Exploring testing strategies for failure of passive transfer (FPT) in Scottish dairy calves.

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Ruminants are born immunologically naïve and are reliant on passive transfer of colostral antibodies to protect against disease until their own immune system becomes fully functional (Weaver *et al.* 2000). Calves which fail to absorb sufficient concentrations of immunoglobulins are said to suffer from failure of passive transfer (FPT).

In dairy calves, FPT results in an increased risk of calfhood morbidity, ill thrift and mortality (Tyler *et al.* 1999, Pardon *et al.* 2015). Furthermore, calves with FPT have reduced liveweight gains following weaning (Furman-Fratczak *et al.* 2011) and reduced first milking lactation yields (Denise *et al.* 1989). Surveys of dairy calves in the USA, Australia and New Zealand have reported that the prevalence of FPT is between 19 and 38% (Beam *et al.* 2009, Vogels *et al.* 2013, Cuttance *et al.* 2017). The current Scottish work (with farms enrolled from Dumfries and Galloway, Lanarkshire and Stirlingshire) reports a prevalence of FPT of 14.1%-46.4% depending on geography and on testing strategy for FPT. Serum IgG levels of ≥10g/L are indicative of adequate passive transfer (Tyler *et al.* 1999, Virtala *et al.* 1999). The reference test for measuring IgG in serum is radial immunodiffusion (RID) which directly measures the IgG in a sample (Cuttance *et al.* 2017. In Scotland this test is prohibitively expensive for use in general veterinary practice so total protein (TP) tests are often substituted such as serum TP refractometry or Brix refractometry. Zinc sulphate turbidity (ZST) is an indirect measurement of IgG in serum (Hogan *et al.* 2015). ZST testing is commonly used in Scotland by clinicians and disease investigation centres to measure FPT in calves, despite a growing body of evidence to suggest its inferiority to other tests (Hogan *et al.* 2015); in particular, its poor specificity.

The current work validates an RID zonal diffusion test kit and compares this with more traditional testing methods for FPT (Table 1), with a view to redefining cutpoints for FPT herd monitoring in Scottish dairy calves. In all cases, current internationally recommended cutpoints could be lowered to improve performance of FPT testing in Scotland.

Table 1. Test results for 3 indirect tests to predict FPT in dairy calves (defined as serum IgG concentrations of >10g/L). The tests used were serum total protein (TP) concentrations (g/L), Brix refractometry (%) and Zinc sulphate turbidity (ZST) (units) in 1-7 day old calves. Cut-points were derived from published data (Ref) and were optimised based on receiver operating characteristic curve analysis (ROC).

Test		Cutpoint	Sensitivity		Specificity		PPV		NPV		Accuracy	
Brix	Ref[a]	8.4	40/52	76.9	208/315	66.0	40/147	27.2	208/220	94.5	248/367	67.6
	ROC	8.2	34/52	65.4	238/315	75.6	34/111	30.6	238/256	92.9	269/367	73.3
ZST	Ref[b]	20	45/52	86.5	191/315	60.6	45/169	26.6	191/197	96.5	236/367	64.3
	ROC	15	40/52	76.9	253/315	80.3	40/102	39.2	253/265	95.5	293/367	79.8
TP	Ref[c]	5.2	37/52	71.2	246/315	78.0	37/106	34.9	246/261	94.3	283/367	71.3
	ROC	5	27/52	51.9	272/315	86.3	27/70	38.6	272/297	91.6	294/367	80.1

[a]Cutpoint set by Deelan *et. al* 2014: [b]Cutpoint set by Hogan *et. al* 2015: [c]Cutpoint set by Tyler *et al.* 1999