Efficacy of the *AGRO-JET MIT-II NEEDLE-LESS JET INJECTOR* for Iron Dextran Administration in Piglets

Final Report to

Karim Menassa
Medical International Technologies
2281 Guenette St-Laurent,
Montreal, Quebec, Canada H4R 2E9

By

Glen Almond
Department of Farm Animal Health & Resource Management
College of Veterinary Medicine
North Carolina State University
4700 Hillsborough Street
Raleigh, North Carolina USA 27606

Introduction

The pork industry relies on hypodermic needles for the administration of parental compounds. Unfortunately, use of needles for injections is hazardous to pigs and farm personnel, and raises concerns regarding consumers' perceptions of pork products and the well being of pigs. Recently, the National Pork Producers Council launched a national campaign, ***One Is Too Many,*** to reduce problems associated with hypodermic needles. Obviously, an alternative to hypodermic needles needs an objective evaluation.

Long-Term Goal: *Evaluate the effectiveness and commercial applicability of needleless injectors for routine use in pigs.*

Immediate Objectives:

- Evaluate the Agro-Jet Needle-Less Injector (MIT-II) for the administration of iron dextran in neonatal pigs.
- Determine the hematological values and iron absorption in piglets treated with iron dextran by intramuscular administration with the Injector and hypodermic needles.
- Compare the practicality of the Injector to traditional hypodermic needles for the administration of iron dextran to neonatal pigs.

Materials & Methods

The study was conducted on a 1200-sow commercial farm. The farrowing facilities were typical for sow farms in North Carolina. Each farrowing room had 12 farrowing crates with perforated floors. Each sow was housed in an individual farrowing crate. Feed and water were provided ad libitum. Piglets from 13 sows were used in the study.

Iron Administration:

Phase I: Six litters of piglets (approximately 1-3 days of age) were selected for Phase I of the study. Using the Agro-Jet- MIT-II Needleless Injector, four piglets from each litter were treated intramuscularly (IM) with 1 ml of iron dextran (200 mg/ml; Iron Guard™; Vetmedica/Boehringer Ingelheim). As advised by MIT, 100 PSI was used for the injection. The injector was equipped with a 0.008" orifice. Four piglets from each litter were treated with 1 ml iron dextran by IM injection with a 20g, 1-inch hypodermic needle. Pigs were weighed immediately prior to the iron injections and 21 days later. For the two injection methods, piglets were matched by body weight and the iron dextran was given in the neck region of the pig. Any spillage or seepage of iron dextran was recorded.

Phase II: In Phase II, 7 litters of piglets (approximately 1-3 days of age) were used. Within litter, an equal number of piglets (3-4 piglets/device) were injected with the Injector and hypodermic needles. Pigs were weighed prior to injection and 21 days later.

Blood Collection and Laboratory Analyses:
In Phase II of the study, two 2.5-ml blood (one for serum and one whole blood sample) samples were collected from each pig prior to iron injection and 21 days after injection. Blood samples were kept on ice and transported to the laboratory. Serum and whole blood samples were aliquoted and submitted to Anntech Diagnostics for determination of red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentrations (MCHC), packed cell volume (PCV), hemoglobin, unsaturated iron-binding capacity (UIBC), total iron-binding capacity (TIBC), iron % saturation, and serum iron concentrations. These tests were used to assess iron absorption and transport, and the influence of the iron on red blood cells. In addition, white blood cells were quantitated to evaluate potential inflammatory reactions.

Results

Phase I: Results of Phase I indicated that piglet growth (as measured by average daily gain) did not differ between injection methods (Table 1). One pig from each treatment group died during the study. The cause of death (enteric disease) was not related to the method of iron injection. It was evident that the use of MIT-II did not interfere with the growth of piglets.

Table 1. Phase I Results: Assessment of growth in piglets injected with iron dextran. Piglets (n=23/treatment) were injected with the Agro-Jet Injector (MIT-II) or with conventional hypodermic needles. Piglets were similar ages between the treatments and the number of male and female piglets was the same for the two methods.

	MIT-II		**Hypodermic Needle**	
Parameter	Mean	SEM	Mean	SEM
Age (days) at time of injection	1.70	*0.16*	1.65	*0.16*
Parity of sows	1.39	*0.28*	1.48	*0.30*
Starting body weight (kg)	1.86	*0.04*	1.87	*0.04*
Body weight (kg) 21 days after injection	7.42	*0.25*	7.78	*0.21*
Total weight gain (kg)	5.56	*0.22*	5.91	*0.19*
Average daily gain (kg/day)	0.26	*0.01*	0.28	*0.01*

Phase II: As shown in Phase I, there were no apparent differences in piglet growth between the MIT-II and hypodermic needle injection methods (Table 2). Starting body weights, weights at 21 days and average daily again were almost identical. These results confirm observations in Phase I, in that the MIT-II injection method did not have adverse effects in the pigs. Four piglets died during the study from enteric disease. This was not related to the method of injection.

Table 2. Phase II Results: Assessment of growth in piglets injected with iron dextran. The Agro-Jet Injector (MIT-II) and conventional hypodermic needles were used to inject piglets. Blood samples were collected prior to injection and 21 days after injection. Piglets were similar ages between treatments and the number of male and female piglets was the same for the two methods.

	MIT-II (n=18 piglets)		**Hypodermic Needle** (n=21 piglets)	
Parameter	Mean	SEM	Mean	SEM
Parity of sows	3.00	*0.37*	2.76	*0.33*
Age (days) at time of injection	1.21	*0.23*	1.24	*0.22*
Starting body weight (kg)	2.12	*0.07*	2.17	*0.07*
Body weight (kg) 21 days after injection	8.81	*0.30*	8.88	*0.29*
Total weight gain (kg)	6.68	*0.26*	6.71	*0.25*
Average daily gain (kg)	0.32	*0.01*	0.32	*0.01*

In regard to the iron absorption and hematological values (Table 3), there were some minor numeric differences between the injection methods. The statistical analysis indicated that these differences were not significant.

It is important to note that the iron % saturation did not differ between groups. Ideally, the % saturation should be approximately 33%. The values of % saturation indicate that 200 mg of iron dextran at 1-3 days of age does not provide optimal iron, regardless of injection method, for pigs weaned after 21 days of age.

In contrast to the % saturation, there were no apparent detrimental effects of iron injection on serum hemoglobin (Hgb) concentrations in each group. Approximately 65% of an animal's iron is in the form of hemoglobin. By day 21, normal hemoglobin concentrations should be greater than 10 g/dl. The results of Phase II indicate that on average, normal hemoglobin concentrations were achieved with both methods of injection. In addition, the results infer that the iron dextran was deposited in the appropriate location/depth with the MIT-II or at least in a site comparable to hypodermic needle injection.

The mean corpuscular hemoglobin concentrations (MCHC) did not decrease with age for both groups of pigs. Thus, piglets were *not* affected with hypochromic anemia, which would be present if insufficient iron was absorbed. Also, the mean corpuscular volume (MCV) did not change and stayed within normal limits for both groups of pigs. Hence, the pigs did *not* have a microcytic anemia. Overall, the results of Phase II indicate that the MIT-II injector delivered sufficient iron dextran to the piglets.

Table 3. Phase II Results *(continued)*: Hematological values in piglets prior to and 21 days after iron dextran injection.

	Prior to Injection		**21 days after Injection**	
	MIT-II	**Needle**	**MIT-II**	**Needle**
Parameter*	Mean ± SEM	Mean ± SEM	Mean ± SEM	Mean ± SEM
Serum iron (µg/dl)	63.9 ± 7.5	63.4 ± 5.9	94.3 ± 17.3	102.9 ± 12.1
UIBC (µg/dl)	161.1 ± 13.0	153.0 ± 14.7	283.9 ± 8.2	287.1 ± 4.6
TIBC (µg/dl)	224.9 ± 13.2	216.4 ± 14.0	378.2 ± 12.9	389.9 ± 10.2
% SAT	28.9 ± 3.0	31.5 ± 3.2	23.3 ± 3.4	25.4 ± 2.3
Hgb (g/dl)	9.1 ± 0.5	8.7 ± 0.4	10.2 ± 0.4	10.8 ± 0.3
PCV (%)	29.6 ± 1.7	28.3 ± 1.4	34.0 ± 1.6	36.9 ± 1.2
RBC (mill/cmm)	4.4 ± 0.3	4.2 ± 0.2	5.3 ± 0.2	5.5 ± 0.1
MCV (μm^3)	67.5 ± 1.0	68.4 ± 0.8	64.4 ± 1.5	66.7 ± 1.2
MCH (pg)	20.9 ± 0.3	21.0 ± 0.3	19.4 ± 0.4	19.5 ± 0.3
MCHC (g/dl)	30.9 ± 0.3	30.8 ± 0.4	30.3 ± 0.6	29.3 ± 0.3
WBC (thds/cmm)	11.1 ± 0.9	10.2 ± 0.8	13.5 ± 1.2	14.2 ± 0.8

*UIBC = Unsaturated iron binding capacity; TIBC = total iron binding capacity; % SAT = iron % saturation; Hgb = Serum hemoglobin concentration; PCV = packed cell volume; RBC = red blood cells; MCV = mean corpuscular volume; MCH = mean corpuscular hemoglobin; MCHC = mean corpuscular hemoglobin concentration; WBC = white blood cells.

White Blood Cell Evaluation:

As shown in Table 4, there were no differences in WBC counts between piglets in the two treatment groups. There was no evidence to indicate that an inflammatory reaction and infection resulted from either injection methods. All values were within the normal ranges of piglets.

Table 4. White blood cell (WBC) counts on blood samples collected from piglets prior to injection and 21 days after injection. Absolute counts and percentage of the WBC count are given.

	Prior to Injection				21 days after Injection			
	MIT-II		NEEDLE		MIT-II		NEEDLE	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Neutrophils								
Absolute	7834.0	795.5	6825.2	741.2	3096.6	235.0	3795.5	338.8
%	69.6	2.7	64.5	3.2	23.9	1.9	27.5	2.4
Bands								
Absolute	34.9	18.9	14.7	8.4	0.0	0.0	0.0	0.0
%	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Lymphocytes								
Absolute	2690.7	211.0	2968.6	325.5	9246.1	897.1	9079.0	718.9
%	27.4	2.8	31.8	3.2	67.3	2.1	62.7	2.7
Monocytes								
Absolute	252.9	75.4	242.7	42.8	649.4	86.1	691.4	57.7
%	2.3	0.7	2.3	0.4	4.7	0.3	4.8	0.3
Eosinophils								
Absolute	108.6	33.2	133.7	28.6	442.6	49.9	576.7	50.7
%	4.2	3.2	1.1	0.2	3.5	0.4	4.4	0.5
Basophils								
Absolute	3.9	3.9	19.4	11.4	94.0	18.7	86.0	16.6
%	0.0	0.0	0.1	0.1	0.7	0.1	0.6	0.1

General comments on the MIT-II injector

- Minor loss (seepage or spillage) of iron dextran product was observed in only 4 animals injected with the MIT-II.
- On rare occasion, it was evident that some of the CO_2 pressure was lost during an injection. The change in pressure was audible and for practical purposes, the difference in sound would serve as an indicator for "questionable" injections.
- Many pig producers extend the head/neck of piglets to one side to facilitate iron injections with hypodermic needles. This routine practice was not suitable for injections with the MIT-II. With the MIT-II, it was evident that extending the piglet's head forward improved the quality of injection.
- Excessive force (attempting to improve contact) with MIT-II appeared to be contraindicated and actually impaired penetration. Firm pressure was sufficient for the injections.
- User or technician training and experience would be beneficial for implementation of the MIT-II in commercial pig farms.

Conclusions

The results of this study indicate that the Agro-Jet MIT-II injector effectively delivered sufficient iron dextran to neonatal pigs. There were no differences in growth and performance between pigs injected with the MIT-II injector and pigs injected with hypodermic needles. The hematological values revealed that the piglets did ***not*** have a microcytic, hypochromic anemia, which is indicative of iron deficiency. Evidently, the MIT-II injector deposited sufficient iron dextran to prevent the onset of anemia in the piglets. The results of the WBC counts indicated that the MIT-II did not create an inflammatory reaction or infection at the site of injection. Thus, it is evident that the method did not "inject" bacteria into the neck muscles. **In summary, it is apparent that the MIT-II injector is a viable alternative to traditional hypodermic needles for the administration of iron dextran to piglets.**

One fundamental question was not addressed in the study. Birth weight is a major determinant of weaning weight. With considerable variation in birth weight, should the dose of iron dextran be adjusted based on piglet body weight? With traditional hypodermic needles, a 2 kg piglet receives the same quantity of iron as a 0.5 kg piglet. The same volume is used because it is extremely difficult or impossible to adjust the volume of administration with a 10 ml or 5 ml syringe. Should the heavy piglets receive more iron dextran? Obviously, additional work is required to "fine tune" iron dextran administration methods.