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Routine quality monitoring of embryo transfer in dairy cattle based on NR56

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1. Introduction

The CR Delta VRV organisation started performing commercial embryo transfer (ET) in The Netherlands around 1980 with MOET (Multiple Ovulation Embryo Transfer). Since the early 1990's this service is extended with OPU-IVP (Ovum Pick-Up In Vitro Production). Currently over 40 ET technicians perform over 10,000 embryo transfers per year. Embryos are collected at the Holland Genetics nucleus farm and on private farms. Of each embryo over 25 variables are recorded concerning embryo production as well as embryo transfer conditions. To monitor the performance of the ET technicians and the overall quality of ET, until now raw averages of gestation-status at 6 to 8 months have been used. This method has two main disadvantages. First, the method is inaccurate since only raw averages are provided. Secondly, the interval between the embryo transfer and information on success of this embryo transfer is long. This makes it difficult to link changes in practice to the success rate. The objective of this study is to develop a procedure, which routinely provides, at an early stage, accurate information to monitor the performance of ET technicians and the overall quality of ET.

2. Material and methods

2.1. Data

Data included observations on 54,622 transfers from June 1997 until June 2001. Information on the embryo production can be divided into information on the donor-cow and the embryo (Table 1). Variables of the donor-cow are identification as well as age (in years) recorded from 0 to 5 and >5. Variables of the embryo include method of collection (MOET, OPU-IVP), quality (class 1, 2 and 3 according to the IETS standard), stage (3 to 8 days), whether the embryo is sexed after collection and its sire. Information on the embryo transfer conditions can be divided into information about the transfer practise and the recipient-cow. Variables of the transfer practise include year*month of transfer, method of freezing/thawing (10% GLY, EGDT, EG-IDT) and ET technician. Variables on the recipient-cow include herd, parity (0, 1 and ≥2), quality (good, medium and bad), day-in-cycle (5 to 9 days) and whether the recipient was hormonally synchronised.

Table 1. Embryo production and embryo transfer variables.

Embryo production		Embryo transfer	
Variable	No. of classes	Variable	No. of classes
Identification donor-cow	6,554	Year*month of transfer	48
Age donor-cow	7	Method of thawing	4
Method of collection	3	ET technician	43
Quality of embryo	3	Herd of recipient-cow	3,282
Stage of embryo	6	Parity of recipient-cow	3
Sexing of embryo	2	Quality of recipient-cow	4
Sire of embryo	1,127	Day-in-cycle	6
		Synchronisation	2

In addition information was available on artificial inseminations (AI), natural services (NS), calvings and cullings of the recipient-cows.

2.2 Methods

Definition of successful ET

Non-return at 56 days (NR56) was used as a measure of success of ET. Based on the information on AI, NS, calvings and cullings this NR56 was defined in two different ways. The first NR56 (full method) defined successful as a calving between 259 and 287 days after transfer. Unsuccessful was defined as an embryo transfer where an AI, NS, transfer or culling occurred within 56 days after transfer. If none of these events took place within 56 days and also no calf was born between 259 and 287 days after transfer, NR56 was unknown.
The second NR56 (reduced method) only used the information on AI, NS, transfers and cullings. If none of these events occurred within 56 days the transfer was successful. By defining NR56 in this way the NR56 was known for all transfers.

Statistical model

Non-return at 56 days is a binary trait, therefore initial analyses were performed in ASREML (Gilmour *et al.*, 2000) using a binary model with logit link-function. Since implementation of a routine evaluation using a linear model is preferred, data were also analysed using a linear model.
The use of the full as well as the reduced NR56 and the binary as well as the linear model resulted in four different analyses. To select the best NR56 and the best model for routine evaluation, significance levels of the fixed and random effects and Spearman rankcorrelations for ET technician were used. These were compared between the different analyses where the analysis with the full NR56 by the binary model was considered the "Golden Standard".

3. Results

Average NR56 for the full and reduced method is described in Table 2. With the full method of NR56 the status of about 15,000 transfers could not be determined. NR56 for the reduced method is therefore about 10% higher. This absolute difference is, however, of less interest for the quality monitoring where relative differences are more important. The correlation between NR56 of the full and reduced method for observations with both NR56's was 0.97. Only 1.5% of the observations had a different NR56 status with the reduced method in comparison to the full method.

Table 2. Number of transfers (n) and average NR56 for the full and reduced method.

Method	n	NR56
Full	39,375	59.4%
Reduced	54,622	69.6%

All tested fixed effects were significant in the four analyses. When the quality of the embryo was good, stage of the embryo had only a small effect on NR56, however when quality was medium or bad, stage had an unfavourable effect on NR56 of up to 20%. Third and higher parity recipients had a 7% lower NR56 than first parity recipients. Synchronisation of the recipient had a positive effect of 4% on NR56. Quality of recipients had an effect of up to 12% on NR56.

The random effects herd of recipient, sire of embryo, donor-cow and ET technician were also significant in all four analyses. The average effect on NR56 of the worst 10% of the ET technician was -6.8% whereas the average effect of the best 10% is 6.7%. Figure 1 shows the unadjusted and adjusted estimates for ET technician. The figure shows considerable effects for some technicians e.g. for technician 4 the unadjusted NR56 is 59% while adjusted the NR56 is 63% and for technician 8 the unadjusted NR56 is 67% while the adjusted NR56 is 61%. A rankcorrelation of 1.00 between the analyses with either a binary model or a linear model shows that the rank of ET technicians is not affected when a linear model is used in stead of a binary model. Using reduced NR56 gives only minor re-ranking of technicians compared to the full method (rankcorrelation of 0.90).

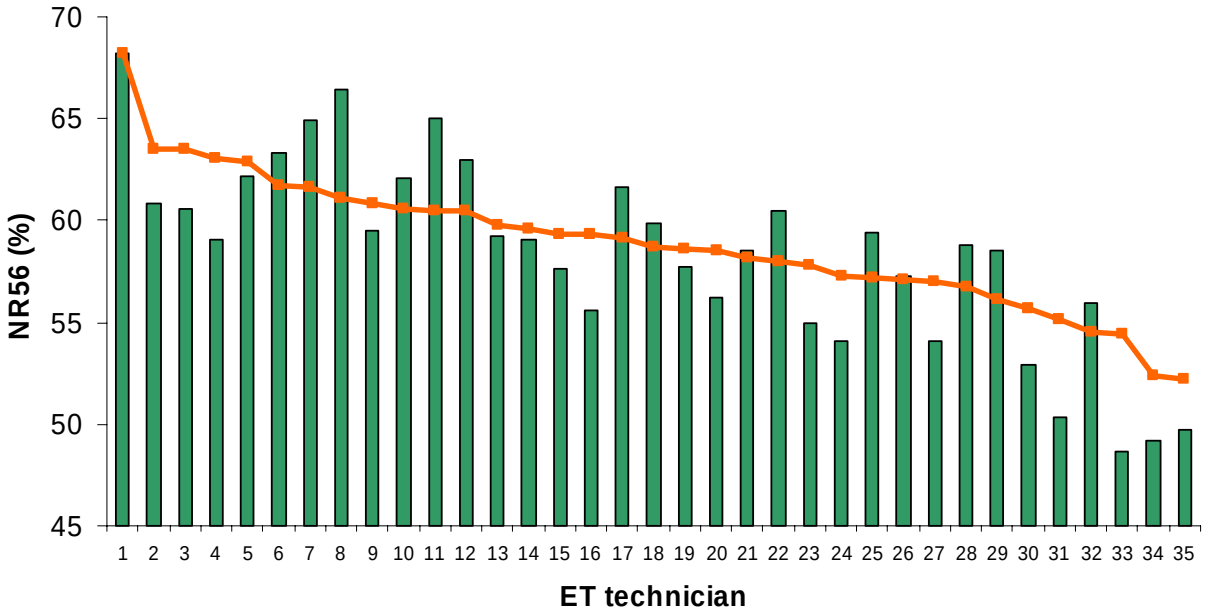

Figure 1. Unadjusted (bars) and adjusted (line) estimates for ET technician with more than 300 transfers (n = 35).

4. Discussion and conclusions

The high correlation between NR56 for the full and reduced method shows that early information on NR56 based on AI, ET, NS and cullings is a very good estimate of the true NR56. The advantage of defining NR56 as is done in the reduced method is that information on success is already available 56 days after transfer.
The analyses show that numerous effects affect NR56 after ET and that proper adjustments are required for a fair comparison of the ET technicians. The analyses furthermore show that estimates and significance levels of the fixed and random effects for the full and reduced method are very similar. This also suggests that the reduced NR56 is a good estimate of the true NR56. The analyses with the linear model give similar results compared to the binary model. Therefore due to the large size of this dataset, for routine analyses, a linear model was chosen instead of a more complicated binary model. Finally, the high rankcorrelations show that the choice of a full or reduced NR56 and a binary or linear model has very little effect on the ranks of ET technicians.
In conclusion, routine quality monitoring of ET can be based on adjusted NR56 using data on artificial insemination, embryo transfer, natural service and culling data. Adjusted NR56 is a good way to monitor the performance of ET technicians and helps to maintain or improve the quality of the embryo transfer service offered to the Dutch dairy farmers.

5. Implementation

Quality monitoring of embryo transfer by the CR Delta VRV organisation has been operational since May 2004. Every three months ET technicians receive their NR56 estimates of the last year. Besides this latest estimate ET technicians also receive a trend as rolling year average of the last 2 years (Table 3). In addition the ET executive monitors fixed effect classes.

Table 3. Output for ET technicians of the quality monitoring procedure in August 2004

				Trend		
ET technician	n	Unadjusted	Adjusted	May03-May04	Feb03-Feb04	Nov02-Nov03
1	812	75.6%	3.1%	3.7%	4.0%	4.2%
2	214	73.4%	-1.1%	-2.2%	-2.6%	-2.2%
…	…	…	…	…	…	…
…	…	…	…	…	…	…
34	122	68,9%	-0.5%	-0.6%	-0.6%	-0.9%
35	654	76.8%	0.9%	0.2%	-1.1%	-1.2%

6. Reference

Gilmour, A. R., B. R. Cullis, S. J. Welham, and R. Thompson. 2000. *ASREML Manual*. New South Wales Dep. Agric., Orange, Australia.