French Reference Centre
for Animal Welfare

OPINION

Effects of transport on the welfare of calves under five weeks of age

Original title in French

Conséquences du transport sur le bien-être
des veaux âgés de moins de 5 semaines

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French Reference Centre for Animal Welfare

Effects of transport on the welfare of calves under five weeks of age

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Summary

In 2023, the European Commission published a proposal for a regulation on the protection of animals during transport to replace Council Regulation (EC) No 1/2005. This new text proposes regulatory transport conditions based on the recommendations of the EFSA opinion on the welfare of cattle during transport, with specific recommendations concerning the transport of calves (EFSA AHAW Panel, 2022). The new regulatory proposal would increase the minimum age for the transport of calves to 5 weeks, whereas the minimum age is currently set from 10 days (for journeys over 100 km) to 14 days (for journeys lasting more than 8 hours). At the request of the Animal Welfare Office (BBEA) of the General Directorate for Food (DGAL) at the French Ministry of Agriculture, this report, written by the FRCAW, addresses the main welfare issues encountered during the transport of calves under 5 weeks of age. The information reported by the EFSA has been supplemented by a comprehensive analysis of scientific literature not cited in the EFSA opinion, particularly studies that have been published since 2022. In Europe, calves are generally transported at the age of 2 to 4 weeks, a sensitive stage in their lives during which their own immune systems have not yet developed and their thermoregulatory capacities are limited. For such animals, transport conditions are likely to increase fatigue, stress, dehydration, the development of disease and mortality. This vulnerability decreases with age. two-week-old calves are more vulnerable than four-week-old calves, who in turn are more vulnerable than six-month-old calves, whose immune systems have reached maturity. Furthermore, navel healing, which is a regulatory prerequisite for the transport of calves, is complete only at 3 to 4 weeks of age. Throughout this report, the recommendations for the transport of unweaned calves formulated either in the EFSA opinion or by other authors are reiterated. Studies in the literature emphasise the need for good management of colostrum intake from birth to promote the transfer of passive immunity. They also stress that sufficient energy must be provided to calves by offering them milk replacer 4 hours before transport, and that the total journey duration should be limited to 8 hours.

Keywords

Transport / Vulnerable animals / Age / Welfare / Calves

Context

The European regulations on the welfare of farm animals are currently under review. In December 2023, the European Commission issued a proposal for a regulation of the European Parliament and of the Council on the protection of animals during transport and related operations, amending Regulation (EC) No 1255/97 and abrogating Council Regulation (EC) No 1/2005 currently in force. This revision is intended to update regulatory requirements in light of the latest scientific advances on animal welfare during transport, and is based on the expert opinion published by the European Food Safety Authority (EFSA) at the request of the European Commission. Negotiations between Member States were ongoing at the time of publication of this report in French (Autumn 2025) on the proposed regulation.

The EFSA opinion on the welfare of cattle during transport recommends that calves should not be transported before they have reached the age of 5 weeks (EFSA AHAW Panel, 2022). In its proposal, the European Commission draws on the EFSA's work, raising the minimum age for the transport of calves to 5 weeks (European Commission, 2023). Currently, the European regulations permit calves of less than 10 days of age to be transported for journeys under 100 km, and from 10 days old for journeys under 8 hours, provided in both cases that the navel has completely healed. For long journeys (more than 8 hours), calves must be older than 14 days (Council of the European Union, 2004).

Request

As part of the European negotiations currently underway on the minimum age for the transport of calves, the French State, through the Animal Welfare Office (BBEA) of the General Directorate for Food (DGAL), has asked the CNR BEA to answer the following question as fully as possible: 'What are the welfare consequences of transporting calves under five weeks of age?'

Reference documents

+ COUNCIL REGULATION (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97
+ Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of animals during transport and related operations, amending Council Regulation (EC) No 1255/97 and repealing Council Regulation (EC) No 1/2005(2023)
+ EFSA AHAW Panel (2022). Welfare of cattle during transport. EFSA Journal 2022;20(9):7442, 121 pp. https://doi.org/10.2903/j.efsa.2022.7442

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Glossary (English version)

Abomasum

The abomasum in ruminants is the true stomach, which secretes gastric juices. The other digestive compartments (reticulum, rumen, omasum) are forestomachs that enable microbial digestion and hence the breakdown of fodder. These are still developing in calves (French animal welfare chair, 2024).

Assembly centres

Assembly centres are places such as holdings, collection centres and markets where animals originating from different holdings can be grouped together to form consignments (Council of the European Union, 2004).

Calf

A calf is the young (male or female) up to one year of age of a cow. The European legislation for the protection of calves applies to cattle under 6 months of age (Council of the European Union, 2008). Below this age, their digestive systems and nutritional autonomy are still developing. Calves aged from 0 to 1 week are referred to as newborn calves (EFSA AHWA Panel, 2022).

Colostrum

Colostrum is the initial form of nourishment produced by the mammary glands on the first few occasions that a newborn mammal suckles. It is high in nutrients such as proteins, carbohydrates, lipids, vitamins and minerals, but also in growth factors and hormones (Insulin-like Growth Factors (IGFs), Transforming Growth Factors-beta (TGF-β)) and antimicrobial compounds (including immunoglobulins, cytokines and lysozymes) that are essential to the immunological defences of newborns during the first few days of life (see Abdou et al., 2012).

Control post

Control posts are facilities that can be visited and inspected by an official veterinarian and have been approved by the competent authorities as laid down in the European regulations (Council Regulation (EC) No 1255/97). At the control post, animals can rest, feed, drink and be cared for during long journeys (European Commission, 2018a). The journey break must last at least 12 hours (Council Regulation (EC) No 1/2005).

Journey duration (EU ‘journey time’)

In the present report, for the avoidance of ambiguity, ‘journey duration’ is used in preference to ‘journey time’ to refer to ‘the time period during which animals are moved by means of transport, including the time for loading and unloading the animals' (see the Commission of the European Union 2023, definition of 'journey time').

Loading density

Ratio between the number (or preferably live weight) of animals and the surface area available in the vehicle (usually expressed in kg/m²) (Buckham-Sporer et al., 2023a).

Long journey

In the current regulations, a long journey exceeds 8 hours, starting from when the first animal of the consignment is moved (Council of the European Union, 2004).

In the proposed regulation, this is a journey that exceeds 9 hours. A journey starts with the loading of the first animal at the place of departure and ends with the unloading of the last animal at the place of destination (European Commission, 2023).

Lower critical temperature (LCT)

Ambient temperature below which an animal must increase its metabolic heat production to prevent its body temperature falling below the normal range for the species.

Road transport vehicle

Means of wheeled transport that is propelled (lorry) or towed (trailer). The characteristics of transport vehicles vary greatly depending on the transporter and the country. In Europe they may have 1 to 3 decks, each of which may be divided into 2 to 4 compartments. According to EC regulation 1/2005 (Council of the European Union, 2004), there are 2 types of transport vehicle: vehicles used under Type 1 transporter authorisation (< 8 hours) and those used under Type 2 authorisation (≥ 8 hours). In addition to the vehicular features required for both lengths of journey (weather protection, non-slip flooring surface, appropriate loading and unloading equipment, etc.), Type 2 vehicles must be equipped with a properly insulated light-colour roof, a specified water supply system, an active ventilation system, a temperature control system and a warning system to alert the driver if maximum or minimum temperature limits are reached. For journeys lasting 8 hours or more, animals of all ages must also be provided with appropriate bedding.

Space allowance

Area available per animal (expressed in m²/animal), generally calculated on the basis of the weight and body dimensions of the animals (Petherick, 2007).

Stress

Stress, including in animals, refers to the presence of negative affective states. These states occur when the animal feels threatened, whether the threat is real or not. In order to adapt to this threat, the animal responds through its behaviour, with reactions of fight or flight if it is afraid, for example, and through its physiology, with an increase in heart rate and the secretion of certain hormones to enable physical effort, among other things.

Thermoneutral zone (TNZ)

The thermoneutral zone marks the range of ambient temperatures within which metabolic rate and heat production of a homeothermic individual remain fairly minimal and stable independently of the ambient temperature. The zone is bounded by the lower critical temperature and the upper critical temperature (Bracke et al., 2020).

TRACES

TRACES (Trade Control and Expert System) is the web-based system designed to record and track the results of official inspections and controls. It was established by Commission Decisions 2003/24/EC and 2004/292/EC in accordance with Council Directive 90/425/EEC, and is currently used to manage data on animals and animal products and the official controls relating to their movement (Regulation (EU) 2017/625 of the European Parliament and of the Council).

Transport[1]

The movement of animals effected by one or more means of transport, and the related operations, including loading, unloading, transfer and rest, until the unloading of the animals at the place of destination is completed (Council of the European Union, 2004). *This report deals only with road transport by lorry*.

Unweaned calf

Unweaned calves are fed a liquid diet based on milk (or milk replacer). From 1 or 2 weeks of age, solid feed is added to the milk replacer to aid the development of their polygastric digestive system. This mixed diet continues until weaning, at between 8 and 12 weeks of age, when the calf's rumen is sufficiently developed to digest solid feed only. In the present report – as in the EFSA opinion (2022) and in the Regulation (Council of the European Union, 2004) the designation of calves as ‘unweaned’ is used to draw attention to the need for milk (or milk replacer) in calves under 5 weeks of age that are covered by the referral from the requesting body.

[1] Referred to as ‘travel’ in Regulation (EC) No. 1290/2005 (Council of the European Union, 2004)

Upper critical temperature (UCT)

Ambient temperature above which an animal must increase its heat loss and/or decrease its heat production to prevent its body temperature rising above the normal range for the species.

Weaning

In cattle production, weaning refers to the transition phase during which milk (whole milk or milk replacer) is withdrawn from a calf's diet, after which Its digestive system is sufficiently developed to be fed exclusively on solid feed (forage, concentrates). On French dairy farms, calves are considered to be weaned when their consumption of concentrates reaches 2 kg/day and when they weigh at least double their birth weight. Calves are therefore weaned between 8 and 12 weeks of age (average age in conventional farming: 9 weeks; average age in organic farming: 12 weeks) (Pomiès et al., 2023).
Natural weaning in domestic cattle occurs between 7 and 14 months after birth (Enríquez et al., 2011), as animals gradually cease to suckle.

Abbreviations

BBEA

Animal Welfare Office (of the DGAL)

BHB

Beta-hydroxybutyrate

CK or CPK

Creatine kinase (CK) or creatine phosphokinase (CPK)

DGAL

French General Directorate for Food

EFSA

European Food Safety Authority

EU

European Union

EURCAW

European Reference Centre for Animal Welfare

FRCAW

French Reference Centre for Animal Welfare

IDELE

French livestock institute

NEFA

Non-esterified fatty acids

PITD

Passive Immunity Transfer Deficiency

Tables and figures

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1 Method

This document provides a synthesis of information from the literature on the effects of transport on the welfare of calves aged 5 weeks or less. In answering the question, reference has been made in some cases to publications covering animals aged 14 days or under, as this is the threshold below which animals are considered unfit for long journeys under the current European regulation (see *Table 1*). The present opinion is based on the EFSA opinion (EFSA AHAW Panel, 2022) and, where necessary, on the analysis of further literature on this subject, including grey literature and other articles not cited in the EFSA opinion, paying particular attention to works published since 2022. The official version in French of this expertise followed the conventions associated with its purpose, including readability for decision makers. Accordingly, not all references to the EFSA opinion or its sources were flagged, but references to additional materials not mentioned by the EFSA report were included, as were references to specific information in reports cited by the EFSA for other purposes. The English-language version of this report therefore reflects these choices but strives to follow the original English texts as far as possible. The content of the English-language version of the glossary is based on the FRCAW's own definitions and cited sources, but has been adapted where appropriate to suit the requirements of an English-speaking audience.

The bibliographical corpus was established by first conducting a search on the Web of Science^{TM} (WOS) and SCOPUS platforms using the following search parameters:

(transport*) AND (welfare OR "well-being" OR "animal welfare" OR "stress" OR "behavior" OR "behaviour") AND (calf* OR calves OR vealer* OR "bobby calf*" OR "unweaned calf" OR "unweaned calves")

From the 886 documents obtained (823 on WOS and 63 on SCOPUS), duplicates were removed and titles of interest were selected, leaving 154 documents (139 from WOS and 15 from SCOPUS) for further consideration. A final selection of 46 items from the original search was made having read the abstracts and contents, to which 27 further works referenced in the wider search corpus and deemed relevant to the subject of this report were added. Hence, 73 articles from the scientific literature have been referenced in this report, including 17 articles already cited by the EFSA opinion.

A grey literature search was carried out by scanning all documents relating to animal transport and welfare posted on the websites of the IDELE, the Chaire Bien-être Animal (French animal welfare chair), the European Care4Dairy project, EURCAW-Ruminants & Equines, the Irish Department of Agriculture (DAFF) and the European Commission. Seven documents from these sources were selected for inclusion.

In total, the bibliographical corpus compiled for the present opinion therefore consists of these 80 documents, along with the three relevant regulatory reference documents and the EFSA opinion (2022) itself.

2 Calf destinations by type of source farm

According to TRACES data collected within the EU, approximately 1.5 million unweaned calves are transported from one Member State to another each year. The main exporters are Germany (44% of calves exported within the EU), France (18%) and Ireland (8%) (Velarde et al., 2021). Most transported unweaned calves are from dairy breeds.

2.1 Calves from dairy farms

On dairy cattle farms, newborn calves are usually separated from their mothers immediately after birth or within the first 24 hours, after they have ingested colostrum. Reasons for this early separation are, for farmers, better use of the milk produced and monitoring of the calf's colostrum and milk intake and, for the calves, reduction in stress levels, which increase when separation occurs at a later age (4 to 7 days) after the mother-calf bond has been established (Stěhulová et al., 2008). Following separation, calves are bottle-fed and weaned at around 8 to 12 weeks. Most female calves, destined for herd renewal, remain on farm for their entire lives. In France, the males are fattened to be slaughtered either as veal calves, before the age of 8 months (61% of calves), as young cattle, before 2 years of age (14% of calves), or as beef cattle, at around 30-36 months (6% of calves). The remainder of male calves are exported or used for breeding (IDELE, 2022).[2] Calves are usually transported from their farms of birth to specialised fattening farms at between 2 and 4 weeks of age. Calves may travel directly to a fattening farm but mostly travel via markets or collection centres, or spend time at a control post.

[2] The GEB is the IDELE's livestock economics group.

2.2 Beef calves

On suckler farms, calves are reared alongside their mothers, who suckle them naturally until weaning, which occurs at between 6 and 9 months, depending on the calving season (winter or spring). Females are kept on the farm for herd renewal and males are slaughtered at around 18-24 months of age following a fattening phase. Beef breed calves are therefore most often transported after weaning. However, some males are reared as 'suckling calves' to be sold as veal (approximately 10% of production). To prevent these calves from grazing, they are not left in constant contact with their mothers but are instead placed with them at fixed times for suckling (Chaire Bien-être Animal, 2024). 'Suckling calves' are transported for slaughter at around 6 months of age and are therefore not covered by this report.

3 European regulations on the transport of calves

3.1 Current regulations

The following points summarise the contents of the current European regulation (Council of the European Union, 2004) pertaining specifically to the transport of calves:

- **Calves of less than 10 days of age shall not be considered for transport unless the journey distance is less than 100 km**.
- Calves whose **navels have not yet completely healed** shall not be considered for transport.
- **Calves under 6 months of age must be provided with appropriate bedding material** or equivalent material which guarantees their comfort appropriate to the species, the number of animals being transported, the journey duration and the weather. This material must ensure adequate absorption of urine and faeces.
- **Ramps shall not be steeper than an angle of 20°,** that is 36.4% to the horizontal, for calves.
- Unweaned calves still on a milk diet must, **after 9 hours of travel**, **be given a rest period of at least 1 hour,** sufficient in particular for them to be given liquid and, if necessary, fed. **After this rest period, they may be transported for a further 9 hours.**
- **Except if accompanied by their mother, long journeys are only permitted if calves are older than 14 days.**

3.2 Proposals for new regulations

The recent proposal for an EU Regulation on the transport of live animals (European Commission, 2023) (online version available here) proposes new measures applicable to **unweaned calves** for transport by road:

- A **minimum age of 5 weeks** and minimum weight of 50 kg, unless the journey distance is less than 100 km (5-year transition period)
- A **journey duration not exceeding 8 hours**
- By way of derogation from the previous point, a maximum journey duration of 19 hours (**9 hours + 1 hour rest without unloading + 9 hours**), **provided that an efficient feeding system is installed in the vehicle** (5-year transition period)
- **Provision of water *ad libitum* and species-specific milk or appropriate milk replacement at 9-hour intervals** from the start of the journey

Table 1 summarises the journey durations and minimum ages set out in the current legislation and the proposed regulation.

Table 1: Comparison of journey durations and minimum ages specified in Regulation (EC) No 1/2005 (in blue) and the proposed regulation (in green) for calves and adult cattle.

	Current regulation		Regulatory proposal	
	Journey duration/distance	**Min age**	**Journey duration/distance**	**Min age**
Short journey	< 100 km	Navel healed	< 100 km	Navel healed
	> 100 km and < 8 hours	10 days	> 100 km and < 9 hours	5 weeks (50 kg)
Long journey	> 8 hours	14 days	> 9 hours	5 weeks (50 kg)
Calves	(9h-1h-9h = **19h**) x 2 = **38h** (after a minimum break of 24h)		With on board feeder system: 9h-1h-9h = **19h** No on board feeder system: **8 hours** maximum	
Adult cattle	(14h-1h-14h = **29h**) x 2 = **58h** (after a minimum break of 24h)		(10h-1h-10h = **21h**) x 2 = **42h** (after a 24h break) Animals for slaughter: 9 hours maximum	

4 Factors affecting the welfare of calves under 5 weeks of age during transport

Based on a review of the available literature, the EFSA has identified factors that may influence the welfare of unweaned calves during road transport. The main factors are: low level of adaptive immunity, specific nutritional requirements, availability of water, stage of healing of the umbilical cord, vulnerability to disease, handling issues, microclimatic conditions, age, and weight (EFSA AHAW Panel, 2022). Based on the information available in the literature, the **EFSA recommends that unweaned calves under the age of 5 weeks and**

calves whose body weight is less than 50 kg should not be transported. In the following sections, each factor identified by the EFSA is described and then assessed in terms of the constraints associated with transport and the risks posed to calf welfare. Information provided in the EFSA opinion has been supplemented, where necessary, by additional analysis of the literature on the subject.

4.1 Immune system and colostrum

4.1.1 Role of colostrum in the development of immunity in calves

Calves are considered to be agammaglobulinaemic at birth, because the bovine placenta does not allow the passive transfer of antibodies to the foetus. They are therefore highly susceptible to environmental pathogens. The ingestion of maternal colostrum can protect them against such pathogens and is essential for the development of their immune systems. The colostrum a calf ingests contains immune cells and antibodies in the form of immunoglobulins (IgG, IgA and IgM). These are absorbed into its bloodstream in a process known as 'passive transfer' and protect the calf until its own immune system becomes fully functional (*Figure 1*). The endogenous production of IgM (i.e., production by the calf's own immune system) begins approximately 8 days after birth, while endogenous IgA and IgG only reach functional levels from 16 to 32 days after birth. The calf's immune system does not reach full maturity until it is around 6 months old (Chase et al., 2008).

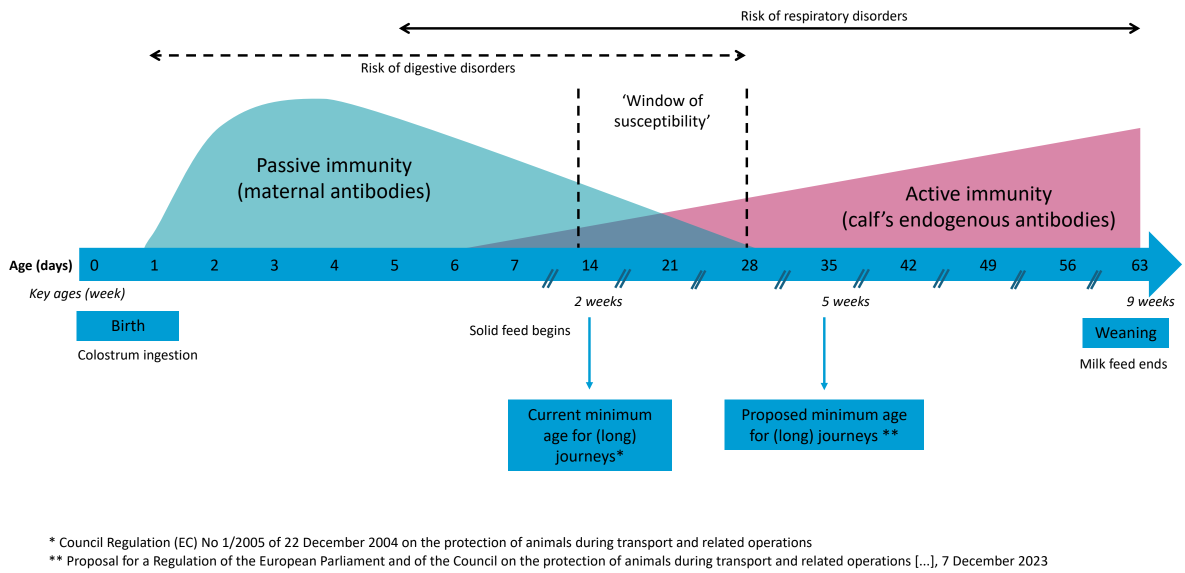

Figure 1. The development of an Immune response in dairy calves and their management from birth to weaning (diagram adapted from Hulbert & Moisá, 2016)

Calves ingest maternal antibodies via colostrum from birth. Starter feed is introduced at around one week of age. The risk period for digestive disorders is shown by the black dashed horizontal arrow. The risk period for respiratory disorders is shown by the solid black horizontal arrow. Between 2 and 4 weeks of age, antibodies from passive transfer are low and the calf is just beginning to develop its own antibody responses to pathogens in the environment. It is during this 'window of susceptibility', or 'immunity gap', (between the dashed vertical lines) that the transport of calves generally occurs. The proposed European regulation would raise the minimum age for transport to 5 weeks. The average age at which calves are weaned from milk or milk replacer is around 9 weeks.

Unlike beef calves, who are left to suckle their mothers, dairy calves are separated shortly after birth and fed maternal or defrosted colostrum. **When colostrum intake is insufficient or delayed, or when the colostrum is of poor quality, a deficit in passive immunity transfer (DTIP) is introduced,** reflected in low measured concentrations of circulating immunoglobulins in the blood of calves aged 2 to 7 days (IgG < 10.0 g/L) (McGuirk and Collins, 2004). Several studies have drawn attention to the close link between insufficient colostrum intake, DTIP and increased calf mortality or morbidity (Godden et al., 2019; Lombard et al., 2020). Since the calf's intestine is permeable only during the first 6 hours after birth, the timing of colostrum intake is crucial. To ensure the passive transfer of antibodies, **a calf must have received 10 to 12% of its birth weight – approximately 4 litres of high-quality colostrum (> 50g IgG/IgL) for a 40 kg dairy calf – by 6 to 12 hours after birth in 2 feedings (of which the first must occur within 2-3 hours of birth)** (see Care4Dairy 2023c. See also Elmore & Chibisa, 2023 for a review of colostrum management as part of mortality and morbidity reduction). European Council Directive 2008/119/CE (Annex I, 15) states that 'each calf must receive bovine colostrum as soon as possible after it is born and in any case within the first 6 hours of life'.
A recent study has shown that consuming only 2 litres, rather than 10 litres, of good quality colostrum during the first 24 hours has a negative impact on feed intake, body weight, gut functionality and calf health and behaviour in the week following transport (Pisoni et al., 2023).

4.1.2 Transport-related constraints

The transport of calves under 5 weeks of age occurs at a sensitive stage in their development, when their immune systems have not reached maturity (*Figure 1*). In cases where the quantity, quality and timing of colostrum intake have not been adequate during the first hours of life, calves may suffer from a deficit in passive immunity transfer, meaning that their health is already compromised at the time of transport. The vulnerability of calves' health is also exacerbated by the stress of transport (see *4.4.2*).

Summary

Proper management of colostrum intake from birth, ensuring sufficient quantity and quality, is essential to prevent a deficit in passive immunity transfer and make calves fit for transport.

Recommendations to ensure adequate passive immunity transfer (adapted from Care4Dairy, 2023c)

- All calves should consume high-quality colostrum within 2-3 hours of birth. A second colostrum intake should take place within 6-12 hours.
- The total amount of colostrum consumed within the first 6 to 12 hours should be at least 10-12% of the animal's body weight (e.g. a minimum of 4 litres for a 40kg calf).
- Colostrum must be provided at a temperature of 38-40°C and its quality (> 50 g/L protein, including IgG) checked using a Brix refractometer (Brix measurement ≥ 22)

4.2 Specific nutritional requirements

4.2.1 Feeding of dairy calves

4.2.1.1 Provision of milk

At the beginning of a calf's life, it is 'pre-ruminant', with a digestive system that cannot process solid feed. Only the abomasum, enabling it to digest milk, is functional. After dairy calves have received their first colostrum and have been separated from their mothers, they are fed artificially twice a day using an open or nipple bucket, a 'milk bar' (container with several flow-controlled teats) or an automatic milk feeder. They are fed either whole milk from milking, powdered milk replacer diluted in hot water, or a combination of the two (Pomiès et al., 2023). The minimum amount of milk provided on farm that meets maintenance requirements is typically 10% of a calf's body weight. When milk is freely available, **young calves can feed up to 12 times a day, or once every 2 hours** (Borderas et al., 2009), and the quantity consumed can be as high as 20% of body weight per day at between 2 and 6 weeks of age (Lidfors et al., 2023). To meet maintenance and growth requirements, facilitate gastrointestinal development and prevent signs of hunger, **the recommended daily intake of milk is 20% of body weight**, i.e., **10L per day for a 50kg calf** (Khan et al., 2011; Jongman et al., 2020). According to European Commission Directive 2008/119/EC (Annex I, 12), '[a]ll calves must be fed at least twice a day'.

4.2.1.2 Sucking behaviour

Calves display strong sucking behaviours for both physiological and behavioural reasons. The act of suckling, whether naturally from the udder or from an artificial teat (generally described as 'bottle' feeding), allows a calf's head to be positioned in such a way that milk does not enter the still-developing rumen, thereby reducing the risk of digestive problems. When liquid feed is provided through, it must be possible for this natural sucking action to occur, alternating between negative and positive pressure phases and triggering a physiological reflex in the oesophageal groove found in young unweaned ruminants (Comline & Titchen, 1951). This reflex allows the ingested milk to bypass the three undeveloped forestomachs (the rumen, reticulum and omasum) and be directed straight to the abomasum. Given the opportunity, newborn calves suckle an average of 4 to 9 times per day (6 to 7 minutes per suckling session on average), a rhythm that decreases with age, while the duration of the suckling sessions increases (Lidfors et al., 2023). When calves are unable to suckle sufficiently, they may develop cross-sucking behaviours (non-nutritive sucking directed towards other calves), particularly if the quantity of milk intake is less than 6 litres per day.

4.2.1.3 Introduction of solid feed and weaning

From an age of 2-3 weeks, calves naturally consume fibrous feed (provided in the form of a 'starter' ration containing concentrates, and forage), which allows them to develop their adult polygastric digestive systems. The plant fibres are broken down in the rumen. Concentrated feeds should contain easily digestible ingredients and be enriched with protein, minerals, vitamins and iron (Care4Dairy, 2023b). To meet their basic physiological and behavioural needs, calves should receive 16-22 MJ of energy and 160-240 g of crude protein daily (Velarde et al., 2021). **For dairy farming, it is recommended that solid feed be made available from the first week onwards**, even though calves are unable to compensate for a low milk intake in the first 6 weeks of development. **Only once they reach 8 to 9 weeks** of age can metabolisable energy be provided entirely by solid feed (Rosenberger et al., 2017) and **calves be generally weaned** from milk feed *(Figure 1)*. To achieve gradual weaning, dairy calves must consume at least 1 kg of concentrate per day for three consecutive days before their milk ration is reduced (Farm Animal Welfare Advisory Council, 2020). Under natural conditions, the weaning process occurs at between 7 and 14 months of age, at which point the calf spontaneously ceases to suckle (Enríquez et al., 2011).

4.2.2 Feed restriction related to transport

4.2.2.1 Prolonged feed deprivation

Currently, it is technically challenging to feed unweaned calves in transport lorries, a constraint that significantly extends the interval between feedings. In Europe, it is permissible for calves to be transported for up to 9 hours before a rest of at least 1 hour, during which they should 'be given liquid and, if necessary, fed.' They may then continue their journey for a further 9 hours (*Table 1*) (Council of the European Union, 2004). In cases where the animals are not offloaded for the one-hour break, and where no on-board vehicle feeding system is installed, the logistics of providing milk feed for each calf during this break may be viewed as overly complicated by the transporter. **The calves may hence be deprived of feed for a total of 19 hours.** This can however become an issue, since **prolonged hunger is one of the main causes of mortality during the transport of unweaned calves** (Velarde et al., 2021). The maximum interval tolerated by calves between feedings has not as yet been clearly determined in the literature. **Although blood glucose levels would appear to remain stable for up to 14-18 hours of fasting, signs of hunger, dehydration, metabolic stress and gastrointestinal permeability can appear much earlier.** The metabolic and energy balance of 18-day-old calves is less affected following 6 hours of transport without feeding (lower NEFA and BHB concentrations and higher serum glucose levels) than after 18 hours. Similar results were observed in 14-day-old calves subjected to feed withdrawal periods of 8 or 19 hours, suggesting that their energy balance was less affected after 8 hours than after 19 hours of feed deprivation. Additionally, 19 hours of feed restriction can modify gastrointestinal permeability, causing endotoxin infiltration and activating an inflammatory response (Pisoni et al., 2022). Based on farm practices, a **maximum interval of 12 hours between 2 milk meals is recommended by the EFSA**, but this recommendation needs to be validated under transport conditions that make greater demands on calves' energy requirements. The proposed European regulation would limit the period spent without feed to 8 hours unless feeding systems are present on board the vehicle, in which case the journey could last 19 hours *(Table 1)* (European Commission, 2023). This measure would limit the negative effects of prolonged fasting on metabolic stress and calf health. In the case of long journeys, though, it would require an acceleration in the development of such on-board feeding systems, which are currently only at the prototype stage.

4.2.2.2 Nutritional deficiency

Before leaving a control post, the final meal often given to calves is an oral electrolyte solution (in the form of a mineral-based feed supplement that may also contain glucose/lactose), which is known to aid digestion and reduce the risk of diarrhoea and dehydration. Based on the existing scientific literature, the EFSA opinion considers that **this intake does not fulfil the nutritional and energy needs of calves and should not be an alternative to milk or milk replacer,** which are rich in essential nutrients, proteins and fats. Feeding electrolytes compared to a milk replacer before transport is associated with an increase in creatine kinase (CK) and lactate in the blood, indicating potential muscle fatigue, and an increase in NEFA and BHB concentrations, signalling an imbalance in energy profiles (Marcato et al., 2020). When calves were fed an electrolyte solution instead of milk replacer before departure, a higher occurrence of diarrhoea and respiratory diseases was observed during the 2 weeks following transport (Bajus et al., 2024). Further scientific studies are necessary to determine the respective health benefits for calves of an oral electrolyte solution or a milk replacer as the last meal before transport.

4.2.2.3 Digestive disorders

Based on the recommendations of the Irish Department of Agriculture (Farm Animal Welfare Advisory Council, 2020), **the EFSA takes the view that, after a milk meal, unweaned calves need 1 to 3 hours of calm rest with sufficient space to lie down and digest their meal before being loaded** (EFSA AHAW Panel, 2022). It is known that the stress of loading immediately after a meal prevents the formation of a casein clot in the abomasum and increases the risk of diarrhoea.

4.2.2.4 Post-transport feed intake

In unweaned calves, **transport combined with prolonged feed deprivation affects the recovery of feed intake levels for up to 7 days after arrival**, especially if the journey duration is long (Pisoni et al., 2020).

Summary

When milk is freely available, young calves can feed up to 12 times a day, or once every 2 hours. Calves display a strong sucking behaviour. The calf must be 8 to 9 weeks old before metabolisable energy can be provided entirely by solid feed and is generally weaned at this age. Of the constraints associated with the transport of unweaned calves, prolonged feed deprivation is one of the main indirect causes of mortality. Under current regulations, the period spent without feed can sometimes last up to 19 hours.

The EFSA's recommendations on milk intake before and during transport

- The recommended daily quantity of milk is equivalent to 20% of body weight, i.e. 10 litres per day for a 50 kg calf.
- The last meal should be given approximately 4 hours before loading onto the lorry to allow calves 3 hours to rest and digest their meal, thereby reducing the risk of diarrhoea during transport.
- The interval between meals should never exceed 12 hours.
- Before transport, the last meal provided should be milk or milk replacer.
- The liquid feed must be at the correct temperature (38-40°C), should not be contaminated, and should be diluted to the correct concentration to avoid digestive problems.
- Feeders with teats are necessary to satisfy the calves' need to suck. The teats should be made of soft rubber and enable alternating phases of positive and negative pressure.
- In the absence of calf feeding devices inside the lorry, the maximum journey duration should not exceed 8 hours.

Additional recommendations for post-transport feeding

At their destination, 'make sure that calves are familiar with the drinking system to supply milk, milk replacer or electrolyte solutions' (European Commission, Directorate General for Health and Food Safety (2018b), in order to facilitate the resumption of feeding.

4.3 Provision of water

4.3.1 Natural needs

Even if unweaned calves are given a liquid feed (milk or milk replacer), they have a fundamental need for water, particularly for rumen development (Kertz et al., 1984). When sources of water are made available, calves will drink. This does not diminish their milk consumption and reduces non-nutritive oral behaviours, especially unwanted cross sucking directed towards other calves (Gottardo et al., 2002). **Calves drink approximately 5 litres of water** in addition to their milk feed for every kilogram of dry feed they consume (Farm Animal Welfare Advisory Council, 2020). The water must be clean and lukewarm, and should be provided *ad libitum* from birth. Water consumption depends in part on the ambient temperature: at 30°C, consumption is twice as high as at 0°C.

4.3.2 Transport constraints

Transport lorries, control posts and assembly centres are equipped with drinking troughs, but these are not always suited to the sucking needs of unweaned calves, which may prevent them from drinking properly. According to DG (SANTE)'s audit report 2023-7719, no guidelines exist for the assessment of the suitability of drinking systems for unweaned calves in vehicles. Notwithstanding this fact, the **watering of calves during transport is essential and is mandatory on journeys longer than 8 hours.** Severe dehydration can lead to lethargy, weakness, hypovolaemic shock and death. The clinical signs of dehydration can be observed by using the skin tent test (Pempek et al., 2017). When the animal's skin is pinched, the 'tent' should disappear in less than 2 seconds, returning the skin to its normal state (Goetz & Renaud, 2024).

Summary

The provision of water during calf transport is essential. However, no guidelines exist to assess whether watering systems provided in-vehicle for unweaned calves are adequate.

EFSA recommendations for the provision of water to calves during transport

At control posts, the height of drinking troughs should be 50 cm for calves weighing 50 kg.

Additional recommendations (European Commission, 2018a)

- Young calves should be given lukewarm water (around 30°C), as cold water can cause diarrhoea (especially in winter).
- Electrolytes may be added to the water to lessen dehydration.
- In the transport vehicle and at control posts, calf feeding systems must be equipped with rubber teats.

- Sufficient drinking troughs must be provided in each compartment of the lorry (or in each pen at control posts) for every calf to be able to drink (a minimum of 2 teats per compartment).

4.4 Vulnerability to disease

4.4.1 Health status of unweaned calves

Before weaning, calves are vulnerable to disease. This vulnerability stems from both the gradual decline that occurs in their passive immunity and the fact that their adult adaptive immune system has not yet fully developed (*Figure 1*). **Diarrhoea and respiratory diseases are the health problems most commonly encountered**. The causes of mortality most frequently recorded are diarrhoea and respiratory diseases, with digestive diseases tending to occur earlier in life (2 weeks of age) than respiratory diseases (5 weeks). The most common treatments for digestive and respiratory diseases are antibiotics and oral electrolytes (see Elmore & Chibisa, 2023 for a review). Multiple factors can cause these conditions, including a number of infectious agents (e.g., bovine respiratory disease virus (BRD), rotavirus, E. coli, Salmonella, etc.) and non-infectious predisposing factors such as the poor colostrum management described above, but also poor neonatal hygiene, environmental contamination, unsuitable microclimatic conditions, and environmental stressors (Care4Dairy, 2023a).

4.4.2 Vulnerability exacerbated by transport stress

Numerous physiological and behavioural indicators of stress have been measured in calves during road transport (for a review, see Buckham-Sporer et al., 2023). These are summarised in the following paragraph.

Concerns over transport and prolonged feed deprivation include the negative impacts of the stress they place on the already fragile immune systems of unweaned calves and on calf protein metabolism and energy status (Earley et al., 2017; Marcato et al., 2020; Pisoni et al., 2022). Increases in NEFAs and BHB blood metabolites have been reported, which impair the immune function and facilitate disease development (Goetz et al., 2023). Other concomitant processes may affect the immune system (increased white blood cell and neutrophil counts, decreased lymphocyte blastogenesis) and the inflammatory system (release of pro-inflammatory cytokines and haptoglobins, decreased antioxidant capacity). The above are associated with an increase in the frequency and severity of respiratory and digestive diseases (for reviews, see Devant & Marti, 2020; Buckham-Sporer et al., 2023). One study has shown that the stress caused by long-distance transport also damages the liver function of young calves (Uetake et al., 2009). Gastrointestinal permeability is a further important health parameter that can be affected by transport conditions and extended fasting, as this is modified by the circulation of cortisol, the main hormone produced by the stress response of the hypothalamic-pituitary-adrenal axis. The free passage of molecules, microorganisms and other pathogens from the intestinal lumen to the bloodstream that result from this permeability increases the chances of developing diseases (Pisoni et al., 2022). The variability in measurement methods and conditions among the studies conducted has produced differences in the results recorded – which is not unusual when studying a biological system – but all results point to a decrease in immune defences linked to transport stress, and hence a greater vulnerability to disease.

The transport of calves during the pre-weaning window of susceptibility (or 'immunity gap') period (*Figure 1*) **thus increases the risk of morbidity and mortality**. During transport, the studies reported by EFSA (2022) show that 6 to 14% of calves suffer from diarrhoea. In one-week-old calves, this diarrhoea can last for up to three weeks following transport (Morrison et al., 2019).

The legislation states that an animal that is already unwell prior to transport is unfit to travel and must not be loaded onto the vehicle (Council of the European Union, 2004). What is more, the transport of a sick animal increases the risk that pathogens will spread to the entire group, particularly when animals are confined in an enclosed space or when groups are mixed in assembly centres. Due to the greater sensitivity of unweaned calves to transport conditions, specific protocols are required in assessing their fitness for transport. Guides setting out the calf health indicators that should be used when assessing fitness for transport are provided on the websites of the European Commission and EURCAW Ruminants & Equines.

Summary

Unweaned calves are particularly vulnerable to diseases, especially those affecting the digestive and respiratory systems. The stress induced by transport can further damage their already fragile immune systems, thereby increasing the risk that such diseases will occur.

Recommendation from the EFSA on the prevention of disease during transport

Adequate provision of colostrum as early as possible post-birth should be part of the preparation for transport.

This measure ensures ensure sufficient immunity to better withstand the stress of transport.

Summary of recommendations for all cattle found to be unfit during transport (European Commission. Directorate General for Health and Food Safety., 2018a)

If any illness or injury is identified during the journey the driver should implement the emergency procedure and take the appropriate measures (unloading the animal(s) and/or providing care). A contingency plan including the list of people to contact along the route (control post, assembly centre, veterinarians, abattoirs) should be available on board the vehicle.

4.5 Vulnerability to microclimatic conditions

4.5.1 Thermoregulation in calves

Calves are homeothermic animals, regulating their body temperature by controlling the balance between the heat produced from their basic metabolism and the heat lost from their bodies to the environment. A calf's level of heat production is determined by its metabolic rate, physical activity and digestion. **For most cattle under one month of age, the TNZ (thermoneutral zone) lies within a range from 5°C to 25°C.** The lower critical temperature (LCT) for calves would appear to vary between 5°C and 15°C, with unweaned calves being more sensitive to cold (Scanes, 2011). The EFSA places the upper critical temperature (UCT) for calves at around 25°C.

4.5.2 Microclimatic stresses associated with transport

Microclimatic conditions in transport vehicles are difficult to control. The dairy calves transported have low body fat reserves, making them less efficient at thermoregulation. In addition, limited feed intake or prolonged fasting during transport constrains the production of metabolic heat linked to digestion, making young calves even less tolerant to cold (Schrama et al., 1992). **A possible passive immunity deficit in calves suffering from colostrum deficiency prior to transport increases their risk of disease (pneumonia, gastroenteritis), especially if ventilation and ambient temperature are not sufficient or appropriate, going beyond the upper or lower critical limits of the TNZ.**

Summary

If the microclimatic conditions inside the vehicle are not satisfactory and temperatures fall outside the limits of a calf's TNZ, the risk of disease increases.

EFSA recommendations on microclimatic conditions during transport

To avoid heat stress for unweaned calves, the EFSA recommends a minimum temperature of 15°C and a maximum temperature of 25°C inside the vehicle. In cold weather, a minimum litter depth of 15-20 cm is necessary for calves to be able to nest and trap warm air around themselves. Straw is particularly effective in winter, while sand or sawdust is preferable in summer.

The FRCAW's 2025 report on the thermal comfort of cattle, including calves, during transport summarises the EFSA's recommendations (CNR BEA, 2025).

Additional recommendations (European Commission. Directorate General for Health and Food Safety., 2018b)
In cold weather:
- Prewarm vehicles prior to loading
- When necessary, apply additional heating

In hot weather:
- During breaks or delays, water the calves manually

4.6 Umbilical healing

4.6.1 Umbilical cord healing period

In livestock farming, daily observations are required to ensure that the navel is healing properly, with the provision of appropriate care where necessary. Besides the local infection, bacteria can also spread via the bloodstream into joints and other organs (Wieland et al., 2017). The wound also acts as an entry point for pathogens. In the EU, calves are considered unfit for transport until their navels are completely healed (Council of the European Union, 2004). According to Roccaro et al. (2022), **full healing occurs only after 3 or 4 weeks. This would mean that calves should not be transported before this age**. However, the length of the healing period would appear to vary greatly between individuals (Von Konigslow et al., 2022) and differs between studies. Von Konigslow et al. (2022) found that 56% of calves retained their umbilical cord beyond the 15-day observation period, but observed that all calves had **dry navels by day 5.** The discrepancies in the literature are in all likelihood due to the lack of agreed criteria for complete umbilical healing. No criteria are therefore mentioned in the European regulations. **Further work is needed to clarify the criteria for the assessment of umbilical healing and the length of time required for complete healing**, given the high prevalence of inflammation and infection of the navel in dairy calves and its importance in assessing fitness for transport.

4.6.2 Constraints related to transport

The condition of the healed navel should allow a calf's suitability for transport to be determined. It should also be ensured that calves to be transported over distances greater than 100km are more than 10 days old and should only be transported on longer journeys once they are over 14 days old (Council of the European Union 2004). A study from Italy suggests that the presence of a scab covering the umbilical wound (not just a completely dry and shrivelled navel) is an acceptable indicator, as the risk of transporting calves less than 10 days old would be low (4.3%), but that awaiting complete healing of the navel would constitute best practice, giving reasonable certainty that no calves that are too young or unfit are transported (Roccaro et al., 2022). If the navel is not healed, there is a significant risk of umbilical infection. North American surveys cited in the EFSA opinion reported that 8% of calves (aged 5 days) already exhibited umbilical inflammation before transport and that **umbilical inflammation reported on arrival is associated with an increased risk of mortality** in the three weeks following transport. In Europe, no similar studies have been reported on the condition of the navels of unweaned calves, either after transport, or before transport as a criterion for fitness for transport.

Summary

Complete healing of the navel is a regulatory prerequisite for calves to be considered fit for transport. There is no consensus in the literature on the time required for complete healing. The umbilical cord remnant is reported to be dry after 5 days, but healing is only complete at 3 to 4 weeks of age. Further research would help to clarify the criteria for the assessment of umbilical healing and the time required for complete healing.

4.7 Handling problems

The lack of natural herd behaviour in **young calves** makes them **more difficult to move than adult cattle**. In the case of unweaned calves, those less than one week old are more difficult to handle than 10-day-old calves (Jongman & Butler, 2013). The studies cited in the EFSA opinion (2022) specify that the processes of loading and unloading increase the risk of inappropriate handling, injuries, discomfort and pain. Slips, falls, balking and turning are the main problems during loading. During unloading, slips and vocalisations are most commonly observed. Calves that have been group-housed show greater resistance to loading than calves housed individually. As with older cattle, slippery surfaces, lack of appropriate flooring, overly steep loading/offloading ramps and inappropriate side protections can lead to increased human intervention, which increases calf stress. Fear of falling when descending steep ramps can also contribute to stress. Calves, especially those that have had little exercise prior to transport, require lower gradient loading ramps than adult cattle.

Summary

Young calves are more difficult to move than adult cattle.

EFSA recommendation on loading and unloading calves

To limit the risk of falls and injuries, a maximum slope of 20° (or 36%) is appropriate for calves, provided that the ramp is equipped with a non-slip surface and with cleats spaced no more than 30 cm apart.

Additional recommendations (European Commission, 2018a)

- Calves can be individually helped onto the lorry (by placing one hand on the head and the other on the hindquarters of the animal).
- When calves are loaded in groups, group size should be kept to 15 calves.

5 Factors that increase the risk of harm to calf welfare during transport

5.1 Age and weight of calves

In general, the younger the calf, the greater its sensitivity to transport stress. **In Europe, most unweaned dairy calves are transported to a fattening farm at around 2 to 4 weeks of age.** However, as explained above (*Section 4.1*), the transport of calves at this age coincides with a vulnerable period in a calf's life when its immune system is still immature. If calves are suffering from passive immunity transfer deficiency as the result of poor colostrum management during their first hours of life, their chance of achieving good immune status before 5 weeks of age is not assured. Additionally, feed deprivation during transport increases the risk of energy depletion, hunger and hypoglycaemia, particularly in young calves with low body fat reserves (Roadknight et al., 2021). For this reason, the thermoregulation of very young calves is also less efficient and they are therefore easily exposed to the risk of heat stress (Hulbert & Moisá, 2016). Indeed, the lower critical temperature for two-week-old calves has been estimated to be 9.4°C, falling to 6.1°C for four-week-old calves (Davis & Drackley, 1998).

In the scientific literature, few studies have specifically addressed the effects of age at the time of transport on calf welfare. These are outlined below and are summarised in *Table 2*. It should be noted that in the oldest of these studies, the mortality rate was chosen as the variable to be measured.

A 2022 meta-analysis identified only four studies that examined **age** as the sole risk factor for calf welfare during transport (Goetz et al., 2022). In two of the studies cited by Goetz et al. (2022), calves were transported at ages ranging from 1 to 4 days (Barnes et al., 1975) and from birth to over 3 weeks (Staples & Haugse, 1974). In both these studies, mortality rates were higher among younger animals. In the study by Stapels & Haugse (1974), the mortality rate recorded in the weeks following transport was 6% when the calves transported were over 3 weeks old, while that of calves transported at under 3 weeks old was 14-23% (see *Table 2*). However, there is no certainty that these mortalities were directly related to transport, as the study did not include an untransported control group. A different study included in the meta-analysis tested calves' response to novelty after transport at different ages ranging from 2 to 8 days, but the effect of transport itself was not discussed (Eicher et al., 2006). The last study reported in the meta-analysis measured the effect of transport (for 6 and 18 hours) on the stress of calves aged from 1 to 3 weeks (Kent & Ewbank 1986a). These authors compared these results to those they had obtained in another study (not discussed in the meta-analysis) conducted on three-month-old calves transported under the same conditions (Kent & Ewbank, 1986b). In the calves aged 1-3 weeks, the increase in plasma cortisol measured before and after loading was 5 times lower than in the three -old calves. Knowles et al. (1997) attributed this difference, not to lower stress levels in the young calves, but to **the calves' inability to adapt physiologically to transport.** It is known that the corticotropic axis in calves under 4 weeks of age is less functional than in mature animals. In a literature review, Knowles had previously found that **high morbidity and mortality rates were negatively correlated with the age of calves at the time of transport** within the European Union (Knowles, 1995). The author took the view that calves should not be put on the market before they are at least 4 weeks old.

Table 2: Effects of calf age at transport on indicators measured in the scientific literature

A + or – sign indicates the reported comparative increase or decrease in a variable between 2 age groups in a particular study (study references shown in brackets).

	Calf age at time of transport					
	0 weeks	**1 week**	**2 weeks**	**3 weeks**	**4 weeks**	**5 weeks**
Mortality	14-23% (Stapels & Haugse, 1974)			6% (Stapels & Haugse, 1974)		
			5.9% (Marcato et al., 2021)		2.8% (Marcato et al., 2021)	
Carcass weight			- 14.8kg (Marcato et al., 2021)		+ 14.8kg (Marcato et al., 2021)	
Live weight	-1.30kg (Rot et al., 2022)	+ 1.30kg (Rot et al., 2022)				
Nonantibiotic treatment			+ 5.4% (Marcato et al., 2021)		- 5.4% (Marcato et al., 2021)	
Risk of digestive disorders		+ risk (Goetz & Renaud, 2024)	- risk (Goetz & Renaud, 2024)			
Adaptive immunity			- lymphocytes, IgM and IgA (Marcato et al., 2022)		+ lymphocytes, IgM and IgA (Marcato et al., 2022)	
Dehydration		+ dehydration (Goetz & Renaud, 2024)	- dehydration (Goetz & Renaud, 2024)			
Fatigue	+ lying down during and after transport (Bajus et al., 2023)		- lying down during and after transport (Bajus et al., 2023)			

Since the publication of the meta-analysis by Goetz et al. (2022), further studies have been published on the effects of calf age and weight on signs of fatigue observed during and after transport, on morbidity, and on mortality (see *Table 2*). Of these, Bajus et al. (2023) showed that behavioural signs of fatigue were more pronounced in calves less than one week old, with more time lying down during and after transport than in calves aged 1 to 3 weeks (Bajus et al., 2023), while Goetz & Renaud (2024) reported that calves transported at one week of age had a significantly greater risk of dehydration (measured using the skin tent test) and of developing digestive diseases than did calves transported at 2-3 weeks of age (Goetz & Renaud, 2024). With regard to live weight loss during transport, one study showed that calves under 5 days old lost an average of 1.30 kg more than calves aged 5-9 days old (Rot et al., 2022). Meanwhile, Marcato et al. (2021) found that calves transported at 2 weeks of age had a significantly higher risk of mortality than calves transported at 4 weeks (5.9% versus 2.8% respectively) (Marcato et al., 2021). The latter had a significantly higher carcass weight at slaughter (+14.8 kg) and the use of non-antibiotic treatments (anti-inflammatories, multivitamins, anticoccidials) was significantly lower (-5.4%) for this group than for two-week-old calves. Indeed, a different study led by Marcato found that **adaptive immunity measured several weeks after transport was more developed** (significantly higher lymphocyte counts and IgM and IgA antibody levels) **if calves were transported at 4 weeks rather than at 2 weeks** (Marcato, et al., 2022). Only from the age of 6 to 8 weeks is the immune system sufficiently effective (see 4.1) for calves to withstand the challenge of transport , even though **full maturity of the immune system is not reached until the age of 6 months**. According to Velarde et al. (2021), best practice would be to **increase the minimum age at the time of transport to 6 or 8 weeks**. It should be noted that no studies in the literature on the effects of transport specifically compare calves transported at 5 weeks with calves under 5 weeks.

Some studies have focused on **the body weight** (rather than age) of calves to assess the risks of transport. In this work, the authors estimated that to predict morbidity, the threshold body weight on arrival determined by the Youden index[3] would be 46 kg (Goetz et al., 2021), while to predict mortality, the threshold would be either 44 kg (Goetz et al., 2021) or 48 kg (Renaud et al., 2018). Although the predictive sensitivity [62% for mortality, 55% for morbidity] and specificity [29% for mortality; 46% for morbidity] for disease and death at these thresholds were not high, no other calculated predictor was able to estimate the risk of disease and mortality more consistently. Based on this work, the EFSA (2022) takes the view that calves weighing less than 50 kg are more susceptible than heavier calves to disease (particularly respiratory disease) for several weeks after arrival and are at greater risk of early mortality. In calves aged 1 to 19 days, one study found that signs of fatigue (lying down after transport) were more common in lighter calves, who required a longer post-transport recovery time (Atkinson, 1992).

Based on the studies reviewed in the literature, **the EFSA recommends that unweaned calves should not be transported until 5 weeks old and at a minimum body weight of 50 kg.** However, these thresholds should not be considered in isolation, as older calves with low

[3] The Youden index is a summary measure of the ROC (receiver operating characteristic) curve (Youden, 1950). It is used in Cox proportional hazards multivariate models to measure the accuracy of a diagnostic marker and generate optimal cut-off points to maximise the sensitivity and specificity of continuous predictive variables. Here, the predictive variables are morbidity and mortality rates.

body weights for their age (even if they weigh more than 50 kg) may have health problems and reduced growth performance.

Summary

Calves aged 0 to 4 weeks are particularly vulnerable. In these animals, the conditions surrounding transport are likely to increase fatigue, dehydration, development of disease and mortality. Vulnerability decreases with age, with four-week-old calves being less vulnerable than two-week-old calves.

EFSA recommendation on the age of calves during transport

The EFSA recommends that unweaned calves should not be transported before the age of 5 weeks or at a body weight below 50 kg.

Other recommendations regarding the age of calves during transport

- Minimum age of at least 4 weeks (Knowles, 1995)
- Minimum age of 6 to 8 weeks (Velarde et al., 2021)

5.2 Journey duration

The longer the journey duration for unweaned dairy calves, the greater the negative effects on their welfare and health, especially if transport is combined with withdrawal of feed and water. These effects increase the risk of fatigue, hypoglycaemia, dehydration and weakened immunity. Long periods of feed restriction also affect intestinal permeability, making calves more susceptible to pathogens (see *4.2.2.1* and *4.4.2*). Before transport, it is therefore essential that calves are well prepared for their journey, that the journey is as short as possible and that they are fed properly on arrival (Collard et al., 2000).

5.2.1 Fatigue

Fatigue increases with journey duration. One study showed that calves under 2 weeks old transported for 12 to 16 hours spent significantly more time lying down during and after the journey than those transported for 6 hours (Bajus et al., 2023). According to studies measuring blood parameters such as serum biochemistry, the main effect of journey duration (beyond the effects caused by fasting) is an increase in concentrations of plasma creatine kinase (CK), indicating increased muscle activity, physical lesions and/or fatigue in calves (Todd et al., 2000; Fisher et al., 2014). For journey durations of 10-11 hours, for example, Gebresenbet et al. (2012) found a significant increase in plasma lactate concentration and CK activity compared to shorter journey durations (< 2 hours or 4-6 hours).

5.2.2 Health status

Transporting calves for long periods has a negative impact on their subsequent state of health. Regardless of age, unweaned calves transported for 18 hours have significantly higher plasma concentrations of NEFAs and BHB, indicating greater levels of metabolic and energy adaptation (Kent & Ewbank, 1986b) and lower blood glucose levels (Marcato et al., 2020) than calves transported for 6 hours. Similarly, **following 12 or 16 hours of transport, levels of these blood metabolites were higher, blood glucose levels were lower, and physiological signs of dehydration were more pronounced by comparison with calves transported for 6 hours** (Goetz et al., 2023). Increased diarrhoea in the 2 weeks following a 16-hour journey has also been reported by members of the same team (Goetz & Renaud, 2024). In calves transported over a distance of more than 500 km, blood glucose has been observed to decrease eight times faster with each additional kilometre than in calves transported over shorter distances (Roadknight et al., 2021).

The body weight of calves less than 3 weeks old on arrival at their destination has been studied in relation to journey duration. Calves transported for only 6 hours had a higher weight upon arrival than those transported for 12 hours (-1.15 kg) or 16 hours (-1.96 kg) (Rot et al., 2022). These figures also show that calves transported for 12 hours were heavier on arrival than those transported for 16 hours (Rot et al., 2022). Weight loss during transport is directly related to the prolonged withdrawal of feed and water while in the vehicle, which leads to dehydration and the mobilisation of fat reserves to provide energy (Kent & Ewbank, 1986a; Todd et al., 2000; Fisher et al., 2014). Thus, **the longer the journey duration, the lower the body weight of the calves on arrival**. Other harmful effects have also been observed even for shorter journey durations. Calves less than 1 month old transported for 8 hours exhibited clinical dehydration on arrival and signs of hypoglycaemia up to a week after transport, in contrast to calves transported for 3 hours (Mormède et al., 1982). The incidence of respiratory diseases in the three weeks following transport was also reported to be higher in the group transported for 8 hours.

In a comparison of the distances travelled from the farms of origin, one study reported that calves transported over distances greater than 110 km showed more abnormal physical signs on arrival (chiefly ocular discharge, lack of hide cleanliness, swollen navel and dehydration score the last being indicated by persistent skin tent and/or sunken eye) than calves whose farm of origin was less than 25 km away (Ramos et al., 2023).

5.2.3 Mortality

A link has also been established between the duration (or distance) of the journey and the mortality of unweaned calves, with an increased risk above 400–500 km (Cave et al., 2005).

For journey durations under 10 hours, one study has estimated that the mortality of calves over 4 days old increases by 45% for each additional hour of transport (Boulton et al., 2020).

5.2.4 Length of journey break at the control post

Rest periods at the control post must be long enough to ensure that all animals can rest, feed, drink and be tended to during long journeys. Currently, this minimum 24-hour stop is therefore mandatory after 19 hours (9h-1h-9h) of transport for unweaned calves (*Table 1*) (Council of the European Union, 2004). After this break, the calves are permitted to travel for a further 19 hours. According to the new regulatory proposal, this break at the control post would no longer be required since the destination should be reached within 19 hours (9h-1h-9h) of departure in the case of vehicles equipped with a feeding system. Otherwise, the journey duration should not exceed 8 hours (*Table 1*) (European Commission, 2023).

Some authors comment that a break at the control post not only increases the total journey duration to the final destination but also generates the stress associated with additional loading and unloading and exposure to new environments, also increasing the risk of exposure to disease (Tarrant and Grandin, 2000). Conversely, Marti et al. (2020) consider that, even if the journey is longer, the negative effects on arrival of this extension are negligible because of the feed and rest that have been provided at the control post. Recently, the effects of the duration of a journey break on different types of cattle have been studied (for a review, see Buckham-Sporer et al., 2023). Some authors have reported that a rest period of 8 hours at a control post (8 hours of transit/8 hours of rest/8 hours of transit) improved body weight on arrival compared to journeys without breaks (Goetz & Renaud, 2024), but not if the break was extended to 12 hours (Meléndez et al., 2020). According to Knowles et al. (1997), it is preferable to restrict the journey duration, and the new regulations propose this.

The effects of the one-hour break on board the vehicle

Allowing a one-hour interval between two 9-hour journeys (current regulations) does not allow animals to be unloaded at a control post. They must therefore be watered and fed inside the vehicle, meaning that it must be equipped with an adequate liquid feeding system (*Table 1*) (European Commission, 2023).

Herzog et al. (2020) consider the one-hour rest period to be insufficient to ensure that all calves on board the vehicle are fed. These authors therefore advocate a **reduction in the total journey duration to 8 hours** for unweaned calves. Additionally, the EFSA opinion (2022) reports that unweaned calves need at least 3 hours of rest to properly digest a milk meal. This means that the one-hour break currently mandated is sufficient only for the administration of an oral rehydration solution, which is still preferable to no intake at all and justifies its existence. Nevertheless, to meet the calves' nutritional needs, the provision of milk replacer during the one-hour break without unloading would appear preferable to the administration of an electrolyte solution. Further study would be required before implementing this strategy, to determine the time needed for the calf to digest a milk meal in a vehicle that would begin to move again after one hour. The technological development of lorries equipped with milk feed distribution systems, as specified in the proposed regulations for journeys of more than 8 hours, should be encouraged, while assessing the economic impact of this equipment on the industry.

Summary

Increased journey durations exacerbate the negative consequences of transport on calf welfare, such as fatigue, dehydration and deterioration in an animal's state of health. The appropriateness of a 24-hour break at a control post for unweaned calves is debated among scientists due to the increase it introduces in the total journey duration and the stress generated during loading and unloading. Some authors argue in favour of a limit on the journey duration. A one-hour break where animals are kept in the vehicle between two 9-hour journeys would not be sufficient to allow all calves to feed and digest a milk meal properly before setting off again. Further research is needed on this issue.

EFSA recommendations on journey durations for calves

The EFSA recommends that the journey duration for unweaned calves should not exceed 8 hours.

Recommendation on the duration of the break at a control post

In the case of long journeys, some authors recommend an 8-hour break at a control post, but no longer (Goetz & Renaud, 2024).

6 Mitigating Actions

This chapter identifies levers for action – mainly relating to nutrition – intended to reduce the stress of transport on unweaned calves.

6.1 Before transport

First and foremost, the good **nutritional status of the calf prior to transport**, linked in particular to good colostrum management in the first hours of life, is essential. It helps to mitigate prolonged feed deprivation, maintain physiological functions, facilitate subsequent weaning and ensure a calf's continued growth, health and welfare.

Administering a **milk feed (whole milk or milk replacer) or an electrolyte solution** to calves **at least 3 hours** before transport reduces energy depletion, hypoglycaemia, dehydration and, consequently, body weight loss, but **outcomes are better with a milk feed** (see Paragraph *4.2.2.2*) (Marcato et al., 2020).

In a recent study, a **slow-release milk replacer** (conventional milk replacer mixed with a slow-release milk formula containing microencapsulated carbohydrate, fat and whey protein along with micellar casein) was fed as a one-off single meal before prolonged feed withdrawal to assess its potential effectiveness in maintaining calf blood glucose levels during transport. In measurements taken at 6, 12, and 18 hours after feeding, a significantly greater increase in plasma glucose levels was observed in the slow-release group (+30-40 g/dl) than in the group receiving conventional milk replacer (+0-15 g/dl) (Krump et al., 2023). If further studies confirm this result, such a feed formula offered prior to transport could compensate for the energy deficits of prolonged feed deprivation.

6.2 Inside the transport vehicle

For long-distance transport, lorries are systematically equipped with drinking systems. To encourage calves to drink and reduce dehydration, there must be a sufficient number of drinkers (2 water access points per compartment) **equipped with** rubber **teats** to satisfy the sucking needs of unweaned calves. The water in the drinkers must be at room temperature and electrolytes may be added.

6.3 During the journey break at the control post

The success of calf feeding at control posts depends on the calves' **familiarity with the feeding systems** provided (Meléndez et al., 2021) and **the space available at the feeding point** (Ross et al. 2016). Provision of drinkers containing water to which an **electrolyte solution** has been added next to water drinkers has been observed to increase calves' overall liquid intake (Ferreira et al., 2024), which further reduces dehydration. A further measure could be to offer **acidified milk ad libitum** in the control post **in addition to traditional milk feed** or rehydration solution (Devant & Marti, 2020). Acidified milk has the advantage of not spoiling, even if it is not consumed immediately, since the addition of organic acids helps to preserve its bacteriological quality (Todd et al., 2018).

6.4 On arrival at the fattening farm

Feeding strategies after a journey are primarily intended to help calves recover from dehydration, hypoglycaemia and oxidative stress, to restore the health of their gut barrier impaired during transport, and to prevent further deterioration of their energy status (for a review, see Devant & Marti, 2020). In their survey, Devant and Marti (2020) explore various nutritional strategies and describe the effects of different **recovery feed formulations** intended to restore intestinal function (cytokines, polyamines, clover peptides, prostaglandins) and help calves recover from oxidative stress (vitamin E, carotenoids, minerals, etc.). For example, replacing lactose with dextrose in milk replacer between 3 and 7 weeks of age in fact increases gastrointestinal permeability (Wilms et al., 2019).

Pempek et al. (2024) observed better recovery (reduced risks of passive immunity transfer deficit and hypoglycaemia) in calves that were dehydrated on arrival at their destination if, **in addition to milk replacer, an oral electrolyte solution** was administered for 2 to 3 days following transport (Pempek et al., 2024). In this study, the incidence of dehydration was lower in calves that received the electrolyte solution for 2 days (0.2%) than in those that received no electrolyte solution (0.8%, $p < 0.01$). Additionally, blood glucose concentrations were higher in calves receiving the supplement for 3 days (101.4 mmol/L) than in calves that received it for only 1 day (93.7 mmol/L, $p = 0.01$). In a different study, electrolyte-supplemented water was provided **for 3 days prior to transport and for 30 days thereafter** (Qi et al., 2024). This intake improved peripheral immunity (significant increase in lymphocytes, neutrophils, basophils and immunoglobulins), increased intestinal nutrient absorption and, *subsequently,* improved the respiratory health of transported calves. Additionally, greater weight gains (measured from day 46 to day 108 after transport) were observed in calves receiving the supplement compared with those who did not (30.870 kg *vs* 7.552 kg respectively, $p < 0.001$) (Qi et al., 2024).

7 Conclusions

To support France's position in the European discussions on the proposed revision of the regulations laying down a minimum age of 5 weeks for the transport of calves, the FRCAW here provides an overview of current knowledge (based on the existing literature) concerning the question '**What are the welfare consequences of transporting calves under five weeks of age?**' asked by the DGAL's BBEA. Currently in Europe, most calves are transported to a fattening farm at around 2 to 4 weeks of age. However, it is precisely at this age that the calf's immune system is most fragile, since antibodies from passive transfer are at their lowest levels and the calf's adaptive immunity has not yet developed. At this age, a calf's body reserves are also low. According to the literature, the transport of calves aged 2 to 4 weeks is likely to cause fatigue and stress and increase the risk of dehydration, disease and mortality. This vulnerability decreases with age. Two-week-old calves are more vulnerable than four-week-old calves, who are in turn more vulnerable than six-month-old calves, the age at which their immune systems reach full maturity. Knowles (1995) therefore suggested that **calves should not be transported before the age of four to four-and-a-half weeks**. This recommendation is in line with the regulatory requirement that **complete healing of the navel** is a prerequisite for calves to be fit for transport. Complete healing is **achieved only after 3-4 weeks**, meaning that calves under this age should not be transported. Based on its review of the available literature, summarised in Section 5.1 of this report, the EFSA opinion (2022) recommends an increase in the minimum age for calf transport to 5 weeks. In the absence of studies specifically dealing with five-week-old animals, a formal conclusion that five-week-old calves are significantly less vulnerable than four-week-old calves is not possible. However, the research does demonstrate that the resistance of calves increases gradually with age.

Velarde et al. (2021), meanwhile, consider that the best practice for ensuring the welfare and health of calves during and after transport would be to transport dairy calves after weaning (i.e., at around 8 to 10 weeks) and beef calves at around 6 to 8 weeks. The authors consider that calves of this age have a sufficiently functional immune system and would be able to ingest solid feed provided in the lorries to avoid prolonged feed deprivation during long journeys. The feasibility of providing feed (solid or liquid) in the transport vehicle is one of the avenues for future research discussed in the following chapter.

8 Areas for further research

+ Few studies have been conducted on **the effect of the age of calves at the time of transport on their welfare**. There is a need for further research using validated welfare indicators to investigate cattle aged 2, 3, 4, 5 and 6 weeks, both transported and untransported (control), with measurements taken over a period of at least 6 to 8 weeks following transport (see Knowles (1995). It is essential that the measurement of blood parameters should be accompanied by measurements of health and behavioural indicators, since blood parameters are strongly influenced by age and cannot therefore, in isolation, reflect the impact of transport on unweaned calves.
+ Further research is required on the **energy and nutritional requirements** of unweaned calves before, during and after transport, and on the most effective **rehydration strategies**.
+ There is a need to determine **the effects on a calf's digestion of the consumption of feed (either liquid or solid) while in the lorry**, and the time required for digestion before the lorry can set off again. In calves, the interval between feeding and gastric emptying is unknown. Further research and the **technological development of effective on-board feeding systems** (taking into account both feeder type and quantity) are needed to prevent prolonged hunger in unweaned calves during transport. To supplement the drinkers that are already present and operational during the journey, a **liquid feeding** system (milk-bar type) in each compartment of the lorry could be filled with acidified milk (to preserve its bacteriological quality) during mandatory one-hour breaks where calves are kept on board the vehicle. Further, the on-board provision of an empty feeder system during transport would allow calves to use the teats for non-nutritive sucking behaviours. The provision **of solid feed** (concentrates, hay) during the journey could also be considered. Research needs to be carried out to develop optimal nutritional formulas and feed delivery methods based on the age of the calves, to facilitate ingestion and digestion.
+ There is a gap in the literature on the **optimal duration of journey breaks for the welfare of unweaned calves unloaded** at control posts during long journeys. During such a break, the optimal duration should take into account the time needed for calves to become ready to feed and drink, followed by the time needed for them to rest and digest the meal.
+ An objective clinical **scoring method** needs to be developed to assess when **the navel is completely healed** and to decide whether or not to transport individual calves.
+ Drinkers are often placed at **a height** of 50-75 cm, but **the exact height of the teat** to ensure the optimal position for a calf's head is not known.

+ Last, further basic research is needed to understand the effect of transport on **the mental and emotional states** of calves. This would provide a better understanding of how calves perceive the environmental challenge of transport and would enable informed proposals for improvements to be made.

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