Application of Simulation Modelling and Decision Theory for Clinical Trial Analyses : Reproductive Management in a Commercial Dairy.

SLENNING, B. D.
Kingsburg Veterinary Clinic, 1991 Simpson, Kingsburg CA, USA, 93631.

A heat detection based reproduction program was evaluated both biologically and economically against a prostaglandin F2a (PGF) treatment based reproduction program in a clinical trial. Cows from a dairy with a herd average 305 day production over 9,800 kg milk found normal at the pre-breeding examination were randomly allocated to two cohorts: (1) PGF (PT); (n=56) - cows with a palpable corpus luteum were injected with 25 mg dinoprost tromethamine and artificially inseminated (AI) 72 and 96 hours later; (b) HEAT DETECTION (HD); (n=53) - cows identified as being in heat through twice a day observation and tail chalking were AI bred twelve hours later. Commencing one week after PGF, PT animals were tail-chalked and observed for heats with HD animals. Age, body weight, production, and reproductive data were collected for all cows. Milk samples were taken for five days following PGF injection for PT and at all breedings for both cohorts for progesterone analysis.

Data for average age, body weight, and three measures of milk production displayed no significant differences ($p>0.05$) between the cohorts except in the body weight measure ($p=0.03$). When cohort effect was adjusted for lactation number by ANOVA it was no longer statistically significant ($p=0.15$). The baseline data suggest the two groups were comparable cohorts and appropriate for the clinical trial.

Performance outcome data for days in milk (DIM) at 1st, 2nd, and 3rd breedings; days open (DO); and services per conception (S/C) displayed no significant differences ($p>0.05$) between cohorts except for DIM 1st breeding (PT= 56 +/- 9, HD= 60 +/- 12; $p=0.03$). Average DIM at entering the bull string was significantly less for PT than HD (105 +/- 18 vs 119 +/- 23; $p=0.02$) and the open cows entering the bull string for PT tended to fewer, but not significantly fewer, AI breedings than HD (1.7 +/- 0.7 vs 2.1 +/- 0.8; $p=0.07$). Using accepted measures of reproduction (DO, S/C, and breeding DIM) there were no differences in treatments and no advantage to either program.

Cost-accounting using the dairy's average costs of semen ($9.25), inseminator charges ($4.50), veterinary input ($1.15), prostaglandin costs ($3.15), and estimated labor costs ($3.21), resulted in a heat detection based breeding costing $16.96 and a prostaglandin based breeding costing $30.65. The extra PT costs are via breeding twice, doubling insemination and labor costs, and by cost of PGF. The simple cost-accounting combined with the lack of differences in performance suggested a PT strategy is less efficient than an HD strategy.

A deterministic mathematical model calculated discounted income over feedcost (IOFC) as a function of DO using the dairy's costs and performances. IOFC minus costs of breeding determined the expected monetary value (EMV) of getting a cow bred at a certain DIM. These values were then used as endpoints for a decision tree (DT) analysis of the two breeding strategies. Cows not bred by the dairy's own cut-off criteria (>100 DIM or three AI) were valued by assuming probabilities and times of bull breeding and determining IOFC. The DT was composed of four levels of chance events producing 34 endpoints.

DT analysis produced PT EMV of $352, HD EMV of $171, just the opposite of simple cost accounting. Sensitivity analyses imply PT EMV is resistant to changes in conception rates (CR) from 10% through 90% ($349 vs $356) but that HD EMV nearly doubles ($127 vs $236) with this change in CR. Changing heat detection rate (HDR) likewise affect HD EMV more than PT EMV. Sensitivity analyses suggest at HDR between 20%-80% PT EMV is greater than HD EMV; maximum difference ($195) occurs near HDR = 40%.

A survey of veterinary literature will reveal that few clinical trial analyses go beyond statistical measures of performance; those that do rarely apply economic analyses more rigorous than cost-accounting. In fact, the count of papers performing decision analysis on clinical trial results probably equals fewer than twenty. The number of inapproriate conclusions and incorrect choices resulting from this inadequacy is unknown but probably is quite significant. They are entirely avoidable by using simulation modelling and decision theory on clinical trial results.

Proceedings of the 5th International Symposium on Veterinary Epidemiology and Economics, 1988
Published in Acta Veterinaria Scandinavia, Supplementum 84
Available at www.sciquest.org.nz