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Evaluation of the systematic recording of diagnostic data in the Valdostana cattle

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ABSTRACT

At present, in Italy no systematic recording of diagnostic data for improving animal health and welfare at farm level is available. A first approach towards a health recording system for cattle has been attempted in the Aosta Valley, recording the diagnoses of local Valdostana cattle between 2017 and 2018. The objectives of the present study were: (1) to evaluate the strengths and the critical points of the recording system and (2) to determine the incidence of specific diseases for the year 2018 in Valdostana cows. A standardised key with 69 specific diseases was used by 21 veterinarians for registering the diagnoses in a database. Data were collected from almost 80% of the farms present in the Aosta Valley. The main recorded diseases were those affecting the udder, reproductive apparatus, locomotor system and parasitic infections. Diseases affecting the respiratory and digestive system played a minor role. Since the general data loss through data validation was limited (8.8%), the recording system might be considered as an effective tool for gaining an objective overview of the farm health status. Nevertheless, some diagnoses in the recording system have to be more specified for allowing more precise epidemiologic insights.

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Diagnostic data; health monitoring; recording system; Valdostana cattle

HIGHLIGHTS

- A health recording system enables farmers and veterinarians to improve animal health and welfare on farm level.
- Valdostana cattle show lower incidences for some health disorders when compared with literature data from other dairy cattle breeds.
- More specific diagnoses for parasitoses and claw disorders could be useful for breeding purpose.

Introduction

In the last years, animal health and welfare have become important issues for evaluating the sustainability of farming systems (FAO 2016). For this reason numerous projects focussing on animal health and welfare have been launched both at a regional and at a national level worldwide (Egger-Danner et al. 2012; Koeck et al. 2012; Neuenschwander et al. 2012). In Europe, apart from the Nordic countries that have been collecting diagnostic data in bovines for decades (Heringstad et al. 2000; Østerås et al. 2007) and have been using this information in genetic selection for many years (Heringstad et al. 2005), other countries have also started to record direct health data of cattle (Egger-Danner et al. 2007). However, there are substantial differences in the data collection systems between countries in terms of diseases to be recorded and the stakeholders involved in the health data recording. In Austria the cooperation between governmental health officers, universities, breeders associations, milk recording organisation, farmers and veterinary practitioners enables a national standardised and systematic recording of animal diagnostic data (Egger-Danner et al. 2007). In contrast, in Germany many projects have been started at a regional level e.g. GKuh Niedersachsen, Pro Gesund Bayern, GMON Baden Württemberg, KuhVital Schleswig-Holstein. Each regional recording system has been based on slightly different diagnoses to be registered (diagnoses key), mainly following the diagnoses list recommended by the International Committee for Animal Recording (ICAR 2020b). In

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France, at present, few systematic recording systems of direct health data are available and are mainly related to mastitis (Govignon-Gion et al. 2016) and claw disorders with the projects GENOSANTE and MO3SAN (Leclerc et al. 2020). In Spain direct recording of mastitis cases are reported (Pérez-Cabal and Charfeddine 2013).

In Italy, no systematic recording of diagnostic data has been performed before 1st of January 2019, when the electronic registration of veterinary treatments has become mandatory by law (Law of the 20th November 2017 Nr 167 Art 3). Accordingly, since 01 January 2019, veterinarians have to register the reason for treating the single animal at the time of prescribing medications in pets, horses, and in food-producing animals. Since the primary goal of this electronic recording system is the monitoring of the use of veterinary medications by the Italian Ministry of Health, the prescribed drug and the general group of the observed diagnosis for which the animal is treated (e.g. respiratory, enteric, urogenital) but no specific pathology with the exception of dry-off treatments and vaccinations have to be indicated (Ministry of Health, 2020). Therefore, in parallel, another electronic registration system was tested in Aosta Valley (Molino 2013). Within this latter project, specific veterinary diagnoses were registered by the system SI.VE for every drug prescription in farms rearing local Valdostana cattle.

The objectives of this study were (1) to evaluate the registered data within the project in Aosta Valley in order to highlight the strengths and the critical points of the recording system and (2) to determine the incidence of specific diseases for the year 2018 in Valdostana cows.

Materials and methods

Animals and diagnostic data collection

Animals of both sexes of Valdostana cattle were included in the project. The Valdostana is an autochthonous cattle breed from Aosta Valley and is represented by three breeds: the Valdostana Red Pied (VRP), the Valdostana Black Pied (VBP) and the Valdostana Chestnut (VC). The National Breeders' Association of Valdostana Cattle (A.N.A.Bo.Ra.Va) organised the veterinary diagnoses recording. The data collection took place between 1st March 2017 and 31st December 2018 in the Aosta Valley region (north-west of Italy). The 21 veterinarians involved in the project registered electronically diagnoses and medications on farm in a database (SI.VE), specifically established in agreement with the veterinarians for the project. The standardised key for the registered diagnoses comprised 14 main groups of diagnoses indicating pathologies affecting one specific apparatus or the entire organism of the animal, and 69 specific diagnoses divided per affected apparatus that are depicted in Table 1. Data was collected per single animals. A total of 15,794 diagnoses from 717 farms in 2017 and 20,514 diagnoses from 795 herds in 2018 were collected during the registration period (Table 2).

Husbandry system and farms characteristics

Mountain farming in Aosta Valley is characterised by small-scale dairy farms with tie-stables (mean cow number/farm = 15.5 and mean animal number/farm= 32.5) which are generally following a seasonal calving pattern (A.N.A.Bo.Ra.Va. personal communication). The calving season usually takes place between November and February. Access to pasture is provided in spring and autumn while in summer the animals are brought to highland pastures for a minimum of 90 days/year (A.N.A.Bo.Ra.Va. personal communication). The herds involved in the project presented all these characteristics. For the year 2017, the minimum age at calving was 30.7 (934 days) in VRP and 31.9 months (969 days) in VC–VBP whereas the maximum age was 40.9 months (1244 days) in VRP and 43.1 months (1311 days) in VC–VBP (A.N.A.Bo.Ra.Va. personal communication). The average (and standard deviation) age at calving was 35.8 months (1089 ± 155 days) in VRP and 37.5 months (1140 ± 171 days) in VC–VBP. Mean intercalving periods were 377 ± 20 days in VRP and 379 ± 20 days in VC–VBP during the 1st and the 2nd parities whereas from to the 3rd parity 386 ± 21 days in VRP and 388 ± 21 days in VC–VBP (A.N.A.Bo.Ra.Va. personal communication). The VRP presented an average milk yield per lactation of 4,036 Kg in 2017 with 3.4% fat and 3.2% proteins whereas in the same year VC and VBP showed a lower production (2,956 Kg average milk yield, 3.4% fat and 3.3% proteins). For the year 2018 VRP milk yield ranged between 3,487 Kg and 4,234 Kg depending on parity with 3.4% fat and 3.2% proteins while VC–VBP varied from 2,470 Kg and 3,358 Kg with 3.4% fat and 3.3%–3.4% proteins (ANABORAVA 2020).

Data editing

The data was considered valid if the sex and the age of the animal treated was plausible with the diagnosis reported for that treatment (e.g. metritis in a bull or heat induction in a three months old female calf were

Table 1. Diagnoses keys used during data registration.

Udder diseases	Reproductive disorders	Parasites infestations	Locomotion disturbances	Diseases of the respiratory system
Udder oedema	Anoestrus	Coccidiosis	Laminitis	Bronchitis
Mastitis	Ovarian cysts	Dermatophytosis	Trauma	Bronchopneumonia
Dry cow therapy	Postpartum injuries	Distomatosis	Lameness	Pleurisy
Oxytocin deficiency	Metritis	Flies infestation	Other	Pneumonia
Other	Uterine prolapse	Parasitoses		Other
	Retained placenta	Scabies		
	Heat induction	Intestinal/pulmonary strongylosis		
	Male pathologies	Other		
	Other			
Diseases of the digestive system	**Metabolic disorders**	**Tegumentary alterations**	**Vitamins deficiency**	**Cardiocirculatory diseases**
Rumen blockage	Acidosis	Abscesses	Vitamin A deficiency	Hematoma
Colic	Ketosis	Dermatitis	Vitamin B deficiency	Hemorrhage
Abomasum displacement	Milk fever	Infected wounds	Vitamin D deficiency	Phlebitis
Enteritis	Other	Bites by reptiles/insects	Vitamin E deficiency	Pericarditis
Rumen bloating		Papillomatosis	Vitamin K deficiency	Other
Intestinal occlusion		Pyodermitis	Other	
Oropharyngitis		Other		
Pathologies of the forestomaches				
Peritonitis				
Traumatic reticuloperitonitis				
Other				
Pathologies of the nervous system	**Diseases of the urinary system**	**Other**	**Pathologies of the newborns**	
Keratoconjuntivitis	Urolithiasis	Allergy	Enteritis	
Meningitis	Cystitis	Vaccinations	Meningitis	
Postpartum paresis	Nephritis	Anaphylactic shock	Omphalitis	
Other	Other	Post-surgical therapy	Pneumonia	
		Other	Other	

Diagnoses groups are presented in bold and specific diseases are shown for every diagnoses group.

deleted from the cleaned dataset). Furthermore, mastitis and metritis reports in heifers younger than 30.7 months as well as dry cow treatments in animals younger than 37 months were excluded from the analysis. Furthermore, heat inductions recorded in heifers younger than 20 months were eliminated in the datasets. With the exception of dry cow therapy, that was not perfectly correlated to individual animals, the same pathologies observed in the same animal within a week were considered only once (Pérez-Cabal and Charfeddine 2013) in order to avoid overestimation of the real disease frequency. No minimum threshold value for disease incidence in herds was applied, therefore also small herds with few diagnostic data were considered for the analysis. Frequencies per pathology and diagnoses groups (absolute number and %) as well as data loss due to data editing both per year and in total are depicted in Table 2.

Data analysis

Since seasonal calving is a common practice in Aosta Valley, a seasonal trend for the diagnoses mastitis, dry cow therapy, ovarian cysts, metritis, lameness, laminitis, parasites infections and respiratory disturbances was investigated. Further, incidence of each pathology was determined for the year 2018 in female animals aged between 24 and 99 months (Table 3). Incidence was defined as number of cases of a specific disease divided by the number of female animals aged 24–99 months present in the farms over the year 2018 multiplied by 100. Since the parity of cows in 2018 was not available, the classification is based on the mean age at first calving and the average days open in the different parities. The parity number for each breed was determined as follow: 1st parity defined as $\geq$24 and $<$48.19 months for VPR and $\geq$24 and $<$49.9 months for VPN + VC; 2nd parity defined as $\geq$48.19 and $<$60.6 months for VPR and $\geq$49.9 and $<$62.4 months for VPN + VC; 3rd parity defined as $\geq$60.6 and $<$73.28 months for VPR and $\geq$62.4 and $<$75.1 months for VPN + VC; 4th parity defined as $\geq$73.28 and $<$85.97 months for VPR and $\geq$75.1 and $<$87.91 months for VPN + VC; 5th parity defined as $>$85.97 months for VPR and $>$87.91 months for VPN + VC.

Results and discussion

Experiences in systematic health data recording from the Nordic countries and from countries where health monitoring has been establishes since few years

Table 2. Absolute frequency (*N*) and % (in italics) of recorded pathologies in 2017 and 2018.

		2017				2018			
		Clean Data		Raw Data		Clean Data		Raw Data	
Diagnoses group	Diagnoses	*N*	%	*N*	%	*N*	%	*N*	%
Udder diseases	Mastitis	1941	*(13.4)*	2618	*(16.6)*	2950	*(15.8)*	4018	*(19.6)*
	Dry cow therapy	6510	*(45.1)*	6597	*(41.8)*	7403	*(39.7)*	7415	*(36.1)*
	Oxytocin deficiency	367	*(2.5)*	370	*(2.3)*	614	*(3.3)*	618	*(3.0)*
	Oedema	24	*(0.2)*	24	*(0.2)*	23	*(0.1)*	24	*(0.1)*
Reproductive disorders	Anoestrus	44	*(0.3)*	48	*(0.3)*	17	*(0.1)*	17	*(0.1)*
	Ovarian cysts	480	*(3.3)*	507	*(3.2)*	905	*(4.8)*	1009	*(4.9)*
	Post-partum injuries	36	*(0.2)*	49	*(0.3)*	55	*(0.3)*	73	*(0.4)*
	Metritis	257	*(1.8)*	325	*(2.1)*	402	*(2.2)*	510	*(2.5)*
	Heat induction	335	*(2.3)*	350	*(2.2)*	1094	*(5.9)*	1116	*(5.4)*
	Male pathologies	0	*(0.0)*	0	*(0.0)*	3	*(0.0)*	4	*(0.0)*
	Uterine prolapse	11	*(0.1)*	12	*(0.1)*	32	*(0.2)*	49	*(0.2)*
	Retained placenta	65	*(0.5)*	81	*(0.5)*	97	*(0.5)*	117	*(0.6)*
Parasites infestation	Coccidiosis	21	*(0.1)*	21	*(0.1)*	18	*(0.1)*	18	*(0.1)*
	Flies infestation	282	*(2.0)*	282	*(1.8)*	94	*(0.5)*	94	*(0.5)*
	Parasitosis	1979	*(13.7)*	1993	*(12.6)*	2305	*(12.4)*	2306	*(11.2)*
	Scabies	44	*(0.3)*	44	*(0.3)*	112	*(0.6)*	112	*(0.5)*
	Intestinal/pulmonary strongylosis	155	*(1.1)*	155	*(1.0)*	221	*(1.2)*	221	*(1.1)*
Locomotion disturbances	Laminitis	366	*(2.5)*	443	*(2.8)*	444	*(2.4)*	522	*(2.5)*
	Trauma	41	*(0.3)*	48	*(0.3)*	48	*(0.3)*	55	*(0.3)*
	Lameness	201	*(1.4)*	247	*(1.6)*	363	*(1.9)*	436	*(2.1)*
Diseases of the respiratory system	Bronchitis	142	*(1.0)*	161	*(1.0)*	203	*(1.1)*	253	*(1.2)*
	Bronchopneumonia	98	*(0.7)*	122	*(0.8)*	106	*(0.6)*	147	*(0.7)*
	Pleurisy	11	*(0.1)*	14	*(0.1)*	8	*(0.0)*	10	*(0.0)*
	Pneumonia	91	*(0.6)*	125	*(0.8)*	103	*(0.6)*	125	*(0.6)*
Diseases of the digestive system	Abomasum displacement	2	*(0.0)*	2	*(0.0)*	0	*(0.0)*	0	*(0.0)*
	Enteritis	82	*(0.6)*	101	*(0.6)*	169	*(0.9)*	208	*(1.0)*
	Rumen bloating	7	*(0.0)*	12	*(0.1)*	16	*(0.1)*	19	*(0.1)*
	Peritonitis	28	*(0.2)*	51	*(0.3)*	28	*(0.2)*	48	*(0.2)*
	Traumatic reticuloperitonitis	12	*(0.1)*	20	*(0.1)*	32	*(0.2)*	49	*(0.2)*
	Other digestive disorders	43	*(0.3)*	51	*(0.3)*	70	*(0.4)*	94	*(0.5)*
Metabolic disorders	Acidosis	3	*(0.0)*	3	*(0.0)*	0	*(0.0)*	0	*(0.0)*
	Ketosis	7	*(0.0)*	7	*(0.0)*	6	*(0.0)*	9	*(0.0)*
	Milk fever	5	*(0.0)*	5	*(0.0)*	17	*(0.1)*	19	*(0.1)*
Tegumentary alterations		133	*(0.9)*	145	*(0.9)*	110	*(0.6)*	127	*(0.6)*
Vitamins deficiency		34	*(0.2)*	35	*(0.2)*	32	*(0.2)*	32	*(0.2)*
Cardiocirculatory diseases		2	*(0.0)*	2	*(0.0)*	1	*(0.0)*	1	*(0.0)*
Pathologies of the nervous system		26	*(0.2)*	27	*(0.2)*	25	*(0.1)*	34	*(0.2)*
Diseases of the urinary system		15	*(0.1)*	18	*(0.1)*	26	*(0.1)*	32	*(0.2)*
Other		133	*(0.9)*	141	*(0.9)*	144	*(0.8)*	202	*(1.0)*
Pathologies of the newborns	Enteritis	37	*(0.3)*	46	*(0.3)*	46	*(0.2)*	50	*(0.2)*
	Omphalitis	0	*(0.0)*	0	*(0.0)*	2	*(0.0)*	2	*(0.0)*
	Pneumonia	3	*(0.0)*	3	*(0.0)*	6	*(0.0)*	6	*(0.0)*
Not Classifiable		365	*(2.5)*	489	*(3.1)*	313	*(1.7)*	313	*(1.5)*
Total		14438	*(100.0)*	15794	*(100.0)*	18663	*(100.0)*	20514	*(100.0)*

Specific diseases of the diagnoses group presenting a frequency lower than 1% were not displayed individually with the exception of metabolic disorders and pathologies of the newborns both considered a challenge in the dairy industry.

highlight the importance of complete datasets, correct data collection and plausibility cheques of the registered data (Zwald et al. 2004; Neuenschwander et al. 2012; Wolff et al. 2012). The quality of the data was shown to be affected by the person, who registers a health event, the economic situation of a farm as well as the availability of therapeutic alternatives to antimicrobials (Vaarst et al. 2002; Mörk et al. 2009; Espetvedt et al. 2013). Since in the present study neither the disease frequencies observed by farmers nor precise information on farm management were available, no completeness check could be performed. This represents an important critical point of the recording system since we could not evaluate in which extent the pathology frequencies observed by farmers agree with those recorded by the veterinarians. For this reason, pathologies incidences presented in this study should be considered with caution. Moreover, numerous studies reported diagnostic data from limited time range after calving (Egger-Danner et al. 2012; Koeck et al. 2012; Neuenschwander et al. 2012; Govignon-Gion et al. 2016) and considered the direct trait registered as a binary variable (0–1) in absence or presence of a single disease event over respective lactation (Govignon-Gion et al. 2016). This approach is normally used for genetic purpose due to evaluation of lactational incidence as described in Kelton et al. (1998) for first cases. The approach in which the number of case events are considered per diagnosis and per animal can give a more precise overview of the health status

Table 3. Frequencies and incidences of the most common pathologies in female animals of Valdostana cattle aged 24–99 months ($N = 18,092$) in 654 farms in 2018.

	Total			Total	
Specific diagnoses	*N*	(%)	Specific diagnoses	*N*	(%)
Udder diseases			Diseases of the respiratory system		
Dry cow therapy	5382	*(29.75)*	Bronchitis	89	*(0.49)*
Mastitis	2042	*(11.29)*	Bronchopneumonia	45	*(0.25)*
Oxytocin deficiency	384	*(2.12)*	Pneumonia	40	*(0.22)*
Oedema	18	*(0.10)*	Pleurisy	2	*(0.01)*
Reproductive disorders			Diseases of the digestive system		
Heat induction	828	*(4.58)*	Rumen blockage	28	*(0.15)*
Ovarian cysts	706	*(3.90)*	Colic	10	*(0.06)*
Metritis	308	*(1.70)*	Enteritis	68	*(0.38)*
Anoestrus	15	*(0.08)*	Ruminal bloating	9	*(0.05)*
Postpartum injuries	51	*(0.28)*	Intestinal occlusion	3	*(0.02)*
Uterine prolapse	29	*(0.16)*	Oropharyngitis	3	*(0.02)*
Retained placenta	70	*(0.39)*	Pathologies of the forestomaches	5	*(0.03)*
Parasites infestation			Peritonitis	22	*(0.12)*
Parasitoses	1575	*(8.71)*	Traumatic reticuloperitonitis	20	*(0.11)*
Strongylosis	132	*(0.73)*			
Fly infestation	47	*(0.26)*			
Scabies	84	*(0.46)*			
Locomotion disturbances					
Laminitis	253	*(1.40)*			
Lameness	216	*(1.19)*			
Trauma	26	*(0.14)*			

Note: Values in italics indicate incidences.

Table 4. Frequency of pathologies across parities in female animals aged between 24 and 99 months in 2018.

		Parity										Total	
		1		2		3		4		≥5			
Diagnoses	Diagnoses II	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
Udder diseases	Dry cow therapy	1340	*(35.9)*	1292	*(48.9)*	1063	*(43.7)*	934	*(41.5)*	753	*(40.1)*	5382	*(41.6)*
	Mastitis	491	*(13.1)*	379	*(14.4)*	395	*(16.3)*	411	*(18.3)*	366	*(19.5)*	2042	*(15.8)*
	Oedema	10	*(0.3)*	4	*(0.2)*	1	*(0.0)*	0	*(0.0)*	3	*(0.2)*	18	*(0.1)*
	Oxytocin deficiency	87	*(2.3)*	60	*(2.3)*	87	*(3.6)*	65	*(2.9)*	85	*(4.5)*	384	*(3.0)*
Reproductive disorders	Anoestrus	5	*(0.1)*	3	*(0.1)*	3	*(0.1)*	2	*(0.1)*	2	*(0.1)*	15	*(0.1)*
	Ovarian cysts	167	*(4.5)*	138	*(5.2)*	157	*(6.5)*	146	*(6.5)*	98	*(5.2)*	706	*(5.5)*
	Heat induction	277	*(7.4)*	130	*(4.9)*	148	*(6.1)*	150	*(6.7)*	123	*(6.5)*	828	*(6.4)*
	Post-partum injury	30	*(0.8)*	6	*(0.2)*	3	*(0.1)*	10	*(0.4)*	2	*(0.1)*	51	*(0.4)*
	Metritis	112	*(3.0)*	57	*(2.2)*	48	*(2.0)*	48	*(2.1)*	43	*(2.3)*	308	*(2.4)*
	Uterine prolapse	18	*(0.5)*	6	*(0.2)*	3	*(0.1)*	1	*(0.0)*	1	*(0.1)*	29	*(0.2)*
	Retained placenta	31	*(0.8)*	14	*(0.5)*	7	*(0.3)*	9	*(0.4)*	9	*(0.5)*	70	*(0.5)*
Locomotive disorders	Laminitis	89	*(2.4)*	38	*(1.4)*	48	*(2.0)*	45	*(2.0)*	33	*(1.8)*	253	*(2.0)*
	Trauma	10	*(0.3)*	5	*(0.2)*	2	*(0.1)*	4	*(0.2)*	5	*(0.3)*	26	*(0.2)*
	Lameness	71	*(1.9)*	38	*(1.4)*	30	*(1.2)*	45	*(2.0)*	32	*(1.7)*	216	*(1.7)*
Parasites infestation	Fly infestation	18	*(0.5)*	8	*(0.3)*	8	*(0.3)*	9	*(0.4)*	4	*(0.2)*	47	*(0.4)*
	Parasitoses	564	*(15.1)*	295	*(11.2)*	266	*(10.9)*	237	*(10.5)*	213	*(11.3)*	1575	*(12.2)*
	Scabies	42	*(1.1)*	14	*(0.5)*	10	*(0.4)*	10	*(0.4)*	8	*(0.4)*	84	*(0.6)*
	Strongylosis	45	*(1.2)*	18	*(0.7)*	28	*(1.2)*	19	*(0.8)*	22	*(1.2)*	132	*(1.0)*
Total		3734	*(100.0)*	2640	*(100.0)*	2430	*(100.0)*	2248	*(100.0)*	1880	*(100.0)*	12932	*(100.0)*

Note: Values in italics indicate frequencies.

of a herd and allows a more homogeneous background for benchmarking purpose. Some diseases can occur only once in the lifespan of an animal, but others can be observed many times during the same lactation (e.g. mastitis). Therefore, the registration as presence or absence per lactation of some pathologies might have led to an underestimation of the real occurrence (Kelton et al. 1998). After data editing, the datasets comprised 14,438 and 18,663 records for the years 2017 and 2018 (Table 2), respectively. The data loss due to editing amounted to 8.8% (Table 2). It was particularly evident in the pathologies requiring antibiotics and anti-inflammatory drugs. The most common treatments in Valdostana cattle were administrated for treating udder infections (59.9%), parasitic diseases (15.8%), reproductive disturbances (11.6%), and locomotion disorders (4.4%). Respiratory diseases and digestive disturbances followed with frequencies of 2.3% and 1.5%, respectively. Metabolic disorders played a minor role (0.1%). Moreover, diseases in calves, of which enteritis represented the main pathology, were less frequent (0.3%).

Udder diseases

Mastitis presented a frequency of 14.8% of all registered diagnoses throughout the observation period (Table 2) and an average incidence of 11.29% in female animals aged between 24 and 99 months (Table 3). Similarly, Austrian dual-purpose Fleckvieh displayed 17% of udder infections of which 11% referred to acute mastitis (Egger-Danner et al. 2012). In France clinical mastitis cases in Montbéliarde (10%), Normande (13%) and Holstein (14%) in the first 150 days in milk were reported to be similar or slightly higher compared to our results (Govignon-Gion et al. 2016). In the latter study, mastitis cases were considered only once per lactation, therefore, the real incidence could be underestimated. Moreover, in Canada, considering all mastitis events over a lactation primary in Holstein and few other dairy breeds, mean incidences between 20.9 and 23% were reported (Olde Riekerink et al. 2008; Levison et al. 2016). The lower incidence observed in Valdostana cattle might be explained by the lower milk yield compared to other dairy breeds (ANABORAVA 2020), which is partly explainable by the selection for muscularity and fighting ability, especially in VPN and VC. Those traits were shown to be negatively correlated to udder traits related to milk yield (Sartori et al. 2015). Given the well-established positive correlation between milk production and clinical mastitis (Fleischer et al. 2001), the lower milk yield of Valdostana cattle might have led to a lower mastitis occurrence.

Further, mastitis occurrence is known to be more relevant in pluriparous cows (Gernand et al. 2012). In our results, an increased frequency of mastitis treatments was observed across parities starting from 13.1% in primiparous cows and increasing to 19.5% in 5th parity cows (Table 4). Likewise, an increase of medication frequencies for mastitis in Austrian Fleckvieh from 31.9% in the 1st lactation to 37% in the 5th lactation was observed (Egger-Danner et al. 2012). Moreover, in summer and early autumn lower frequencies of mastitis treatments were observed (Figure 1). Since seasonal calving between November and February is commonly practiced, the higher mastitis occurrence during the winter months (Figure 1) might be related to the fact that clinical mastitis frequency is higher in the early lactation (Gernand and König 2014) and late-lactation cows are more prone to subclinical or chronic mastitis (Olde Riekerink et al. 2008; Koeck, Heringstad, et al. 2010). In addition, a recent study in Rendena cows suggested that udder microbiome could exert a protective function against mastitis (Cremonesi et al. 2018). However, the

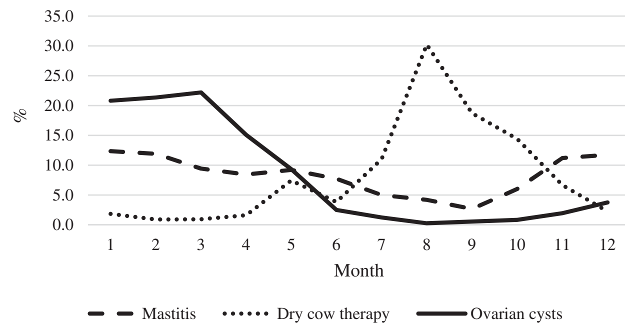

Figure 1. Distribution of mastitis, dry cow therapy treatments and ovarian cysts throughout the year 2018 in female animals of Valdostana cattle aged 24–99 months.

extensive usage of dry cow therapies observed in our study (Tables 2 and 3) might have had a negative effect on the udder microbiota composition, possibly leading to a dysbiosis in the mammary gland which might be a predisposing factor for mastitis (Derakhshani et al. 2018). For this reason, particular attention should be paid on determine the strategy for preventing mammary infections during the transition period.

Reproductive disorders

Valdostana cattle showed less fertility disorders (Tables 2 and 3) like retained placenta (Koeck et al. 2010; Egger-Danner et al. 2012) or metritis (Zwald et al. 2004; Koeck, Egger-Danner et al. 2010; Neuenschwander et al. 2012) when compared with other cattle breeds. In contrary, the low incidence of uterine prolapse described in the present study (0.16%; Table 3) is in line with that (0.10%) observed in Austrian Fleckvieh (Koeck, Egger-Danner et al. 2010). Incidence of cystic ovaries in our study was 3.90% (Table 3). In contrast, higher values were reported in different breeds in Austria (Koeck, Egger-Danner et al. 2010; Egger-Danner et al. 2012), in Germany (Gernand et al. 2012), in Canada (Koeck et al. 2012; Neuenschwander et al. 2012), and in the US (Zwald et al. 2004). The low incidence of ovarian cysts observed in our study (Table 3) might be partly related to the lower milk yield in Valdostana cows compared to Fleckvieh and Holstein-Friesian cows. In fact, Hooijer et al. (2001) observed an increase of 1.5% of incidence for follicular cysts per 500 kg in milk yield within Holstein cows. Some variation in frequencies for reproductive disorders was observed across parities. In fact, heat induction decreased from 1st to 5th parity, having its nadir in 2nd parity (Table 4). Similarly, metritis decreased across parities having its nadir in 3th parity cows. Ovarian cysts slightly increased with increasing parities and peaked in 3th and 4th parity (Table 4). A seasonal variation of diagnoses reports related to reproductive system was observed, which might be related to the seasonal calving pattern (Figure 1). In particular, ovarian cysts showed higher frequencies in winter and spring compared to the rest of the year (Figure 1) which is in line with that reported by Rizzi et al. (2003). A possible explanation might be the fact that ovarian cysts are mainly reported between the 2nd and the 4th month after calving (Fleischer et al. 2001; Zwald et al. 2004).

Metabolic disorders

Low incidences for ketosis (0.02%) and hypocalcaemia (0.6%) were observed. Higher frequencies for ketosis (0.86%) were observed in Austrian Fleckvieh (Egger-Danner et al. 2012). In contrast, high yielding German Fleckvieh cows (16.8%) showed a much higher incidence for ketosis compared to Valdostana cattle (Bijmholt et al. 2012). Moreover, in Holstein cows values for ketosis varied between 3 and 4% for clinical cases in France (Barbat-Leterrier et al. 2016), between 4 and 7% in Canada (Koeck et al. 2012; Jamrozik et al. 2016) and between 2.4% and 10% in the US (Zwald et al. 2004; Weigel et al. 2017). In Austrian Fleckvieh the observed incidence for milk fever was 3.8% (Egger-Danner et al. 2012). In contrast, for German Fleckvieh cows a very high mean farm incidence of milk fever was reported (15.1 ± 7.0%) (Bijmholt et al. 2012). Again, the very low incidences of milk fever and ketosis might be related to the lower milk yield of Valdostana cattle compared to high yielding dairy breeds (ANABORAVA 2020), which result in less metabolic pressure and body fat mobilisation as observed in other local Italian breeds (Curone et al. 2016). Another explanation might be the underestimation of these diseases due to the fact that the drugs used to treat these disorders are normally present in the veterinarian's own supply, who administers them directly in case of urgent treatment such as hypocalcaemia. For this reason, these drugs are not prescribed with the SI.VE system and therefore are not present in our dataset.

Locomotion disturbances

Disturbances of the locomotive apparatus were shown to negatively affect milk yield and fertility and to alter feeding behaviour that can lead to increased occurrence of metabolic and digestive diseases (Green et al. 2002; Morris et al. 2011; Norring et al. 2014). Lameness is a major concern in the modern dairy industry. Claw lesions are major causes for lameness (Bicalho and Oikonomou 2013). The lack of homogeneity between data recording systems allows only to a limited extend a comparison between different countries, breeds, housing systems and management. In Germany a mean incidence of 7.3% for lameness during lactation in Holstein was reported (Gernand et al. 2012) while in the Netherlands a median herd prevalence of 32.3% of lame animals was observed (de Vries et al. 2015). In England and Wales a prevalence of 31.5% of moderate lame and 5.3% severely lame cows was stated (Barker et al. 2010). In contrast, a much lower incidence for lame cows was recorded in Valdostana cattle as the overall incidence of lameness was 1.19% (Table 3), highlighting a good adaptability of this local breed to alpine environment. Another explanation for the lower incidences observed in Valdostana cattle compared to literature might be related to the investigated registration system. In the present study, only locomotion disturbances for which medications subjected to veterinary prescriptions were required, were registered. Other locomotion disturbances which are usually detected during claw trimming or during treatments not requiring veterinary assistance went unreported. Therefore, claw trimming information should be included next to veterinary diagnoses in the system in order to get better insights in claw health of Valdostana breed.

Parasite infestations

On alpine pastures, parasitic infections could induce tissue damages and hampered functions, which represent a metabolic challenge for affected animals e.g. hampered breathing caused by *Dictyocaulus viviparus*, hepatic damages caused by *Fasciola hepatica* (Schnieder et al. 1991), enteritis and haemorrhagic lesions caused by gastrointestinal nematodes (Charlier et al. 2020), myiases by flies infestation (Otranto 2001). Genetic selection for resilience but most important for resistance against important parasitoses has been started in ruminants (Sweeney et al. 2016). However, some genetic mechanisms underpinning resistance are pathogen specific. For this reason, the investigation for specific quantitative loci per type of parasite is required. Therefore, a detailed recording of parasitoses events is essential for using the data for genetic evaluation (Mahmoud et al. 2018). Due to the general formulated diagnoses used during the recording period (Table 1), our data can only give to a limited extend an overview on the general parasitoses incidence (10.16%). For this reason, neither specific management measures to contain infections nor genetic selection for resistance could be pursued. Moreover, as during data analysis it was not possible to distinguish prophylactic treatments from therapeutic ones our data might have been falsified by the common practice in Alpine area of prophylactic use of antiparasitic drugs before summer pasturing to prevent new infection or reinfections by some parasites, e.g. strongyloides. Therefore, parasitic treatments do not automatically mean the occurrence of a parasitic disease.

Suggestions for further improvements of the health recording system

Critical points of the recording system used in our study are mainly related to the software setup, the diagnose key and the lack of additional information about the productions system including feeding and housing. Since the main goal of the electronic system used in Aosta Valley was the surveillance of drugs administration, for each prescribed drug a diagnosis was associated. For this reason, at the time of data extraction from the specific software for data analysis, the same pathologies could be recorded many times in the same animal and day giving rise to multiple records that do not represent the real incidence. Therefore, a time period between a disease event and the new one of the same type in the same animal could be fixed at a week as suggested by (Kelton et al. 1998) for mastitis (Pérez-Cabal and Charfeddine 2013) or at other minimum periods depending on disease (Egger-Danner et al. 2012). In addition, it will be advisable to indicate for treatment reason first the apparatus (the so called 'diagnoses group') and secondly the diagnoses 'other'. Since the recording system did not include drugs of the veterinarian stock, diseases treated with those medications, e.g. clinical hypocalcaemia and ketosis, were not registered in the database and therefore were not included in the analysis leading to a likely underestimation of the disease occurrence. For this reason, further improvements of the recording system should include all data from the veterinarians 'own supplies. With regards to calves disorders, no specific animal-age limit was defined. Therefore, diagnoses like 'enteritis' and 'pneumonia' which were also present for adult animals may be recorded wrongly, leading to an underestimation of the calves disturbances and an overestimation of respiratory and digestive disorders in adults. A possible age limit for calves could be set at 6 months (Gulliksen et al. 2009). To overcome just mentioned problems an automatic plausibility check should be implemented in the recording system, which only allows the selection of specific diagnoses depending on the sex and the age of the animal, considering the individual eartag number. Moreover, the integration of data relative to involuntary culling and, in general, information of animal movements and animal slaughtering should be considered in the data registration as well (FAO 2016).

For some diseases the used diagnose key should be specified more precisely in order to enable more differentiate diagnoses and record next to acute also subclinical events. From literature it is known that some disease incidences (e.g. mastitis, milk fever, ketosis) vary with parity number (Heringstad et al. 2005; Gernand et al. 2012). Furthermore, also the stage of lactation can influence specific diseases occurrence (Zwald et al. 2004). Therefore, specific information regarding days in milk as well as parity number should be included in the dataset in order to identify the most susceptible groups of animals relative to productive, reproductive and metabolic disorders.

Claw lesion are mainly divided in diseases of infection origin and those derived from non-infective horn disruptions (Bicalho and Oikonomou 2013). In our study, with the exception of laminitis, non-infectious claw disorders were not recorded. In order to have a more detailed evaluation of the incidences of the most important claw pathologies, it would be necessary to record individual cases considering the list of specific pathologies described in the ICAR Atlas of claw health (ICAR 2020a). Furthermore, claw disorders are mainly observed during claw trimming, however, such data did not get recorded in the health recording system. Since veterinary advices are more effective in presence of complete claw health information the registration of pathologies detected during claw trimming could be beneficial for the implementation of herd management practices as well as for genetic selection purpose. At present, several projects like Klauen-Q-Wohl in Austria aim to establish an electronic registration system to collect claw trimming reports and lameness events, which afterwards can be used for breeding purpose (Klauen-Q-Wohl 2020).

With regards to parasites infections, more precise formulated diagnoses are required to pursue specific management measures in order to contain infections and to use the registered data in a long-term perspective for genetic selection and resistance induction.

Furthermore, precise health data at the farm level allows the identification of the critical management points of the herd and the application of target measures to improve animal health (de Vries et al. 2015). Increased incidences of infectious diseases e.g. calves pathologies, mastitis, and lameness might highlight the need of improvement of housing conditions e.g. hygiene measures in the barns or boxes or the adaptation of cubicle sizes to animal size. Fertility and metabolic disorders might also benefit from an improvement of the feeding strategy.

Conclusions

Due to the wide range of specific diseases recorded and the limited data loss after data editing and validation, the data recording system used in our study resulted to be an effective tool for cattle health monitoring. The evaluated registered diagnostic data can help farmers to achieve a more objective overview of the health status of the herd and support the veterinary practitioners in the sanitary management of the assisted farms. Further, the validated results from health recording scheme can be considered for benchmarking purposes for describing the national animal health status, which could be a useful parameter in political and sanitary decisions. Lastly, health data recording might pave the way to the introduction of some new traits in the genetic selection for resistance to common diseases in Valdostana cattle population and other cattle populations in Italy, with the finality to improve animal health and welfare.

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Ethical approval

For this study economic and productive figures were used and the approval of the Ethical Committee for the Care and Use of Experimental Animals of the Free University of Bolzano not needed.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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