Standardization of health data. ICAR guidelines including health key

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Abstract

Systematic improvement of animal health requires knowledge about the status quo and reliable measures to characterize it. In dairy herds, health monitoring has gained importance to ensure sustainable and cost-efficient milk production in accordance with public expectations. In this context, standardized recording of health data is essential for comparability and interpretability of health-related analyses, implying the need for generally accepted and clear guidelines.

To assist implementation of health monitoring and convey harmonization, the ICAR Functional Traits Working Group has compiled the ICAR guidelines for Recording, Evaluation and Genetic Improvement of Health Traits, which were approved in June 2012. Disease diagnoses and observations of impaired health can be classified as direct health data, providing the basis for targeted approaches to improve the animal health status. Data sources need to be taken into account because of their impact on information content and specificity. The key for health data recording is characterized by a hierarchical structure that makes it possible to record on different levels of detail and includes comprehensive recording options with coverage of all organ systems and types of diseases. Important features are compatibility with other recording systems and broad usability as a reference regardless of specific intentions and contexts of health data collection. Input can range from very specific diagnoses of veterinarians to very general diagnoses or observations by producers, and the unique coding of clearly defined health incidents minimizes the risk of misinterpretations and facilitates analyses of different types of health data. The overall quality and success of health monitoring is substantially influenced by

appropriate use of standards and available recording tools, implying the need for tailored support particularly in the implementation phase. In integrated concepts, specific qualifications of professions can be used synergistically to further standardize recording of health data and thereby benefit efficiency of animal health improvement on farm and at the population level.

Keywords: direct health data, veterinary diagnoses, integrated health monitoring concepts.

Introduction

Animal health aspects have gained enormous importance in the livestock sector and its public reputation. Society is increasingly requesting transparency with regard to production conditions along the whole food chain, with particular demands for high standards of animal welfare and health (Egger-Danner *et al.*, 2012). Furthermore, the dairy industry has recognized that with the increasing progress in production traits, the health of the dairy cow is increasingly challenged, and the ability to cope with these challenges may impact sustainability and profitability of milk production. Accordingly, more and more weight is placed on collection and use of health- related information today, with the aim to improve health and longevity in dairy cattle (Stock *et al.*, 2012b).

Approaches to improve health may be either based on disease diagnoses and direct observations of impaired health (direct health data) or on health indicators, i.e. traits correlated with health and disease (indirect health data). Although the former promise maximum efficiency of health-oriented optimizations on individual farms and of breeding programs, large- scale implementation of such health monitoring has not yet been possible in many countries. Heterogeneity of documentation is one of the major factors which may delay or frustrate setting-up routine work with direct health data. Without harmonization of trait definitions and recording, there is no basis for analyses across farms, benchmarking and genetic evaluations, so monitoring efforts are unlikely to pay off. However, examples of national health initiatives exist in which documentation standards of different size and format have been installed and successfully tested (e.g. Appuhamy *et al.*, 2009; Egger-Danner *et al.*, 2012; Fourichon *et al.*, 2001; Koeck *et al.*, 2012; Østeras *et al.*, 2007; Stock *et al.*, 2012a; Zwald *et al.*, 2004). In the Scandinavian countries, nationwide dairy health recording systems exist for decades, with a pioneer role of Norway (start of the Norwegian Cattle Health Recording System in 1975; Østeras *et al.*, 2007). Data collection approaches had necessarily impacted the trait spectra, and although stakeholders are aware of the benefits of flexible systems where specific expertise can contribute to long-term success, there are worldwide still only a few routine integrative health monitoring systems for dairy cattle (Stock *et al.*, 2012b).

Animal health within ICAR

Health indicators like somatic cell score have been included in international standards for recording and evaluation published by ICAR since the 1990s, providing the basis for considering health aspects in breeding. To further health monitoring and targeted improvement of dairy health, new guidelines specifically addressing the direct health traits were to be compiled under the responsibility of the ICAR working group for functional traits. In 2012, the ICAR guidelines for

Recording, Evaluation and Genetic Improvement of Health Traits got approved, providing recommendations regarding best practices for working with health data (ICAR, 2012).

General aspects to be considered when working with direct health data include the possible data sources with their specific characteristics concerning information content, pros and cons of their involvement. Furthermore, data security is an important issue to be addressed from the very beginning of planning infrastructure development for health data. Standardization of recording, control of data quality and continuity of data flow require particular attention because of the rather limited options for forcing complete and detailed health documentation for all animals. Because motivation of all parties involved is the major determinant, ways to long-term success of health monitoring are disclosed in the health guidelines addressing early feedback as well as long-term perspectives and both management and breeding. The comprehensive health key, given exemplarily as an appendix of the guidelines, can be considered extremely helpful for setting up health monitoring systems in dairy cattle. In the following, this key will be outlined with its main characteristics, illustrating its suitability for a broad range of applications.

Health key

The central key for health data recording has been referred to in the ICAR health guidelines as kind of gold standard (ICAR, 2012). Its compilation was driven by practical demands and carried by collaborations between science and dairy industry, with fundamental contributions of the German bovine specialist R. Staufenbiel. Apart from the large number of diagnoses included, it is the hierarchical structure of the key which makes it compatible with a variety of recording systems and very flexible in use.

The veterinary diagnoses or disease observations and further health-related information are grouped into nine categories: organ diseases; reproduction disorders in females; reproduction disorders in males; infectious diseases; parasitoses; metabolic diseases and deficiencies; poisoning; behavioral disorders and general findings; and health-related information not representing diagnoses. In each of these categories, subcategories or disease groups and individual items are listed with varying specificity, from low to high (Table 1).

In the health key, most space is devoted to the organ diseases, with some consistent entry options for each organ system: hereditary diseases and malformations are followed by tumors, injuries and various other acquired diseases. Rare diagnoses or observations of impaired health which are not explicitly listed can be entered as 'others' under the respective sub-category.

Depending on who had under which conditions acquired health information on some animal (e.g. clinical observation of farm staff vs. specific veterinary examination) and who had entered this information into the system, the comprehensive health key includes items appropriate for a broad spectrum of users. Providing entries with varying levels of detail, it is up to the user to decide how much information can and should be stored. The two examples given in Table 2 illustrate the user-dependent specificity of health data. After an injury with substantial blood loss the shock condition may be documented under 'organ diseases' as 'Diseases of the cardiovascular system' (1.05.) or specifically as 'Hypovolemic shock' (1.05.06.02.01.). After infertility-related cycle control, results

Table 1. Disease categories and major sub-categories with respective numbers of more specific items in the key for health data recording included as annex in the ICAR guidelines for Recording, Evaluation and Genetic Improvement of Health Traits (version 1.2, April 28, 2013).

Code	Technical term	No. of items
1.	Organ diseases	539
1.01.	Diseases of skin, subcutis and coat	27
1.02.	Diseases of the trunk	22
1.03.	Horn diseases	11
1.04.	Diseases of the lymphoid system	8
1.05.	Diseases of the cardiovascular system	49
1.06.	Diseases of the respiratory tract	46
1.07.	Diseases of the digestive tract	108
1.08.	Diseases of the urinary tract	23
1.09.	Diseases of the locomotory apparatus	63
1.10.	Claw diseases	56
1.11.	Diseases of the central nervous system and the sensory organs	40
1.12.	Diseases of the udder (other than mastitis)	37
1.13.	Mastitis (inflammation of the mammary gland)	36
2.	Reproduction disorders in females	116
2.01.	Diseases of the female reproductive system	23
2.02.	Pregnancy disorders	17
2.03.	Diseases related to calving	24
2.04.	Disorders in the postpartal period	16
2.05.	Female infertility	30
3.	Reproduction disorders in males	44
4.	Infectious disease and other microbe-related diseases *	103
5.	Parasitoses (parasite infestations)	42
6.	Metabolic diseases and deficiencies	73
7.	Poisoning	35
8.	Behavioral disorders and general findings	14
9.	Health-related information not representing diagnoses	45

* except local infections of udder and claws

referring to 'reproduction disorders in females' may be documented unspecifically as 'Female infertility' (2.05.) or specifically as 'Luteal cystic ovary disease' (2.05.02.04.02.). Information on a comatose cow with severe milk fever may be documented under 'metabolic diseases and deficiencies' as 'Disturbances of calcium and phosphorus balance' (6.03.01.) or most specifically as 'Parturient coma / Stage 3 of parturient paresis' (6.03.01.01.02.).

The unambiguous definitions of items and the clear structure of the health key point at the options for future combination of health data from different sources. Different recording options exist for example for clinical mastitis in the keys used for health data recording in German and Austrian dairy cattle, but the comprehensive reference key is providing the common denominator for joint analyses of mastitis data. Depending on how many details have been saved in the least specific of the contributing systems, the level of specificity of trait definitions may be considerably

Table 2. Examples for health data recording with different specificity via the comprehensive key for health data recording included as annex in the ICAR guidelines for Recording, Evaluation and Genetic Improvement of Health Traits

Code	Technical term
1.	Organ diseases
1.05.	Diseases of the cardiovascular system
1.05.06.	Disorders of blood vessels
1.05.06.02.	Shock (acute circulation insufficiency)
1.05.06.02.01.	Hypovolemic shock
2.	Reproduction disorders in females
2.05.	Female infertility
2.05.02.	Ovarial infertility
2.05.02.04.	Ovarial cysts
2.05.02.04.02.	Luteal cystic ovary disease
6.	Metabolic diseases and deficiencies
6.03.	Disturbances of mineral balance
6.03.01.	Disturbances of calcium and phosphorus balance
6.03.01.01.	Parturient paresis (milk fever)
6.03.01.01.02.	Parturient coma / Stage 3 of parturient paresis

lower in joint analyses. However, the increased amount of available data with respective impact on reliabilities may outweigh the loss of details when compared to specific single-source analyses.

With the first release of the ICAR health guidelines, version 1.1 of the health key was published (ICAR, 2012) which was recently updated to allow active recording of absence of certain diseases. Accordingly, standardized documentation is now also possible for extended health-documentation for instance in connection with claw trimming, 'Examination of the claws with no abnormality detected' (1.10.00.), or some gynecological herd screening, 'Examination of the female reproductive system with no abnormality detected' (2.01.00.). With this extension of the key, development towards data structures of test-day-model type is enabled, which is particularly relevant for farms with already established routines and desirable from the analysts point of view. Compared to the recording of only cases which requires assumptions regarding animals without disease records and at-risk periods (Koeck *et al.*, 2012) the picture of the health status of the herd is much more complete when using data from herd screens. However, it is unlikely that broad use will be made of active recording for healthy cows in the near future.

In addition to the expertise of the user of some documentation system, the intention of health data collection is an important factor for how many details are to be saved. To survey herd management, broad and simple documentation may be easiest to implement, so a subset of diagnoses with few details could be used in standard software solutions (Østeras *et al.*, 2007). Optionally, farmers may extend this set by items referring to their herd-specific focus of health disorders in order to obtain information for targeted optimization. Professions like claw trimmers collect data on only relatively small subset of traits, but are interested in options for very detailed recording. Finally veterinarians require solutions for detailed documentation for

Use of the comprehensive health key

the full spectrum of traits, covering all organ systems and types of diseases. With the choice of items from the comprehensive hierarchical health key, recording systems can be designed which reflect user-demands and at the same time facilitate data flow in integrative systems. Cross-referencing between a simplified key for veterinary medical layman (observations of impaired health from farmers) and some specific expert keys (general or organ-specific veterinary key, claw trimmers' key etc.) is avoided, facilitating combination of health data from different sources.

Availability of a single clear and comprehensive reference for health data recording can become the key factor for long-term success of integrative health monitoring concepts, because it maximizes the chances of fruitful collaborations between all parties involved. The hierarchy can guide users and analysts in data recording and processing as well as results interpretation. If needed, focuses can be defined and re-defined with shifts towards more detailed documentation for some disease(s) or disease complex(es) than for others, keeping the same key for coding. Analyses of appropriate depth can be run with maximum information and minimum risk of misinterpretation due to linking of different keys. Experiences with the central key for health data in Germany have shown that harmonized definition and coding of health data can be considered as first step towards an integrative concept of health monitoring in dairy cattle. The central key for health data recording is today equally used in herd management software for farmers, claw trimmers' software and veterinary software, implying that the requirements for an integrative health monitoring system have been fulfilled.

In the era of genomics, international collaborations have become extremely important, implying the need for internationally harmonized definition of phenotypes. With the ICAR health guidelines the standard has been set for international efforts to improve dairy health in a targeted manner and using the full range of available methodologies.

List of References

Appuhamy, J.A., B.G. Cassell & J.B. Cole, 2009. Phenotypic and genetic relationships of common health disorders with milk and fat yield persistencies from producer-recorded health data and test-day-yields. J. Dairy Sci. 92: 1785-1795.

Egger-Danner, C., B. Fuerst-Waltl, W. Obritzhauser, C. Fuerst, H. Schwarzenbacher, B. Grassauer, M. Mayerhofer & A. Koeck, A., 2012. Recording of direct health traits in Austria - Experience report with emphasis on aspects of availability for breeding purposes. J. Dairy Sci. 95: 2765-2777.

Fourichon, C., F. Beaudeau, N. Bareille & H. Seegers, 2001. Incidence of health disorders in dairy farming systems in western France. Livest. Prod. Sci 68: 157-170.

ICAR (International Committee for Animal Recording), 2012. International agreement of recording practices. Available online at *www.icar.org/pages/statutes.htm* (assessed 25 May 2013).

Koeck, A., F. Miglior, D.F. Kelton & F.S. Schenkel, 2012. Health recording in Canadian Holsteins: Data and genetic parameters. J. Dairy Sci. 95: 4099-4108.

Østeras, O., H. Solbu, A.O. Refsdal, T. Roalkvam, O. Filseth & A. Minsaas, 2007. Results and evaluation of thirty years of health recordings in the Norwegian dairy cattle population. J. Dairy Sci. 90: 4483-4497.

Stock, K.F., D. Agena, S. Spittel, R. Schafberg, M. Hoedemaker & F. Reinhardt, 2012a. Comparative analyses of health traits from regional projects for genetic improvement of dairy health. 63. Annual Meeting of the EAAP on 27-31 August 2012 in Bratislava / Slovakia; abstract no. 14772 (S28).

Stock, K.F., J. Cole, J. Pryce, N. Gengler, A. Bradley, L. Andrews & C. Egger-Danner, 2012b. Survey on the recording and use of functional traits in dairy management and breeding. Proc. ICAR Annua!Meeting on 30 May 2012 in Cork l Ireland.

Zwald, N.R., K.A. Weigel, Y.M. Chang, R.D. Welper & J.S. Clay, 2004. Genetic selection for health traits using producer-recorded data. I. Incidence rates, heritability estimates and sire breeding values. J. Dairy Sci. 87: 4287-4294.