Evaluating disease behavior and health interventions using pattern classification of in-process performance in animal cohorts for flows and systems

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INTRODUCTION

Producers typically evaluate records to determine if farm, flow and system performance are meeting expectations and to detect problems. For both reproductive sites and growing sites, these evaluations typically involve assessing time-series reports as well as cohort-based reports (e.g., breeding and growing animal groups). Time-series reports can be useful, but are inadequate for enabling timely and targeted responses to detected problems. Cohort-based reports are better suited for timely detection of in-process problems, but lack objective rigor, appropriate orientation or both. A model was developed to categorize cohort performance patterns and detect in-phase shifts of tracked measures (e.g., mortality, morbidity, clinical events, feed/water consumption).

MATERIALS AND METHODS

To construct the algorithm for pattern characterization, cohort start date is treated as time zero, and interval segments are user-defined. For each interval segment, a time series chart is generated and statistical process control (SPC) calculations are applied to each set of data, resulting in a time-series SPC chart for each interval. Then the control limits from each time-series interval SPC chart are aggregated into a composite chart, representing the entire cohort period. From this aggregate SPC chart, all control limits are standardized (0,1) and standardized values are then calculated for all individual data points. Using a rule-based algorithm, all standardized data points are classified as Low (L), Middle (M) and High (H). A three-interval pattern classification matrix was developed for all combinations of LMH, resulting in a total of 27 patterns (Table 1). These 27 patterns were then ordinally scaled from least (LLL) to most (HHH) serious, and were further consolidated into eight distinct categories (Table 1). A pilot project was conducted utilizing daily mortality data obtained from two producers. Cohorts were classified by type of mortality pattern and category within specific production phases.

Table 1: Twenty-seven primary categorical pattern combinations for three-interval cohort periods with eight secondary pattern combinations ranked in order of assigned relative severity (X)

First Interval	Middle Interval	Last Interval		
		Low	Middle	High
Low	Low	LLL (1)	LLM (1)	LLH (4)
	Middle	LML (1)	LMM (1)	LMH (4)
	High	LHL (3)	LHM (3)	LHH (7)
Middle	Low	MLL (1)	MLM (1)	MLH (4)
	Middle	MML (1)	MMM (1)	MMH (4)
	High	MHL (3)	MHM (3)	MHH (7)
High	Low	HLL (2)	HLM (2)	HLH (5/6)
	Middle	HML (2)	HMM (2)	HMH (5/6)
	High	HHL (6/5)	HHM (6/5)	HHH (8)

RESULTS

This cohort methodology and model was used to dynamically generate pattern classifications for cohort-based measurments. It was then used to conduct mortality pattern analysis within and among source data producers/production systems. Figure 1 shows an example of a standardized mortality pattern for a single finishing pig cohort. Figure 2 shows an example of four of the eight secondary distinct mortality patterns generated from weekly mortality data for 198 finishing cohorts.

Figure 1: Standardized charts for weekly mortality in a finishing pig cohort (Upper chart: weekly mortality; Lower chart: cumulative mortality)

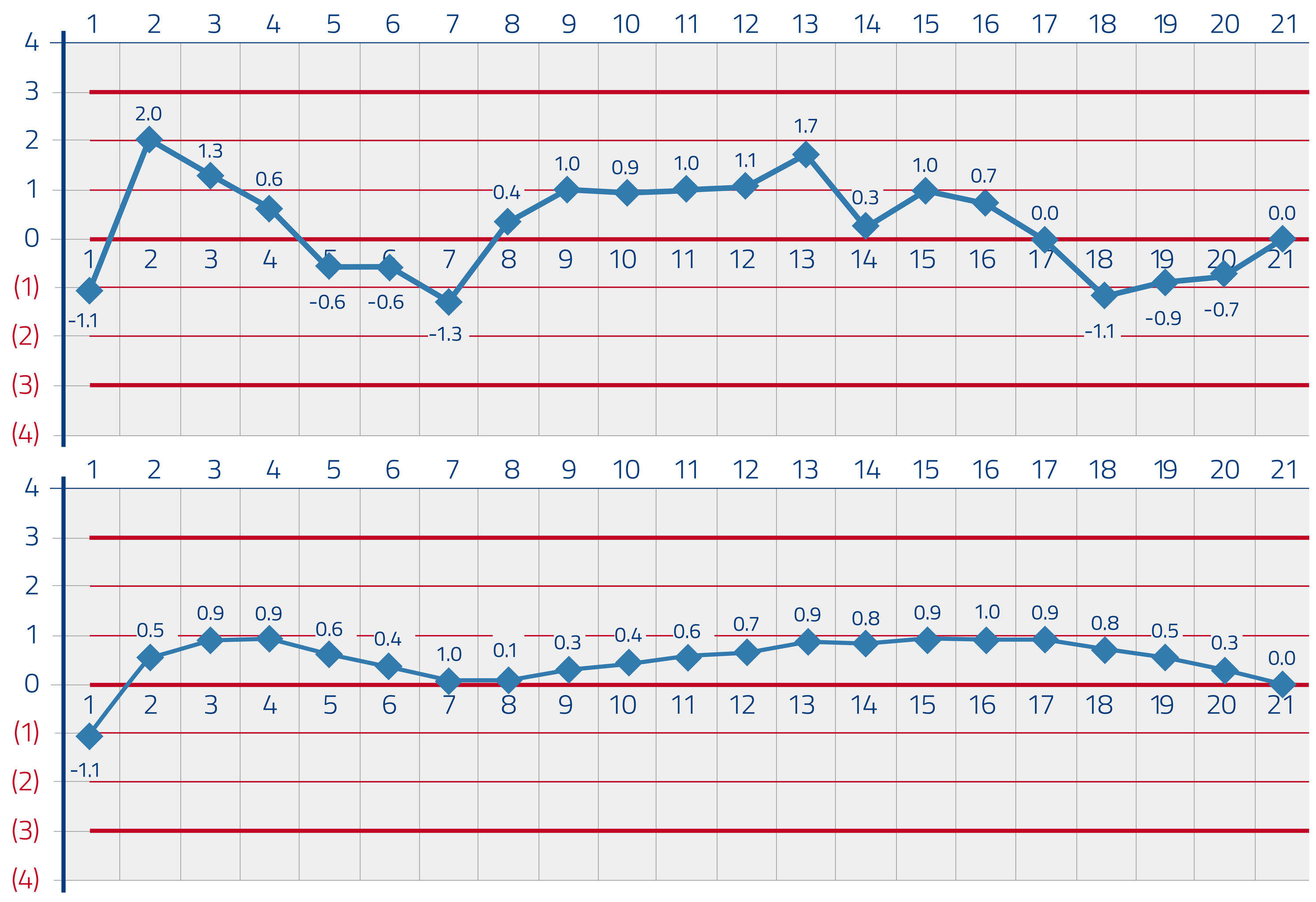
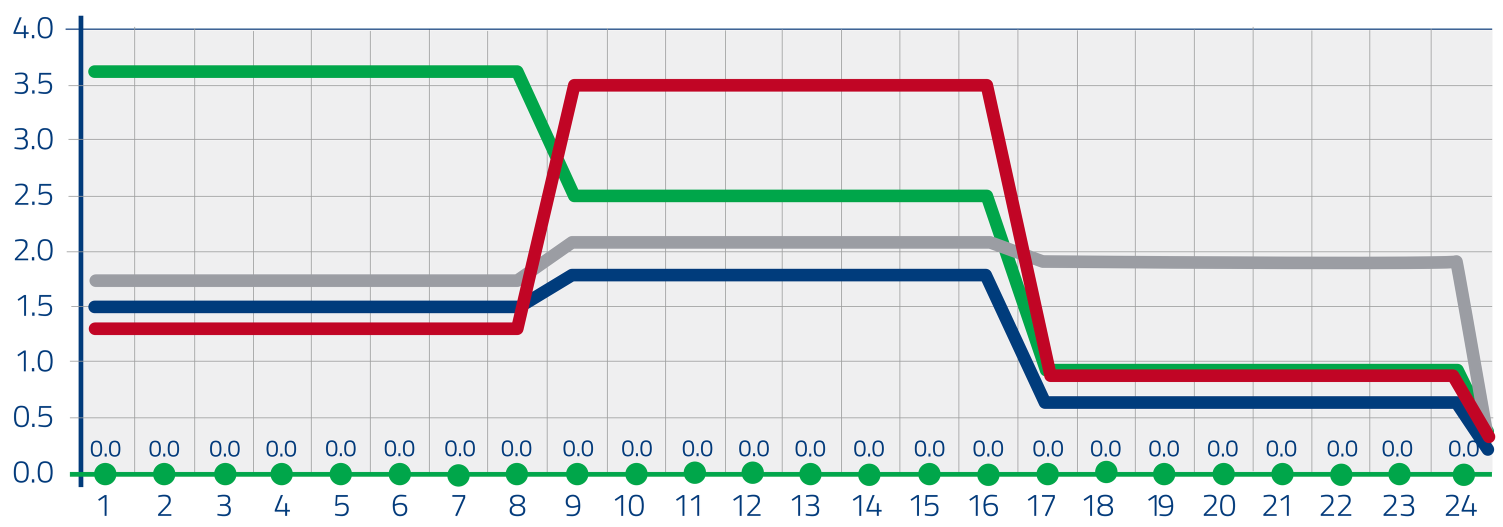


Figure 2: Four secondary mortality patterns generated by a database of weekly finishing cohorts (n = 198)



The model, in conjunction with diagnostic testing, can be used to better inform disease diagnosis as well as enable improved design of interventions. Further, it can be utilized to assess the performance and financial impact of interventions following implementation by enabling the quantification of changes in, for example, mortality patterns post- vs pre-intervention.

CONCLUSION

To evaluate and leverage the methodology, the cohort model will be further developed to include dynamically captured data for leading, early clinical, lagging clinical and ending cohort indicators (e.g., water consumption, cough, mortality, treatments, closeout performance) with systematic animal and environmental sampling/diagnostic testing results; the objective being to improve operational decision-making and intervention design.