began after the researcher had re-read all the transcripts and was familiar with the data. Concepts and themes were systematically identified, refined and elaborated from the transcripts using Nvivo 10 (QSR International). Comparisons were made within and between interviews to formulate a focused, rich and reasoned narrative of the research findings (Rubin and Rubin, 2005).

Stakeholders varied in their response to the idea of using abattoirs as a place to monitor animal welfare. Abattoir owners were concerned about data confidentiality and who owned data and whether it was legal to share data. Abattoir owners were also concerned about who would collect the data and the financial burden if extra staff from the abattoir were responsible for this. They also stated that if the abattoir were busy then extra activities such as monitoring welfare would not be possible and would be stopped. Farmers, and industry bodies for farmers, were also concerned about data confidentiality. Farmers were very keen to receive more information back from abattoirs than they currently received. They were particularly interested in disease data and considered that this would assist with health planning. Farmers defined poor welfare as neglected animals and were concerned that welfare data would be used negatively as a punishment rather than as information to help improve a farm situation. MHIs considered themselves the most qualified and independent staff to monitor welfare and record data. Some members of the FSA and Defra thought all farmers were currently receiving data from abattoirs as part of food chain information when this is highly variable by abattoir. Defra highlighted rare and severe welfare infringements that occurred in abattoirs that required e.g. immediate slaughter of an animal, as an area for concern.

Historic Food Standards Agency (FSA) data: prevalence of current welfare parameters
Historic FSA data recorded by OVs and MHIs and the total throughput for cattle and sheep in cross GB was requested from FSA from July 2012 to August 2013. The data were analysed to examine the prevalence of welfare indicators reported to FSA.

Objective 3. Pilot testing of indicators

Abattoir identification and participation
A list of potential abattoirs was compiled using information from the Association of Independent Meat Suppliers (AIMS) and other contacts. From this list, four abattoirs were contacted and visited, and of these three agreed to participate to pilot test all the welfare indicators. A description of the participating abattoirs is presented in Table 1.

Table 1: **Abattoirs used to pilot test indicators**

Size of abattoir	Location	Animal classes
Medium	England	Adult sheep; lambs; prime beef; cull dairy; cull suckler cattle and bobby calves
Medium	England	Adult sheep; lambs
Large	England	Prime beef; cull dairy cattle ; cull suckler cattle

Data recording
Initially data were recorded on custom-designed paper recording sheets. The feasibility of hand held electronic recording devices with bespoke software for recording welfare indicators was tested. This had benefits in terms of speed of recording and data upload and might assist in technology uptake by the industry. Each abattoir was visited by at least two trained personnel.

Development and testing of new welfare indicators
Using the results from Objective 1, 63 potential welfare indicators were tested in the abattoir for cattle and 59 for sheep. All welfare indicators for each animal class were refined and assessed for practicality by considering where in the abattoir they should be recorded and how they could be practically recorded. The within and between observer repeatability was calculated to identify their likely reliability during the pilot phase. Potential indicators were then reduced to 11-12 per animal class based on relevance to welfare, prevalence, feasibility, reliability, repeatability and acceptability to stakeholders and Defra (Table 2).

Table 2: Final list of welfare indicators agreed by stakeholders

Indicator	Cattle (Beef & Dairy)	Sheep (Adults & Lambs)	Calves (< 4 wks. old)
Low body condition	X		
Poor body cleanliness /dirty	X	X	X
Skin irritation /parasites	X	X	X
Fresh injury	X	X	X
Healing injury	X	X	X
Diarrhoea/ dirty perineum	X	X	X
Broken /docked tail	X		
Mild or moderate lameness	X	X	X
Severe lameness	X	X	X
Respiratory distress	X	X	X
Dull demeanour	X	X	X
Eye abnormality		X	
Fleece condition		X	
Bruising	X	X	X
Stick marks	X		X
Wool pull bruise		X	

Objective 5: Estimating the national prevalence of welfare indicators at abattoirs

Materials and methods
Abattoir selection

Study personnel drew up a list of abattoirs using industry knowledge; 43 abattoirs were selected based on animal class (calves, prime cattle, cull dairy cattle, cull beef cattle, lamb, cull sheep), geographical location (England, Wales and Scotland) and size (medium or large based on throughput data provided by FSA). Abattoirs were contacted by telephone, where possible to a named contact. The British Meat Processors Association (BMPA) and Association of Independent Meat Suppliers (AIMS) also sent a letter of support and invitation to participate to its members.

Abattoirs interested in participating were sent information by email with a follow-up telephone call approximately two weeks later. Following agreement to take part in principle by 15 abattoirs, a visit was arranged to check suitability and answer questions. Confidentiality agreements were provided. Recruitment took over ten months and was on-going whilst data were collected.

Data collection

Cattle data were collected at 27 visits to 8 abattoirs (February 2014 – February 2015). There were 3 visits to 1 abattoir to collect calf data (February – March 2014). Sheep data were collected from 5 abattoirs visited on 14 occasions (February 2014 – April 2015).

Ante-mortem, adult cattle assessments were performed from outside the pen / race and cattle were viewed when standing and moving. For sheep, an observer entered the pen and slowly and systematically assessed animals, whilst standing and moving, for the presence of welfare indicators.

Post-mortem, cattle and sheep were observed by one researcher standing on the line after hides were removed and before the carcase was trimmed.

For all classes, where an animal had the same condition on multiple sites e.g. fresh injury, this was recorded only once (i.e. occurrence not the number of times an indicator was present in same animal was recorded). In addition, time, CPH number, farm/market (origin of animals), classification (e.g. adults/hogs/lambs), number in the batch (defined as a group of animals that arrived at the abattoir from a farmer, market or supplier), ear tag number (cattle only), pen ID, numeric order of slaughter and bruises and stick marks were collected.

Data requested from the abattoirs for sheep and cattle on the day of slaughter included copies of 'kill sheets', FSA ante- and post-mortem inspection results collected by OVs and MHIs, weight and grade, and CPH numbers of suppliers. For cattle, ear tag number, breed, sex and age were also recorded. This was not always available on the visit day and some information was sent to the University by the abattoirs at a later date.

Data analysis

Ante- and post- mortem and abattoir data were matched for individual cattle using ear tag number and CPH. Discrepancies were checked manually. Records were excluded where it was not possible to match data. Matching errors occurred when the order of animals slaughtered was inconsistent with the list supplied and when data were missing. Sheep data were matched at pen level ante-mortem and by day post-mortem; it was not possible to link FSA or abattoir data to batches of sheep.

The percentage, population corrected 95% confidence interval (CI) and range of welfare indicators per day / batch / CPH were calculated by class of animal. A three level mixed effect binary logistic regression model to account for clustering at abattoir (level 1), batch (level 2) and individual inspection (level 3) was built to investigate factors associated with bruising in cattle.

Results

Cattle

The number of cattle observed ranged from 4 - 1831 per abattoir; two of the eight abattoirs provided 51.7% of the data. There were 6490 cattle examined in 951 batches ranging from 1 - 57 cattle per batch. Animals from a total of 732 holdings (CPH) throughout GB were observed. There were data on holding and supplier missing from 791 and 1845 cattle respectively. Cattle came from England 3861 (59%), Scotland, 821 (13%) and Wales 1009 (16%). The origin of 12% of cattle was not known.

Prevalence of ante-mortem indicators

The frequency of ante-mortem indicators of poor welfare is presented in Table 3. The most prevalent indicators were fresh and healing injuries (4.3%), poor body condition (4.2%), mild and severe lameness (2.4%) and dirty (2.2%). These conditions increased with increasing age and were more common in female dairy cattle (Table 3).

Table 3: Frequency and percentage (%) of ante-mortem indicators in 6490 cattle, by sex and type

Indicators	Sex - Number (%)		Type - Number (%)		Total - Number (%)
	Male	Female	Beef	Dairy	
Low body condition	3 (0.1)	270 (7.3)	45 (1.2)	225 (8.6)	273 (4.2)
Poor body cleanliness	37 (1.3)	104 (2.8)	100 (2.6)	37 (1.4)	141 (2.2)
Skin irritation/parasites	20 (0.7)	44 (1.2)	37 (1.0)	27 (1.0)	64 (1.0)
Injury (fresh)	45 (1.6)	76 (2.0)	40 (1.0)	81 (3.1)	121 (1.9)
Injury (healing)	14 (0.5)	144 (3.9)	38 (1.0)	119 (4.5)	158 (2.4)
Diarrhoea /dirty perineum	18 (0.6)	12 (0.3)	21 (0.5)	9 (0.3)	30 (0.5)
Broken /docked tail	2 (0.1)	4 (0.1)	2 (0.1)	4 (0.2)	6 (0.1)
Lameness (mild/moderate)	15 (0.5)	89 (2.4)	23 (0.6)	80 (3.1)	104 (1.6)
Lameness (severe)	4 (0.1)	35 (0.9)	14 (0.4)	25 (1.0)	39 (0.6)
Respiratory distress	-	5 (0.1)	3 (0.1)	2 (0.1)	5 (0.1)
Dull demeanour	-	5 (0.1)	-	5 (0.2)	5 (0.1)

Batch-level prevalence of welfare indicators

The minimum number of cattle per batch with each welfare indicator was zero (Table 4). The median was also zero for all indicators except bruising. The maximum number per batch reached as high as 100% for some indicators, although typically when batch sizes were small. All cattle in a single batch of 32 were in poor body condition and dirty when examined (Table 4); this event was not recorded in the FSA report.

Table 4: Summary of ante and post mortem indicators within cattle batches (total 951 batches)

	Number animals affected	Number (%) batches ≥ 1 affected	Maximum number (%)/ affected in a batch	Min	Median	Mean
Ante-mortem indicators						
Low body condition	273	112 (11.8)	32 (100)	0	0	0.29
Poor body cleanliness	141	67 (7.0)	32 (100)	0	0	0.15
Skin irritation /parasites	64	46 (4.8)	3	0	0	0.07
Injury (fresh)	121	93 (9.8)	5 (12)	0	0	0.13
Injury (healing)	158	105 (11.0)	6 (46)	0	0	0.17
Diarrhoea /dirty perineum	30	20 (2.1)	4	0	0	0.03
Broken /docked tail	6	6 (0.6)	1	0	0	0.01
Lameness (mild/moderate)	104	86 (9.0)	5 (83)	0	0	0.11
Lameness (severe)	39	39 (4.1)	2 (100)	0	0	0.04
Respiratory distress	5	5 (0.5)	1	0	0	0.01
Dull demeanour	5	5 (0.5)	1	0	0	0.01
Post-mortem indicators						
Bruising	4060*	802* (90.1)	41 (98)	0	3	4.56*
Stick marks	150*	89* (10.0)	9 (20)	0	0	0.17*
Total cattle	6490	-	57	1	4	6.82

*890 batches after removing batches with ≥15% missing data, causes an increase of 2% and a decrease of 0.6% difference in prevalence in bruising and stick marks respectively.

Most CPH numbers corresponded to agricultural holdings according to the RADAR database (Table 5). Bruising was the most prevalent indicator in cattle originating from agricultural holdings with 3786 (69.4%) adult cattle having bruises. Cattle that came from collection centres had the highest proportion of bruising (90.9%), followed by markets (82%), while landless keepers had the lowest proportion (58.3%).

Table 5: Frequency and proportion of welfare indicators in cattle by type of premises (determined from County Parish Holding number)

	Type of premises					
	Agricultural Holding	Calf Collection Centre	Landless Keeper	Market	Unknown	Total
Number of						
CPH location matches	638	1	9	12	41	701
Cattle sampled	5162	11	72	90	357	5692
Number (%) of cattle with						
Bruising*	3393 (68.6)	10 (90.9)	42 (58.3)	73 (82.0)	268 (79.3)	3786 (69.4)
Mild or moderate lameness	82 (1.6)	0 (0)	1 (1.4)	2 (2.2)	10 (2.8)	95 (1.7)
Severe lameness	29 (0.6)	0 (0)	1 (1.4)	0 (0)	5 (1.4)	35 (0.6)
Low body condition	200 (3.9)	0 (0)	3 (4.2)	2 (2.2)	28 (7.8)	233 (4.1)
Poor body cleanliness	79 (1.5)	1 (9.1)	3 (4.2)	3 (3.3)	14 (3.9)	100 (1.8)
Fresh injury	102 (2.0)	0 (0)	1 (1.4)	2 (2.2)	8 (2.4)	113 (2.0)
Healing injury	118 (2.3)	2 (18.2)	0 (0)	6 (6.7)	7 (2.0)	133 (2.3)

* Denominator 5456 records

Bruising and stick marks

Bruising was common across all types and ages of cattle. It was present in 77.9% female cattle and 57.3% male cattle. Bruising was more common in dairy (83.5%) than beef cattle (59.1%). Stick marks (linear bruises; Strappini et al, 2012) were less common. They were present on 2.4% and 2.6% of male and female cattle respectively and 3.4% and 2.0% of dairy and beef cattle respectively.

Factors associated with increased risk of bruising (excluding stick marks) were increasing age, female cattle, dairy breeds, evidence of fresh injury, poor conformation class (P in the EUROP system) and thin and fat cattle (1,2,4,5 versus 3 in 1 - 5 EUROP fat classification system)(Table 6).

Table 6: Mixed effects binary logistic regression model for the presence of bruising in 6490 adult cattle

	Number	Percentage[†]	Odds ratio	95% CI
Age				
≤ 18 months	609	9.4	1[‡]	
19-35 months	3410	52.5	2.35	1.80-3.08
≥ 36 months	2465	38.0	4.69	3.36-6.54
Type				
Beef	3842	59.2	1	
Dairy	2623	40.4	2.37	1.90-2.94
Sex				
Male	2779	42.8	1	
Female	3711	57.2	1.32	1.11-1.58
Fresh Injury				
Absent	6369	98.1	1	
Present	121	1.9	3.24	1.62-6.48
Fat Class				
1 – very lean	561	8.6	0.33	0.23-0.50
2	874	13.5	0.63	0.49-0.80
3	1750	27.0	1	
4	3192	49.2	0.75	0.30-0.66
5 – very fat	111	1.7	0.39	0.37-0.73
Conformation Class				
E - excellent	23	0.4	0.27	0.09-0.81
U	621	9.6	0.34	0.22-0.52
R	1687	26.0	0.45	0.30-0.66
O	2842	43.8	0.52	0.37-0.73
P - poor	1315	20.3	1	

[†]Category information missing where summed categories do not total 100% (6490 cattle)

[‡]Baseline reference value, OR = 1, where 95% confidence interval (CI) does not include 1 there is a significant difference between the category and the baseline.

Calves

There were 952 calves observed. The most prevalent indicators were dirty perineum 2.4% (CI: 1.4-3.4), dirty 2.1% (CI: 1.1-3.1) and dull demeanour 1.7% (CI: 0.8-2.6). Dull demeanour was only seen in calves from the collection centre/dealer where the prevalence was 2.1% (CI: 1.0-3.2). Calves transported directly from farms to the abattoir had a higher prevalence of dirty perineum 3.5% (CI: 0.5-6.5) than calves from the collection centre/dealer cohort 2.2% (CI: 1.1-3.3). The prevalence of bruising was 14% (950 calves observed post mortem).

Sheep

There were discrepancies in the number of animals slaughtered by date, between abattoir, FSA, and WISER teams. The ante-mortem indicators with the highest prevalence were dirty fleece (1.6%), diarrhoea/dirty perineum (1.5%) and mild (1.1%) and moderate (1.1%) lameness (Table 7). The prevalence of bruising was 8.5% (CI: 8.0-8.9) across all animals. It varied by day from 0.4% (CI: 0.1-0.7) to 24.3% (CI: 20.2-29.6) (Table 8). Overall 146/15425 carcases were recorded with wool pull, prevalence 0.01% (CI: 0-0.4), it ranged from 0 to 6.1% (CI: 3.8-8.3) per day. At batch level, lameness was the most prevalent lesion, with 45% of batches having at least one lame sheep (Table 9).

Table 7: Frequency and percentage (%) of ante-mortem indicators in 18084 sheep

Indicator	Number	%	Median	Min	Max	Mean
Dirty fleece	295	1.6	1	0	151	21
Diarrhoea /dirty perineum	266	1.5	8	0	76	19
Lameness mild	204	1.1	9	0	33	15
Lameness moderate	193	1.1	9	1	47	14
Fleece loss partial	117	0.6	4	0	47	8
Lameness severe	79	0.4	1	0	43	6
Injuries healing	29	0.2	0	0	12	2
Respiratory distress	23	0.1	0	0	14	2
Fleece loss full	18	0.1	0	0	9	1
Eyes ulcerated	14	0.1	1	0	5	1
Skin irritation /parasites	14	0.1	0	0	10	1
Eyes blind	13	0.1	0	0	6	1
Dull demeanour	11	0.1	0	0	4	1
Fleece shorn cold	10	0.1	0	0	5	1
Injuries fresh	6	0	0	0	2	0
Fleece excessive	0	0	0	0	0	0
Total	18084		917	190	4261	1292

Table 8. Frequency and percentage (%) of bruising and wool pull by date with 95% confidence interval (CI)

Abattoir	Kill date	Carcases observed	Total bruised	Bruised % (CI)	Total wool pull	Wool pull % (CI)
A1	27/02/2014	328	55	16.8 (12.7-20.8)	0	0
A2	11/03/2014	1721	165	9.6 (8.2-11.0)	46	2.7 (1.9-3.4)
A1	19/03/2014	428	104	24.3 (20.2-28.4)	26	6.1(3.8-8.3)
A1	20/03/2014	229	55	24.0 (18.5-29.6)	5	2.2 (0.3-4.1)
A3	30/05/2014	3272	452	13.8 (12.6-15.0)	5	0.2 (0-0.3)
A7	13/08/2014	1829	103	5.6 (4.6-6.7)	17	0.9 (0.5-1.4)
A7	21/11/2014	1641	7	0.4 (0.1-0.7)	2	0.1 (0-0.3)
A3	16/01/2015	2024	102	5.0 (4.1-6.0)	18	0.9 (0.5-1.3)
A2	21/01/2015	1158	63	5.4 (4.1-6.7)	0	0
A7	13/02/2015	1231	68	5.5 (4.2-6.8)	4	0.3 (0-0.6)
A10	19/02/2015	581	43	7.4 (5.3-9.5)	6	1.0 (0.2-1.9)
A10	20/02/2015	366	40	10.9 (7.7-14.1)	8	2.2 (0.7-3.7)
A10	16/04/2015	212	21	9.9 (5.9-13.9)	1	0.5 (0-1.4)
A10	17/04/2015	405	31	7.7 (5.1-10.2)	8	2.0 (0.6-3.3)
Total observations		15425	1309	8.5 (8.0-8.9)	146	0.01 (0-0.04)
Median		869.5	59	8.6	5	0.9
Min		212	7	0.4	0	0
Max		3272	452	24.3	46	6.1
Mean		1101.8	93.5	10.5	10.4	1.4

Table 9. Number of ante mortem indicators in 15,980 sheep and number (and percentage) of batches with at least one condition recorded

Indicators	Number of sheep	Number (%) batches with at least 1 sheep with indicator	Median	Min	Max
Dirty Fleece	295	35 (14.1)	0	0	73
Diarrhoea /Dirty perineum	266	73 (29.3)	0	0	31
Lameness mild	204	112 (45.0)	0	0	11
Lameness moderate	166	83 (33.3)	0	0	7
Fleece partial	115	40 (16.1)	0	0	18
Lameness severe	78	40 (16.1)	0	0	9
Injuries healing	29	14 (5.6)	0	0	9
Respiratory distress	23	16 (6.4)	0	0	3
Fleece full	18	12 (4.8)	0	0	3
Eyes ulcerated	14	10 (4.0)	0	0	3
Skin irritation /parasites	14	10 (4.0)	0	0	3
Eyes blind	13	10 (4.0)	0	0	2
Dull demeanour	11	8 (3.2)	0	0	2
Fleece shorn cold	10	6 (2.4)	0	0	5
Injuries fresh	6	6 (2.4)	0	0	1
Fleece excessive	0	0	0	0	0
Total sheep	15980		40	1	525

Food Standards Agency data

MHIs varied in how they recorded data. In some abattoirs an electronic system was used, others used a clicker counter and in some MHIs remembered the number of abnormalities and recorded this on paper when they took a break from the line.

In FSA records, lameness and respiratory problems were the most frequently reported indicators during ante-mortem inspections in sheep, 129 and 72 times respectively across all slaughter dates. The research group recorded more lameness and eye conditions and fewer respiratory problems in sheep in comparison to the FSA. FSA did not record numbers of dirty animals. There were 1480 offal or carcases recorded contaminated, 1013 had *Cysticercus tenuicollis*, 612 had liver fluke (fascioliasis) and 667 had pleurisy or pneumonia. There were 98 partial carcase rejections due to trauma (mostly bruising). FSA conditions are not presented for cattle records as these were not always available from the abattoirs or in a format that could be matched to our records.

Historic FSA data

The FSA data for sheep is recorded as a daily total. In addition, lambs and ewes are not distinguished. The cattle data consisted of one year of data and only a small percentage of the data matched to farm locations. The historic data recorded low prevalence of welfare indicators but were considered unreliable and not sufficiently high enough quality to analyse because the data matching is unlikely to represent the farms in the UK. These data would therefore not currently be sufficiently reliable to be used to trigger on farm inspections by Defra. It was not possible to compare the research data by class of animal with FSA data.

Discussion

Collection and representativeness of abattoir data

There was some difficulty enrolling abattoirs into the study. Abattoirs declined to take part for several reasons including, having too few staff to accompany researchers on visits, lack of insurance to cover visitors, belief that the line speed would be too fast for researchers to collect data, insufficient space on the line, concern about animal activists gaining access to the plant and lack of interest in the project aims. The abattoirs that did participate were asked to receive two visits from the research team, some abattoirs accepted more than two visits; they were overall compliant with the study, although one abattoir did not provide some data on kill sheets. Initially data collection was planned in spring and autumn to test whether recent management at pasture or housing was associated with different welfare indicators. Because of the low rate of recruitment of abattoirs this was not possible and we visited abattoirs whenever possible to ensure we collected data in a timely way. Abattoirs in the study did take animals

originating from England, Wales and Scotland and the numbers observed are relatively proportionate to the numbers produced by each country.

Quality of currently collected data

Anecdotal observation of the ante-mortem inspection by OVs indicated that this was variable with some animals with severe issues not recorded. Data currently collected by MHIs varies in ability to link it to particular groups / individuals and in likely precision when memory is used; particularly given the number of types of abnormality (>200) that can be recorded. In addition, repeatability and reliability of data recorded is likely to be variable given that MHIs do not regularly retrain to a common standard.

Tracing animals to farm of origin

Sheep arrived at abattoirs in batches directly from farm or via market. They tended to be kept in the batch of origin until slaughter, however, some abattoirs sorted sheep before slaughter (e.g. by size or age) and so batches could not be linked before and after slaughter. In addition, changes from one batch to the next were not physically recorded on the line and abattoirs identified this at the end of the day by lining up batch size and kill number (the consecutive number of animals killed that day or week). The MHIs collected data on sheep by day, not batch, and did not differentiate lambs from ewes. As a consequence data vary between abattoirs and many abattoirs cannot currently report data by farm of origin.

Cattle arrived in batches from farm of origin, market or collection centre. Ear tag number was recorded by the abattoir and linked to the kill number (order in which cattle are slaughtered over a day / week). It was not possible to record ear tag numbers directly because of the speed of the line. We were dependent on abattoirs sending us a list linking kill number and CPH ear tag number. One abattoir that participated in the study did not provide this list after the visits. The current system to record cattle, the British Cattle Movement Scheme, is dependent on manual data entry from cattle movement records. The electronic database is approximately 6 months in arrears and so cannot be used to establish e.g. age, breed, type of animal in real time. In addition, farms, markets and collection centres are not always clearly distinguishable by their CPH.

As a result, analysing data on prevalence of welfare indicators by farm of origin, market or collection centre was not possible at all for sheep and only possible for some cattle where their last known location on BCMS could be traced. For abattoirs to be used to monitor animal welfare on farm of origin, market or collection centre in GB, the system linking ruminants to their farm of origin needs considerable improvement in abattoirs and animal movements. This includes real time electronic recording of both the animal's previous locations and the data recorded in abattoirs.

Overall prevalence of welfare indicators

Overall, the prevalence of most animal-based welfare indicators was low and mild. This is very good information for the industry because it highlights that most animals presented at abattoirs are in good welfare. There were some exceptions and these are discussed below.

Associations between welfare indicator prevalence and age of animal

Abnormal conditions were more prevalent in dairy than in beef cattle and least common in young calves. The difference in prevalence in abnormalities by age is expected, partly because with increasing age the risk of abnormalities increases but also because there are two main types of animal, those bred for meat and those slaughtered at the end of a productive life. This might indicate that a cut-off for acceptable / unacceptable welfare indicators might be different between the two groups of stock, however, adult animals need to be culled before their welfare is compromised as seen in the group of thin, lame, bruised cull dairy cows. This is discussed later.

More prevalent welfare indicators

The most common conditions in adult cattle were lameness, poor body condition, injuries and bruising. These occurred in approximately 10% of batches (typically from several CPHs) and with a prevalence of <3%. It indicates that using abattoirs to monitor welfare would be very challenging because very large numbers of animals per farm would need to be inspected to determine the true prevalence of welfare

conditions before any use could be made of the data. Whilst over time accumulation of these data would be possible, it relies on linking data from abattoirs efficiently to individual farms and (as above) this is not currently possible in many abattoirs. Inspection of farms could then be done but would be based on retrospective data and an inspection might fail to detect a link between retrospective poor welfare and current farm conditions. A high prevalence of a severe welfare infringement should already be detected through the food chain information system and ante-mortem inspection by OVs. In our study the quality of this recording varied by abattoir; future work on the reliability and repeatability of these observations would be beneficial to the industry.

Bruising

One welfare indicator was highly prevalent. Bruising (a bruise was defined as >2 cm in diameter) in adult cattle was common, with 90% of batches having at least one bruised animal and 69% of animals bruised (males 57%, females 78%). This is consistent with studies in other countries (e.g. Strappini 2013; da Silva Frasão et al 2014). Bruising results from trauma and is therefore directly linked to welfare.

Of key importance, and not previously identified in GB before the current study, was the association with bruising, lameness and poor body condition in cull dairy cows, this relationship has been reported elsewhere (e.g. Strappini et al 2010; Hoffman & Lühl 2012). Although the current study did not record location of bruises, the researchers noted that the majority of bruising was over the pelvis ('pin' and 'hook' bones) and that lesions were typically large and apparently chronic and severe. It does suggest that these animals were not coping with their environment and there is a concern about their welfare on the farm of origin. In a study in Chile, Strappini et al (2013), reported that bruises around the pin bone observed at slaughter were more likely to occur on farm of origin.

Bruising was more common in cattle that came from collection centres and markets compared with those coming directly from farms. The link between markets and bruising has also been reported previously (Jarvis et al 1995; Hoffman et al 1998; Strappini et al 2010; Strappini et al 2012). Bruising can also occur during transport (da Silva Frasão et al 2014) and in the abattoir. In a study in Chile, Strappini et al (2013) reported that most bruises in 52 cull dairy cows occurred as a result of falls, the stunning box, animal interactions in the lairage, and human-animal interactions during loading and unloading at the abattoir. Management of ruminants ante-mortem at the abattoir was not part of the current study but this would need further investigation to identify where bruises are arising from.

Bruising was also the most prevalent welfare indicator in calves (14%) and sheep (8.5%).

Objectives 6 and 7 Acceptability of bruising as a welfare indicator

From the results it was evident that bruising was prevalent in cattle and sheep and of sufficient importance to be developed as a novel welfare indicator. In addition to the welfare implications, there is a financial incentive to producers / the industry to reduce the incidence of bruising. Bruises are trimmed from carcasses reducing their weight and value; either farmers or abattoirs are impacted by this reduced value, depending on who owns the carcase at the time of slaughter. Using a welfare indicator with clear financial implications should lead to industry buy-in, although most producers will be unaware of the magnitude of bruising because this information is currently rarely provided by the abattoir or FSA.

The 30 interviewees contacted under objective 2 were contacted again and the proposal that bruising should be considered as a welfare indicator to test in abattoirs was discussed. All stakeholders accepted that it was important for welfare and that its economic concern made it an attractive indicator to test.

To trace back the likely origin of bruising that leads to trimming or condemnation of carcasses, the location needs to be recorded. This was pilot tested in cattle in Objective 8. Whilst also important for sheep, the trial was not extended to sheep at this stage because of the difficulty in recruiting abattoirs and the current inability to link sheep to farm of origin.

Objective 8. Testing of the novel welfare indicator, in GB, bruising in cattle in a commercial setting

Industry trial of a new bruising scoring system in cattle

From the results of the prevalence study bruising was common, there is a financial cost and it is considered of welfare importance, and so bruising was developed as a novel welfare indicator. In addition, bruising was associated with other welfare concerns, including poor body condition and lameness, indicating a group of cattle in poor welfare.

The aims of the trial were to design a novel system to score bruising and to investigate its repeatability and reliability when used by industry personnel. In addition, opinions on the ease of use of the scoring system, the approach to training, where on the slaughter line bruising could be recorded, and who would be best placed to do the scoring were obtained from those in the trial.

Materials and methods

Bruising was defined as injury to underlying soft tissues characterised by ruptured blood vessels and discolouration. Bruises with an area greater than 2cm diameter (in any direction) were recorded.
Bruises were categorised by size (surface diameter 2-8 cm, >8-16 cm, >16 cm), however, unlike Anderson and Horder (1979) the depth of bruises was not recorded. If the bruise had an irregular shape the size was recorded as the longest length. Stick mark bruises were recorded separately as present or absent. Bruises caused by tightening of the shackle chain around the hock joint during hoisting and superficial bruising (reddening of the fat without affecting the underlying tissues or 'fire' bruise) were excluded.

The Australian carcase bruising scoring system (Anderson and Horder, 1979) was adapted for use in this trial. The carcase was categorised into five locations (Figure 1)

- Hindquarter – the area above a line taken from approximately 50 mm above the last sacral (spinal) vertebrae to the flank lymph node, including the pin bone (ischium) but not the shackling region
- Rump and loin – below the hindquarter but above a line between the 10th and 11th ribs, including the hip bone (ilium), but not including the spine
- Rib – below the loin area but above a line between the 4th and 5th ribs, not including the spine
- Forequarter – the area below the 4th and 5th ribs but above the 5th cervical vertebrae, not including the spine
- Spine – along the spine of the animal from the neck to the transverse processes

The location and size of bruises was recorded using symbols placed on diagrams of the carcase (Appendix C).

Carcase assessment started at the rear hindquarter (A in Figure 1) on the first half carcase, worked down through the other locations and this was then repeated on the second side of the carcase. Pilot testing of the scoring system indicated that it would take approximately 6 to 10 seconds to assess an unbruised carcase and 20 - 30 seconds to assess a bruised carcase.

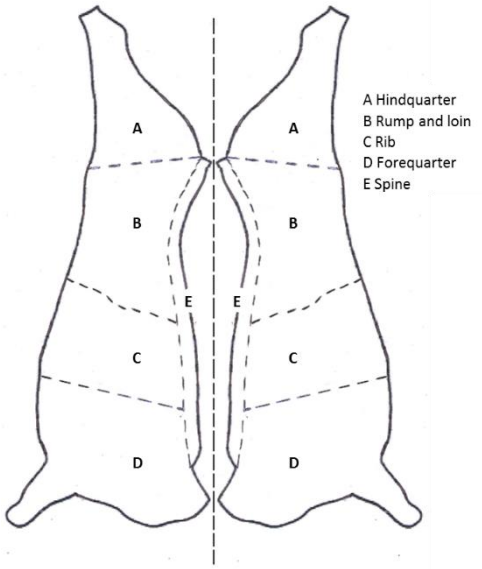

Figure 1. Locations on carcases where bruising was recorded

The trial

The trial took place on the 8th and 14th of July 2015 at a medium-sized abattoir with an estimated daily throughput of 100 cattle (28,000 per annum). The MHI and production line manager signed a consent form for participation. All data were collected and stored confidentially and reported anonymously.

Day 1 – training

Observers were a research team member (observer 1), a meat hygiene inspector (MHI) (observer 2) and a line manager from the abattoir (observer 3). Training on the scoring system was delivered by Miriam Parker from Livestockwise Ltd. and project personnel.

There was 30 minutes of classroom training when observers were given a plan for the two trial days and a brief background to the project, including the reason for the trial and for selecting bruising as the welfare indicator to score. Definitions of bruising and stick marks, bruises excluded, categorisations of sizes of bruises, and an example recording sheet with symbols used to score the bruises (Appendix A) were presented. Photographs, sourced from Carmen Gallo (Universidad Austral de Chile), illustrating a variety of sizes, shapes and locations of bruises were used to demonstrate how to score bruises and to help scorers distinguish between bruises of interest and fire bruises. A transparent polycarbonate square marked with concentric circles of 2cm, 8cm and 16cm diameter was provided. A demonstration was given to show how this could be used to help estimate the size of bruises without touching the carcase.

Following the classroom demonstration, a suitable location in the abattoir was chosen where the observers could see carcases clearly, whilst not interfering with abattoir operations. A demonstration of scoring carcases for bruising on the production line was given and then each observer assessed the same 32 carcases on the line. Observers used paper recording sheets, a clipboard, food industry approved insoluble ink pens and the polycarbonate sheet. At the end of the scoring the assessors discussed the 32 carcases scores for bruises and locations.

Day 2 – data collection

Before data collection began the observers reviewed the scoring system again. They then assessed and recorded bruises on 90 carcasses. After scoring, the MHI and line manager were asked for feedback on the ease of use of the system, the delivery of training, where on the line scoring would be best done and by whom.

Scores were summarised by location and size of bruises. Agreement between observers was assessed using Cohen's kappa.

Results

The cattle observed were all prime beef cattle. Of the 90 carcasses assessed, observer 1, 2 and 3 recorded 36, 43 and 41 carcases as bruised. Agreement was moderate to substantial with agreement between observers 1 and 2, 83.3%, Cohen's K = 0.66, 95% CI 0.51-0.82; observers 1 and 3, 81.1%, K = 0.62, 95% CI 0.59-0.64; and observers 2 and 3, 82.2%, K = 0.64, 95% CI 0.48-0.80). All three observers agreed that 29 carcases were bruised (32%) and that 37 were not bruised (41%). Of the remaining 24 carcases (27%), any two of the three observers recorded bruises on nine carcases (10%), whilst only one of three observers recorded a bruise on 15 carcases (17%).

Table 10. Number of bruises by location and size for three observers of 90 carcases

	Observer		
	1	2	3
Location of bruise			
Rib	4 (1)	0	1 (1)
Spine	27 (2)	57	31 (4)
Hindquarter	9	9 (1)	9
Forequarter	6 (1)	8 (1)	6
Rump & loin	2 (2)	9 (5)	5 (3)
Size of bruise			
2-8 cm	29	53	35
>8-16cm	12	22	8
>16cm	7	8	9
Total number of bruises	48	83	52
Carcases with bruises	36	43	41

Observers differed in the number of bruises recorded by location and size (Table 10). There were 7 – 9 severe bruises (>16cm) recorded by observers; 4 severe bruises on 4 carcases were recorded by all three observers and in 2/4 of these the location was consistent. Observer 2 reported a greater number of bruises 2 – 8 cm, and more bruises over the spine, than both observers 1 and 3. Where only one of three observers recorded a bruise (15 carcases), no bruises were categorised as >16 cm.

Generally there were few bruises to areas other than the spine and too few to analyse location precision statistically.

Feedback from meat hygiene inspector and production line manager

The two participants considered that MHIs were the most logical personnel to record bruising due to their experience in carcase assessments. It was suggested that scoring may require a full time employee for abattoirs with a fast production line otherwise there may be issues with reliability. Concerns were raised about who would own the data and how it would be used. Assessors were concerned that use of data as a law enforcement (e.g. used to prosecute farms, or lead to follow-up investigations) would be negative to the industry and would not promote private regulation of animal welfare. They recognised the benefit of scoring bruises > 16cm diameter and that this warranted follow up investigation of affected carcases. Also if a batch of animals had a distinctive pattern of bruising then this may justify investigation to determine the cause. There was no agreement on smaller bruises and whether they required further investigation. The observers asked why the age of bruises was not recorded; there is currently no reliable scoring system to categorise this (Strappini et al 2012b). The participants felt that the results should ideally be given back to farmers to incentivise them to improve the quality and welfare of their stock. Feedback to farmers was considered important to educate them about the reasons for trimming.

Discussion

Between 40% and 48% of carcases had at least one bruise, with up to 11% having at least one severe bruise. Agreement was moderate to substantial in whether the carcase was bruised or not, and there was variation between observers in the number of bruises and size of bruises, particularly distinguishing between those 2-8 cm and 8-16 cm in diameter. Using a similar scoring system, Strappini et al (2012b) found slight agreement between observers in the number of bruises per location and only moderate agreement for bruise size. Those authors concluded that further training would be required to improve precision and repeatability, this is also our conclusion for the present study; currently agreement is not

sufficiently high to give confidence in the method which would be essential for industry co-operation. It does highlight that there is currently no regular retraining of MHI for any abnormalities observed and this is a concern for consistency of data recorded by MHI if it is used to inform farmers, abattoirs, or a third party about abnormalities observed in animals at slaughter.

The prevalence of bruising was less than in the prevalence study (78% and 58% in female and male cattle) but still relatively high. This probably because the animals were beef rather than a combination of beef and dairy animals.

Further development of the scoring system and testing in more abattoirs is required. The line speed was relatively slow in the abattoir where the pilot study was done and it would be important to test the feasibility of recording bruising in abattoirs with a faster line speed, greater throughput and a greater proportion of bruised carcases (e.g. including dairy cattle). Anderson and Horder (1979) estimated that an experienced assessor could score 40-50 carcasses per hour depending on the speed of the line and the number of bruises (although this did include measures of bruise depth). To ensure that data collection is accurate and reliable industry cooperation will be essential. Other practical requirements are listed below:

- Improvements to training materials, in particular, producing a set of photographs showing the variety of types, size and shapes of bruising seen in abattoirs on carcases of different ages and quality.
- Depending on the level of detail to be recorded, using a paper-based system is inefficient. An electronic recording system would be more effective and efficient and would enable faster collation of results and timely feedback.
- Clear industry approved definitions of bruises to be included or excluded are needed, e.g. omitting superficial fire bruises, minimum size of bruise that is important.
- Agreement on how training would be delivered, who would collect the data and how much time could be devoted to training to ensure that observers have acceptable levels of repeatability and reliability.
- Working guidelines for thresholds of size and patterns of bruising that would result in actions and what these actions would be, e.g. feedback to farmer.

Objective 9. Reporting of project

A paper on the systematic review of animal based sheep welfare indicators has been published in The Veterinary Journal. Further papers are anticipated from the interviews with stakeholders and the prevalence of lesions in abattoirs.

The project results will be presented in a poster at a UFAW meeting in June 2016.

Implications of findings and further work

The overall conclusions from the project are that the vast majority of animals presented for slaughter are in good welfare. This is an excellent finding. In addition, it is not possible currently to use data from abattoirs to monitor the welfare of animals at slaughter and trace back to farm of origin, market or transit. For this to be possible the changes needed include

- consistent methods by which data were recorded in abattoirs are needed, including using electronic data recording linked correctly to individual animals / batches
- objective reliable, repeatable definitions used to record welfare indicators
- trained and repeatedly retrained OV and MHI within an abattoir and between abattoirs to give the industry confidence that data were robust for purpose
- consistent recording of data even in busy periods
- independent personnel to record such data

Overall, most stakeholders considered that data from abattoirs was under-utilised. This has been discussed for over 30 years throughout the world. There is a clear use for abattoir data to monitor welfare and health and with current technology it is possible to record data electronically and in real-time. Some abattoirs are investing in such technology and future work might consider how to make this standard for all abattoirs.

Welfare indicators

Rare and severe welfare indicators

Stakeholders agreed with the current FSA list of severe and rare welfare indicators. We did not plan to record severe welfare indicators in the study because they are sufficiently rare that statistical analysis would not have been possible. However, there were occasional observations of such indicators when the research team was in an abattoir. The batch of thin dairy cows that were all thin and bruised and not recorded by the veterinarian does highlight that there is currently no system to check whether veterinarians in abattoirs are consistent or complete in recording such indicators. Training and a third party system to improve consistency of recording would benefit the welfare of animals because the data recorded could trigger a real time inspection to farm of origin.

Definitions of welfare indicators

Prior to this study there were no objective definitions for welfare indicators in ruminants used in abattoirs. We used objective measurable criteria, from published literature wherever possible (see Llonch et al 2015 for sheep) and had broad consensus from stakeholders that the definitions were appropriate. For most indicators, we consider that using the objective definitions would lead to more consistent recording of abnormalities between observers (OVs, welfare officers, MHIs) than currently.

Because the focus of the current research was on welfare rather than health we did not define health indicators e.g. parasites / pneumonia and we recommend that further work is done to define these indicators. In addition we recommend that staff (OVs, welfare officers and MHI) are trained to record these abnormalities consistently. Regular retraining and comparison e.g. by using training material would be essential to ensure consistency between staff in an abattoir and across abattoirs. For some indicators the definitions would be more informative by refining them to differentiate the indicator further. The key example in the current project was bruising, where location and size of bruising indicate different likely origins of bruises (Strappini et al 2013) and large bruises over the bony pelvis were associated with emaciation and lameness in cull cows.

Prevalence of welfare indicators

Milder welfare indicators

The prevalence of most welfare indicators by proportion within our six classes was low. This is useful information for benchmarking in GB and indicates that overall animals are healthy when sent for slaughter. There were more abnormalities in cull cows and some were particularly emaciated / lame ante-mortem. Only occasionally was a large proportion of a batch of animals affected with a condition.

Bruising – a novel indicator for cull cow welfare

The project identified one set of novel welfare indicators around bruising. Bruising was defined at the start of the project as stick marks or a carcase with at least one bruise >2cm. Using this definition <3% carcases had stick marks on average, these did not vary by sheep / cattle or class of animal in prevalence; although 15% of one batch were affected. Stick marks can be observed at slaughter and tracing could be done immediately to follow up likely source of these.

A large proportion of cattle and sheep had at least one bruise > 2cm. The participants in the bruising trial only considered bruises >16cm to be of concern. Further work on the likely causes of small bruises would contribute to knowing whether they are of concern. In some countries small circular bruises have been linked to prodding with sticks or goads and these could be of concern.

Our models identified that cull cows that were emaciated, and sometimes lame were likely to be bruised – the research team reported that these were large bruises over the pelvis of the cattle. This indicator has been reported elsewhere and warrants further research in dairy cows in GB. A study (e.g. case – control study) tracing back to farm of origin and identifying whether this is associated with poor cow comfort / cows should be culled before becoming so emaciated / chronically lame, would benefit cow welfare. These cows were graded poorly post mortem (typically 2P) but did not appear as emaciated post mortem as when alive. This indicates that the EUROP and 1 – 5 fat class system designed for growing meat animals is not a good measure of very thin adult cattle. This probably also applies to adult sheep; the fleece hides the fat cover of adult ewes ante-mortem and they cannot be handled to determine body condition ante-mortem.

Summarising and providing results from welfare assessments in abattoirs

To use these mild abnormalities as an indicator of welfare on farms of origin to trigger inspections, a database would need to be set up and data streamed live to cumulate number slaughtered and number affected by farm over time. Neither FSA nor many abattoirs are recording abnormalities electronically. The system to link to farm of origin for cattle would be complex because cattle sold via markets / dealers the last CPH is the market / dealer and the BCMS database is not sufficiently 'live' to identify the farm of origin in a timely way. Such a system is not yet possible for sheep, although with electronic ear tags it is a possibility for the future.

The stakeholders were generally not positive about the use of all data from animals slaughtered in abattoirs to inform welfare inspections, which they viewed as a negative use of the data. For data to be collected for this use a third party independent from abattoir employees would be needed and such a party would not be welcomed in most abattoirs. Most stakeholders, however, were positive about the use of abattoir data to benchmark the welfare of animals nationally, and farmers in particular, were keen to receive more data on health issues in their livestock from data currently recorded by the OV and MHI to inform them on better preventive measures for herd health planning.

Future work

1. Use definitions of welfare indicators and other abnormalities to train OVs and MHI to record these consistently (this is not an indication that either group are not competent but that any party recording data or use by a third party must be trained to standardise the data produced).

2. Explore the cost / benefit of real-time electronic recording of welfare and health data in all abattoirs for use by the whole industry

3. A study of the causes of pin / hook bone bruising in cull dairy cows to identify nutrition / housing / parlour changes required to avoid this issue

4. A study to define extremely thin adult sheep post mortem

5. Further work on the appropriate stage of end of productive life is needed to ensure that cattle and sheep are slaughtered before they are extremely thin

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

Llonch, Pol, King, Elisabeth M., Clarke, Kenneth A., Downes, J. M. and Green, Laura E. (2015) *A systematic review of animal based indicators of sheep welfare on farm, at market and during transport, and qualitative appraisal of their validity and feasibility for use in UK abattoirs.* The Veterinary Journal. 206 289-297 ISSN 1090-0233.