

**Short and Long-Distance Transport of Dairy and Dairy-Beef Cross Calves**

**Gustavo M. Schuenemann, DVM, MS, PhD**  
 Dairy Cattle Health and Management  
 Department of Veterinary Preventive Medicine,  
 College of Veterinary Medicine  
 The Ohio State University Extension

(©2025 G.M. Schuenemann)

---

---

---

---

---

---

---

---

---

---

1

Journal of Animal Science, 2025, 109, skaf341  
<https://doi.org/10.1093/jas/skaf341>  
 Advance access publication 28 September 2025  
 Animal Health and Well Being

OXFORD  
 JOURNAL OF ANIMAL SCIENCE

**Short- and long-distance transport: health, survival and growth of preweaned dairy and dairy-beef cross calves**

**Gustavo M. Schuenemann,<sup>1,\*</sup> and Juan M. Piñeiro<sup>2</sup>**

<sup>1</sup>Department of Veterinary Preventive Medicine, The Ohio State University, Columbus, OH 43210  
<sup>2</sup>Department of Animal Sciences, Texas A&M University, College Station, TX 77843  
 \*Corresponding author: schuenemann.5@osu.edu

- Parturition diets
- Maternity and neonatal care
- **Fit-for-transport criteria and logistics**
- Calf pre-weaning diet and management

(©2025 G.M. Schuenemann)

---

---

---

---

---

---


---


---

---

---

2

 **Rationale for the Study**



- Over 64% of calves are raised-off farms
- Most studies assessing calf transport involve veal calves
- Long-distance transport has been associated with poor calf health (diarrhea and pneumonia), and reduced growth or increased mortality
- Management, housing and nutrition are key for calf survival and growth

(Urtakci et al. 2011; ASI 82:587-590; USDA, 2016; Renaud et al. 2018; JDS 101:2659-2668; Scott et al. 2019; JDS 102:3240-3235; Cramer et al. 2024; JDS 107:2454-2464; Fernandes et al. 2024; J. Dairy Sci. 108:3980-3990)

(©2025 G.M. Schuenemann)

---

---

---

---

---

---

---

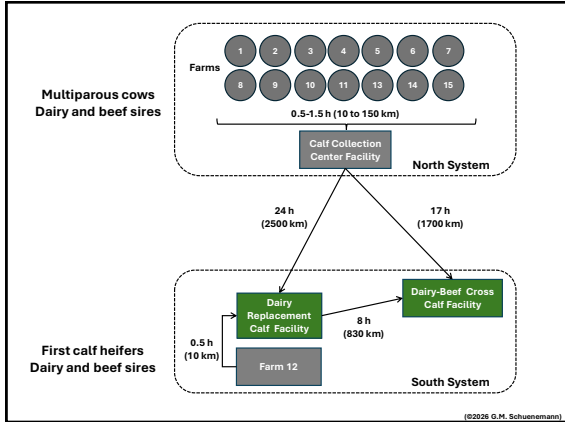
---

---

---

3





7

---

---

---

---

---

---

---

---

### Fit-for-Transport Criteria

Criteria	Description
1) Calving pen and maternity	<ul style="list-style-type: none"> <li>Clean and dry environment</li> <li>Sanitation: Hygiene, Hygiene, Hygiene</li> <li>All newborn calves were washed with warm water</li> </ul>
2) Navel (Umbilicus)	<ul style="list-style-type: none"> <li>Disinfected, completely dry, no signs of swelling</li> </ul>
3) Colostrum intake	<ul style="list-style-type: none"> <li>Quantity + quality + timing to ensure proper IgG transfer</li> </ul>
4) Handling calves with care	<ul style="list-style-type: none"> <li>Gentle loading and unloading with emphasis on safety for both calves and people</li> </ul>
5) General health status	<ul style="list-style-type: none"> <li>Alert, responsive, normal posture and without signs of illness</li> <li>Conditioning protocol consisting of 4 consecutive meals + free choice water</li> </ul>
5) Mobility	<ul style="list-style-type: none"> <li>Able to stand and walk without fractures or joint swelling</li> </ul>
6) Transport trailers	<ul style="list-style-type: none"> <li>Clean and dry bedding (deep sawdust or wheat straw)</li> <li>Adequate space per calf (~0.36 m<sup>2</sup> per calf)</li> <li>Periodic checks</li> <li>Thoroughly washed and disinfected once per day</li> </ul>

(©2026 G.M. Schuenemann)

8

---

---

---

---

---

---

---

---

## Hygiene, Hygiene, and Hygiene

**Pasteurizer (valve): <5 RLU**  
**Tube or bottle: <5 RLU**

**ATP Swabs**

If reading is ≥30 Reading Light Units (RLU) on SystemsSURE Plus, surface is considered dirty. Reading <10 is considered clean

**Maternity Box (20-24 m<sup>2</sup>)**

(©2026 G.M. Schuenemann)

9

---

---

---


---

---

---

---

---



**Neonatal care:**

- Birthweight
- Washed with warm water
- ID with an ear tag
- Colostrum ( $\geq 22\%$  Brix):
  - 1<sup>st</sup> meal of 3.8 L within 2 h of birth (n=142,892)
  - 2<sup>nd</sup> meal of 2 L 6 h later (n=249,172)
- Umbilical cord disinfection
- ...

(©2026 G.M. Schuenemann)

10

---

---

---

---

---

---

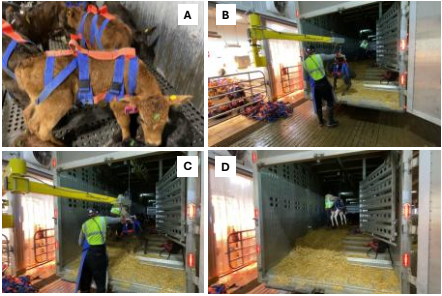
---

---

---

---

**Schematic Representation  
Loading and Unloading Calves**



(©2026 G.M. Schuenemann)

11

---

---

---

---

---

---

---

---

---

---

**What was the Conditioning Protocol  
Prior to Transport?**

- At least 4 consecutive feedings:
  - 2 L per calf (4 L per d with 14% solids)
  - Fourth milk feeding + 1.9 L electrolyte
- All calves who drank 4 consecutive meals and without any signs of illness were considered fit to transport starting at 3 d of age
- Calves were loaded onto the trailers between 30 min and 1 h after their last feeding

(©2026 G.M. Schuenemann)

12

---

---

---

---

---

---

---

---

---

---

Team drivers

2,973 loads  
~0.36 m<sup>2</sup> of space

A n=22  
B n=33  
C n=33  
D n=10  
E n=23  
F n=33  
G n=33  
H n=23

(©2026 G.M. Schuenemann)

13

---

---

---

---

---

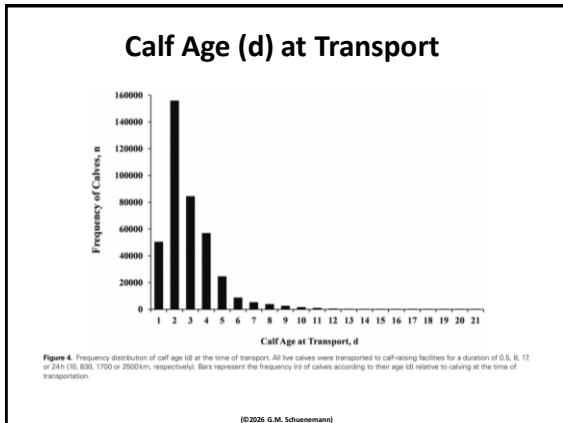
---

---

---

---

---



14

---

---

---

---

---

---

---

---

---

---

## Overall Calf Outcomes

- 392,064 calves transported in 2973 loads

### Calf Mortality:

- Upon arrival: **0.015%**
- At weaning: **2.49%**

(©2026 G.M. Schuenemann)

15

---

---

---

---

---

---

---

---

---

---

### Calf Mortality upon Arrival was 0.015%, did not differ by Transport Duration

**Table 4.** Distribution of calves regarding the effect of birthweight, calving assistance, FPT, age at transport, calf mortality upon arrival at calf-raising facility, preweaning diarrhea and pneumonia, and calf mortality at weaning, and ADG by transport duration

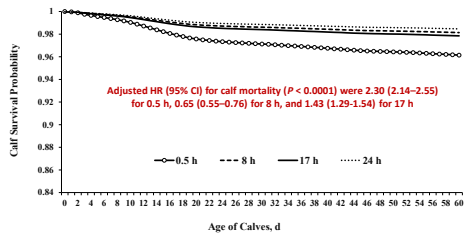
Items	Calf transport duration <sup>a</sup> , h				P-value
	South system		North system		
	0.5	8	17	24	
Calf birthweight <sup>b</sup> , kg	28.50 ± 0.95 <sup>b</sup>	32.09 ± 0.95 <sup>b</sup>	37.41 ± 0.28 <sup>b</sup>	33.84 ± 0.69 <sup>b</sup>	<0.0001
Calving assistance <sup>c</sup> , %	3.48 ± 0.91 <sup>b</sup>	4.21 ± 0.92 <sup>b</sup>	3.61 ± 0.26 <sup>b</sup>	4.79 ± 0.28 <sup>b</sup>	<0.0001
FPT < 1 g/dl <sup>c</sup> , %	1.23 ± 0.12 <sup>b</sup>	1.22 ± 0.23 <sup>b</sup>	0.41 ± 0.12 <sup>b</sup>	0.21 ± 0.10 <sup>b</sup>	<0.0001
Calf age at transport, d	1.63 ± 0.17 <sup>b</sup>	6.93 ± 0.17 <sup>b</sup>	3.08 ± 0.04 <sup>b</sup>	3.47 ± 0.04 <sup>b</sup>	<0.0001
<b>Calf arrival and health</b>					
Mortality upon arrival <sup>d</sup> , %	0.015 ± 0.010	0.005 ± 0.011	0.027 ± 0.006	0.009 ± 0.008	0.32
Diarrhea preweaning <sup>e</sup> , %	17.15 ± 0.77 <sup>b</sup>	3.75 ± 0.77 <sup>b</sup>	3.41 ± 0.24 <sup>b</sup>	16.40 ± 0.27 <sup>b</sup>	<0.0001
Pneumonia preweaning <sup>e</sup> , %	7.21 ± 1.49 <sup>b</sup>	1.73 ± 1.49 <sup>b</sup>	9.48 ± 0.42 <sup>b</sup>	7.64 ± 0.44 <sup>b</sup>	<0.0001
Mortality at weaning <sup>f</sup> , %	3.65 ± 0.32 <sup>b</sup>	1.05 ± 0.26 <sup>b</sup>	2.53 ± 0.10 <sup>b</sup>	2.98 ± 0.12 <sup>b</sup>	<0.0001
<b>Pre-weaned calf performance<sup>g</sup></b>					
BW at weaning, kg	67.39 ± 0.96 <sup>d</sup>	83.69 ± 0.82 <sup>d</sup>	86.34 ± 0.65 <sup>d</sup>	80.54 ± 1.12 <sup>d</sup>	<0.0001
Birth to weaning ADG, kg/d	0.65 ± 0.02 <sup>b</sup>	0.86 ± 0.04 <sup>b</sup>	0.82 ± 0.02 <sup>b</sup>	0.76 ± 0.01 <sup>b</sup>	<0.0001

### Calf Mortality at Weaning Differed, Mostly Due to FPT, Calf Diarrhea, Short Gestation, Etc.

(©2026 G.M. Schuenemann)

16

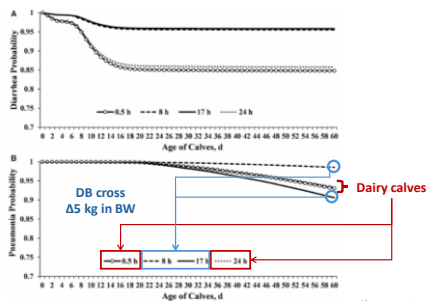
### Cumulative Calf Survival Curves for Time to Mortality (n = 392,064) by Transport Duration



(©2026 G.M. Schuenemann)

17

### Cumulative Survival Curves for Time to Calf Diarrhea (A) or Pneumonia (B)

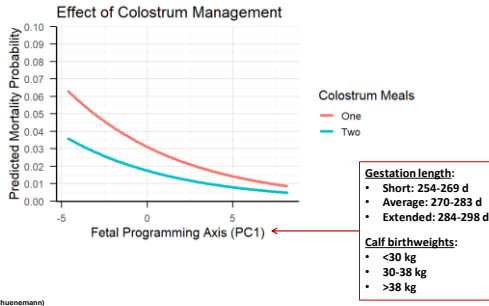


(©2026 G.M. Schuenemann)

18



## Two Colostrum Feedings Mitigates Compromised Fetal Programming



(©2026 G.M. Schuenemann)

22

---

---

---

---

---

---

---

---

---

---

---

---

Calves are born without antibodies (IgG, IgM, IgA), but not immunologically naïve

### Why Does this Matter?

COLOSTRUM intake is necessary but not sufficient

If fetal programming is compromised before birth: IgG may absorb normally, yet fail to respond effectively to pathogens

👉 This explains "high colostrum Brix >> high IgG in blood >> sick calves"

(Hubert and Moisé, 2016 J. Dairy Sci. 99:3199-3216; Saun and Sniffen, 2014 Clin North Am Food Anim Pract 30:689-719)

(©2026 G.M. Schuenemann)

23

---

---

---

---

---

---

---

---

---

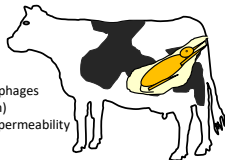
---

---

---

## Why the Last 60 d of Gestation Matters for Calf Immunity?

- ~50% of fetal growth
- Rapid development of calf immunity:
  - Lymph nodes, thymus & spleen
  - Innate immune cells: Neutrophils, macrophages
  - Barrier tissues: GI tract & lung epithelium
- Hypothalamus: Stress, thermoregulation & GI permeability



### Prepartum Nutrition & ↓Inflammation >> Fetal Programming:

- Energy status: ↑cortisol, ↓fetal immune development, ↓IgG
- Protein & AA: lymphocyte proliferation and antibody synthesis
- Trace minerals: Zn (epithelium integrity, innate immunity), Se (antioxidant defense, neutrophil function), Cu (phagocytosis, cytokine signaling)
- Vitamins: A (mucosal immunity in gut and lung), E (antioxidant protection, immune cell stability)

(Hubert and Moisé, 2016 J. Dairy Sci. 99:3199-3216; NASEM 2021 Saun and Sniffen, 2014 Clin North Am Food Anim Pract 30:689-719)

(©2026 G.M. Schuenemann)

24

---

---

---

---

---

---

---

---


---

---

---

---

# Key Health-Related Factors Early in Life Play a Much Larger Role in Calf Mortality at Weaning than Transport Duration

 Calf immunity is largely set before or at calving

- Prepartum nutrition
- Management
- Environment
- Housing
- ...

(©2026 G.M. Schuenemann)

25

---

---

---

---

---

---

---

---

# Calves that Are NOT Fit-for-Transport

- Have not received colostrum
- Unable to thermoregulate
- Dehydrated
- Showing signs of illness (diarrhea, pneumonia)
- Navel swelling or infection
- Fracture, lameness or other injuries
- Unable to stand or walk unassisted
- Recent surgical procedure (e.g., hernia)
- ...

(©2026 G.M. Schuenemann)

26

---

---

---

---

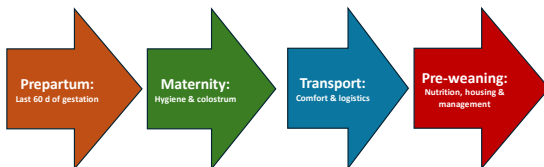
---

---

---

---

# What are the Opportunities?



- 5 Principles of teamwork:
- Appropriate training
- 1) Shared goals
- 2) Clear roles
- 3) Mutual trust
- 4) Effective communication
- 5) Assessing results & continuous improvement

(©2026 G.M. Schuenemann)

27

---

---

---

---

---

---

---

---

Gustavo M. Schuenemann  
Email: schuenemann.5@osu.edu; Ph: +1-614-625-0680

**THANK YOU!**

(©2026 G.M. Schuenemann)

---

---

---

---

---

---

---

---