

# Descriptive characteristics of suckle physiology, milk intake and health in neonatal dairy calves

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## Introduction

The objective of this observational cohort study was to describe patterns in suckle pressure in neonatal dairy heifer calves. Despite technological advancements in precision animal health monitoring, morbidity and mortality in neonatal dairy calves remains pervasive. In calves experiencing diarrhea, suckle reflex can be measured to estimate disease severity by encouraging the calf to suckle on a finger. This diagnostic method is highly subjective. To date, suckle physiology is not well described and sensors to measure the behavior are not available. Our overarching goal is to inform novel sensor design.

## Materials and methods

Female Holstein calves ( $n = 50$ ) from a single New York dairy were enrolled and followed from 1-21 d of life. Calves were raised in pens of 5 from 1 to 5 d, then moved to pens of 20 fed by an automated milk feeder (11 L/d whole milk allowance). Suckle pressure was measured at 1, 3, 5, 7, 10, 14 and 21 d using impression film wrapped around a nipple that calves suckled for 15 sec. Impression image density (scale: 0 to 1), saturation (scale: 0 to 100%), and entropy (scale: infinite) were measured using Python. Milk intakes were recorded daily from 5 d and health scores from 1 d. Statistical analyses were computed in R using summary and lme for fixed effect models to measure least squares means by age.

## Results

Means with standard deviation across sampling days for density, saturation and entropy were  $0.4 \pm 0.1$ ,  $65.4 \pm 27.8\%$  and  $346 \pm 124$  bits, respectively. All suckle pressure metrics peaked at 3 d and declined to 21 d. Density, saturation and entropy means between d 3 and 21 were 0.5 and 0.4 ( $P < 0.01$ ), 1.8% and 1.7% ( $P < 0.01$ ), and 372 bits and 275 bits ( $P < 0.01$ ), respectively. Milk intake increased from 5 to 21 d ( $3.1 \pm 0.6$  kg/d vs.  $7.2 \pm 0.3$  kg/d, respectively;  $P < 0.01$ ). Diarrhea and respiratory disease incidence were highest between 9 and 13 d, and 10 and 21 d, respectively.

## Significance

Consistent patterns in suckle pressure and intake were observed in relation to health outcomes. These findings highlight the potential use of quantifiable suckle characteristics of neonatal dairy calves for veterinary practitioners and producers. These results can be used to inform novel multimodal sensor design. The use of information generated by sensors integrated into the nipples of automated feeding systems for identifying sick calves could provide the opportunity to explore targeted and early interventions. These sensors may also offer a new metric for tailoring feeding and weaning programs on an individual calf basis. Such advancements aim to enhance animal health monitoring, precision management, and overall welfare for neonatal dairy calves. Future work will focus on identifying and quantifying changes in suckle characteristics that are indicative of changes in health status.

