Comparison of drug delivery devices for use in beef cattle.

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ABSTRACT: A study was conducted to compare a Pneu-Dart Type U 7cc Slo-Inject® Remote Delivery Device (RDD) to a hand syringe injection using normal processing procedures and a two-hand tented method with comparable needle length. Forty-eight mature cattle slated to be used were acclimated for seven days prior to study commencement. Cattle were weighed and blocked by bodyweight before being randomly assigned to one of two treatment groups. Results are presented as visually compared injection site variance in the approved neck region utilizing a hand syringe with an industry standard ½-inch 16-gauge needle to a remote delivery device (RDD) equipped with a ½-inch 14 gauge or ¾-inch tri-port 14-gauge cannula (needle). As used throughout this publication, approved neck region refers to injections made in accordance with the Beef Quality Assurance's National Manual. Animals in each treatment group were euthanized by penetrating captive bolt followed by exsanguination. Injection sites were examined and evaluated. Tissue samples of both normal and injection site (classified as abnormal) were collected. These samples were transported to TVMDL (Texas A&M Veterinary Diagnostic Lab, Amarillo, TX) for further evaluation. Gross necropsy reports, along with laboratory evaluations, support the conclusion that the remote delivery device equipped with a ½-inch 14-gauge needle is adequate for subcutaneous injections with least amount of muscle penetration, compared to a hand syringe, absent of ideal processing procedures and that of a remote delivery device supporting a ¾-inch 14-gauge tri-port needle.

Key words: cattle, hand syringe, injection, remote delivery device

INTRODUCTION

Antibiotics are used in food animals to treat clinical diseases, to prevent and control common disease events and to enhance animal growth. The different applications of antibiotics in food animals have been described as therapeutic use, prophylactic use and subtherapeutic use. Antibiotics can be used to treat a single animal with clinical disease or a large group of animals. Definitions of each type of use vary. (McEwen) Application of injectable liquids using remote drug delivery systems for the beef industry is becoming increasingly popular (CBW). Remote Drug Delivery is especially common in situations where corral and chute facilities are not available or where time to treatment is essential while reducing stress on the animal (West). Injection site assessment of injectable liquids delivered remotely along with various RDD devices equipped with various needle lengths is needed to support veterinarians in making science-based recommendations regarding the use of these technologies to producers. This information is urgently needed to assist producers in demonstrating how remote drug delivery provides value to whole herd health and does not threaten the consumer.

Statement of Problem. It is interesting to note as early as 1959 and continued into the 1970's; individuals and some companies began adapting Remote Drug Delivery (RDD) equipment for treating animals (WSJ) (Palmer). The practice of remotely medicating sick cattle has increased along with conflicting opinions over animal welfare, legality and food group safety. Proponents of remote drug delivery advocate judicious use of the technology provides the ability to effectively deliver medication at the first onset of infection and reduces stress by the avoidance of handling animals illustrating signs of infection. Opponents argue the absence of scientific data comparing the results of the method of remote delivery to the method delivering injectable liquids by hand is essential before acceptance. There are many questions as to the effectiveness of remote drug delivery with virtually no cited research to date.

MATERIALS AND METHODS

This study was conducted by Agri Research Center in Canyon, TX, and was designed in accordance to standard operating procedures on file at this facility. All cattle enrolled in this experiment were pre-dominantly Angus-cross, commercial feedlot steers that were free of any clinical signs of disease or injury beginning the study. None of the cattle had received injections for at least sixty days prior to study commencement. A pre-study acclimation period of a minimum of seven days was observed. On arrival day, all cattle were weighed, ear tagged, and randomly allocated into treatment groups by blind draw and remained in these groups for the duration of the study. The design of this study was a randomized block design, with blocks determined by anticipated necropsy date, and experimental unit as animal. The cattle were weighed and blocked by weight prior to random blind draw allocation into one of two treatment groups. Treatments consisted of two different Remote Delivery Device (dart) needle lengths on the right side of the neck, and hand syringe control on the left side. All RDD's were delivered using a Pneu Dart "X-Caliber" gauged Co2 projector from a distance of approximately 7 yards at a pressure setting of 3.9 – 4.0 Bar.

Cattle in treatment A (n=24) were moved through a series of holding pens into a squeeze chute and received 7 ml of a sterile saline solution containing 1% food-grade blue dye on the left side of the industry approved neck region via a single injection using an industry recommended 16 G, ½-inch needle administered by hand syringe. These same cattle received an equal volume of a sterile saline solution containing 1% food-grade blue dye delivered remotely to the right side of the approved neck region using a Pneu-Dart 7cc Type 'U' Slo-Inject® Remote Delivery Device (dart) equipped with a ½-inch needle facilitated by a gelatin collar retention device.

Cattle in treatment B (n=24) also received 7 ml. of a sterile saline solution containing 1% food-grade blue dye on the left side of the industry approved neck region via a single injection using an industry recommended 16 G, ½-inch needle via a hand syringe. These same cattle also received an equal volume of a sterile saline solution containing 1% food-grade blue dye delivered remotely to the right side of the approved neck region using a 7cc Pneu-Dart, Type 'U' Slo-Inject® volume equivalent Type 'U' Slo-Inject® Remote Delivery Device (dart) equipped with a ¾-inch tri-port needle facilitated by a gelatin collar retention device.

Objectives of the study are as stated; Compare the effective delivery of subcutaneous hand syringe injection vs. remote administration of a sterile saline solution containing food-grade blue dye. Visually compare and document injection site variances when delivering a sterile saline solution containing food-grade blue dye via a hand syringe equipped with an industry standard ½-inch 16-gauge needle to a remote delivery device equipped with a ½-inch 14-gauge needle. Visually compare and document injection site variances when delivering a sterile saline solution containing food-grade blue dye via a hand syringe equipped with an industry standard ½-inch 16-gauge needle to a remote delivery device equipped with a ¾-inch tri-port 14-gauge needle. Visually compare and document injection site variances 3 days post injection when delivering a sterile saline liquid containing food grade dye via hand syringe vs. a remote delivery device equipped with ½-inch cannula and ¾-inch tri-port cannula.

Schedule and Amendments

The study commenced on February 20, 2018, with the exception the cattle subjects of the study would be euthanized over a period of four (4) separate days at the following time intervals: 3, 10, 17, and 31 days following administration of injections. On the 3rd day (February 23, 2018), following the administration of the injection on the original forty-eight (48) cattle subjects, twelve (12) of the cattle subjects were euthanized and necropsied (Table 1). On the 10th day (March 2, 2018) following the administration of the injections, twelve (12) of the remaining thirty-six (36) cattle subjects were euthanized and necropsied. After a review of the injection sites administered on March 2, 2018 the remaining two necropsy dates of 17 and 31 days post-delivery were amended given the substantial likelihood similar results of the injection sites, which otherwise demonstrated negligible and undetectable evidence of an injection delivered remotely or by hand. (Table 2).

The additional testing provided as follows: On March 6, 2018, six (6) cattle subjects were remotely injected with a Pneu-Dart® 7cc Type 'U' Slo-Inject® Remote Delivery Device (dart) equipped with a ½-inch needle facilitated by a gelatin collar retention device. All shots were delivered perpendicular to the subjects. All such injections were made in the approved neck region on the right side of the cattle and contained a sterile saline solution containing 1% food-grade blue dye. The volume was 7 ml, and each injection was made once. Another (6) cattle subjects were remotely injected with a 7cc Pneu-Dart® Type 'U' Slo-Inject® Remote Delivery Device (dart) equipped with a ¾-inch tri-port needle facilitated by a gelatin collar retention device. All shots were delivered perpendicular to the subjects. All such injections were made in the approved neck region of the cattle and contained a sterile saline solution of 1% food-grade blue dye. The volume was 7 ml, and each injection was made once. All twelve (12) subjects were injected on the left side with a hand syringe supporting a 16-gauge ½-inch needle. The volume was 7 ml, and each injection was made once, perpendicular to the subject, in the approved neck region.

On March 7, 2018, four (4) cattle subjects that were injected on March 6, 2018, were euthanized demonstrating negligible and undetectable evidence of an injection. On March 7, 2018, the remaining eight (8) cattle subjects, most recently injected on March 6, 2018, were treated as follows: Four (4) cattle subjects were injected with a Pneu-Dart® Type 'U' 7cc Slo-Inject® Remote Delivery Device (dart) equipped with a ½-inch needle facilitated by a gelatin collar retention device. All shots were delivered perpendicular to the subject. All such injections were made in the approved neck region on the right side of the subjects and contained a 7 ml sterile saline solution containing 2% food-grade blue dye. Four (4) of the cattle subjects were injected with a Pneu-Dart® Type 'U' 7cc Slo-Inject® Remote Delivery Device (dart) equipped with a ¾-inch tri-port needle facilitated by a gelatin collar retention device. All shots were delivered perpendicular to the subject. All such injections were made in the approved neck region on the right side of the subjects

and contained 7ml sterile saline solution containing 2% food-grade blue dye. All eight (8) cattle subjects were injected via hand syringe on the opposing side. All such injections were made in the approved neck region on the left side of the cattle and contained 7 ml of a sterile saline solution containing 2% food-grade blue dye. The first of the eight subjects were injected by placing the hand syringe perpendicular to the subject and elected to give the remaining seven subjects two 7 ml shots each. One was using the "Tent" method and the other was of a single-handed angular approach. These eight (8) cattle were euthanized within 5 minutes following injection, and samples were sent at the same time for all cattle euthanized on this day (Table 3).

On March 8, 2018, the final 12 subjects of the original 48 were treated as follows: Six (6) cattle subjects were injected with a Pneu-Dart® Type 'U' 7cc Slo-Inject® Remote Delivery Device (dart) equipped with a ½-inch needle facilitated by a gelatin collar retention device. All shots were delivered perpendicular to the subject. All such injections were made in the approved neck region on the right side of the subjects and contained 7 ml of a sterile saline solution containing 2% food-grade blue dye. Six (6) cattle subjects were injected with a Pneu-Dart® Type 'U' 7cc Slo-Inject® Remote Delivery Device (dart) equipped with a ¾-inch tri-port needle facilitated by a gelatin collar retention device. All shots were delivered perpendicular to the subject. All such injections were made in the approved neck region on the right side of the subjects and contained 7 ml of a sterile saline solution containing 2% food-grade blue dye. All twelve (12) cattle subjects were injected via hand syringe on the opposing side. All such injections were made in the approved neck region on the left side of the cattle using the single-hand angular approach and contained 7 ml of a sterile saline solution containing 2% food-grade blue dye. All twelve (12) cattle were euthanized within 5 minutes of receiving injections. At this time, necropsies and tissue collections were performed, and samples were sent to TVMDL for evaluation (Table 4).

Additional Research

On March 23, 2018, twelve (12) additional cattle subjects (net 60 subjects in total) were injected with liquid remotely and by hand syringe as follows: Twelve (12) cattle subjects were injected with a 7cc Pneu-Dart® Type 'U' Slo-Inject® Remote Delivery Device (dart) equipped with a ½-inch needle facilitated by a gelatin collar retention device. All injections were delivered remotely from an elevated position of not more than five (5) feet. All RDD's were delivered using a Pneu Dart "X-Caliber" gauged Co2 projector from a distance of approximately 7 yards at a pressure of 3.9 – 4.0 Bar. All such injections were made in the approved neck region on the right side of the cattle and contained 7 ml of a sterile saline solution containing 2% food-grade blue dye. All 12 cattle subjects were injected with a hand syringe supporting the approved 16ga ½-inch needle. All such injections were made using the angular approach in the approved neck region on the left side of the cattle and contained 7 ml of a sterile saline solution containing 2% food-grade blue dye. All cattle were euthanized within 5 minutes post injection, then necropsy procedures, tissue collection, storage, reporting of adverse events, data summary, and data analysis were performed following euthanasia (Table 5). Cattle used for the additional research were of "poor-doer" classification but not of chronic/dehydrated condition.

Sample Collection and Analysis

Injection site reviews were performed on each animal coinciding with the necropsy time points. Gross pathological changes were noted. Fresh muscle tissue was submitted to TVMDL (Texas Veterinary Medical Diagnostic Lab, Amarillo, TX). All individuals performing the physical and laboratory analysis were blinded to treatment group. Laboratory samples were labeled in a coded manner, making the treatment status of samples unknown to the laboratory. A single representative section was taken from the affected area if visible. If no grossly visible pathology was identified a representative section of muscle tissue was take from the center of the submitted muscle tissue. Tissue was placed in buffered formalin and allow to fix for 3 days. A pathologist trimmed the fixed tissue to fit standard histology cassettes for imbedding and processing. The histopathology slides were reviewed by a pathologist to look for histologic lesions.

Visual Assessment of Injection Site

All visual assessments of concern have on file a digital photograph.

Animal Handling Guidelines

Cattle in each treatment group were euthanized by penetrating captive bolt followed by exsanguination. This is in accordance with AVMA guidelines. Animals were housed at the facility where administration and sample collection took place. Floor space per animal meets requirements set forth in the Guide for the Care and Use of Agricultural Animals in Agricultural Use and Research and Teaching 3rd Edition. Cattle were fed an appropriate diet that meets NRC nutrient requirements for growing cattle and have free access to water.

RESULTS AND CONCLUSION

Fresh muscle tissue was submitted to TVMDL (Texas Veterinary Medical Diagnostic Lab, Amarillo, TX) in individual bags labeled with the animal ID and side of body. Samples for each side of body were provided. Per the submitter, tissue samples of both normal "N" and injection site classified as abnormal "A" were submitted. Gross inspection of the tissue was conducted by a pathologist to look for visible lesions and changes were noted. A single representative section was taken from the affected area if visible. If no grossly visible pathology was identified a representative section of muscle tissue was taken from the center of the submitted muscle tissue. Tissue was placed in buffered formalin and allowed to fix for three days. A pathologist trimmed the fixed tissue to fit standard histology cassettes for imbedding and processing. The histopathology slides were reviewed by a pathologist to look for histologic lesions. The distribution, type of inflammation, location of the inflammation (muscle, intramuscular fat) and secondary changes (edema, hemorrhage and fibrosis) were determined. If no change was detected it was labeled as no significant lesions observed. In this study a food coloring-based dye with saline was used as the injection material to help demarcate the site of injection. Dye could be detected on samples submitted to TVMDL in this study on gross examination; however, during tissue processing for histopathology the dye appears to be lost. Presumably, because the dye is water based it is removed during the tissue processing and is not visible on histologic exhumation.

Initiation of treatment occurred on Tuesday, February 20, 2018 on forty-eight approximate 700-weight cattle with the intent to follow the study protocol. All forty-eight animals successfully received injections as per the study protocol with forty-three of the forty-eight RDD's (Remote Delivery Devices) recovered. All forty-three recovered RDD's detonated and deployed to full potential with additional evidence later in the study suggested the other five fully deployed. Three-days post-delivery (February 23, 2018) twelve animals were euthanized as per study protocol. Upon gross necropsy inspection of the region of injection on the left (syringe) and right (RDD), no specific lesions were observed either subcutaneously and/or intramuscularly other than that which is denoted hereafter. The only evidence of an injection three days post-injection was in the form of a slight brownish-yellow area approximately the size of a quarter on all animals. No blue dye was detected. Upon evaluation by TVMDL (Accession: 180540065) no specific lesions were observed and muscle tissues were normal. No fibrosis was noted, and no blue dye could be detected when injected by hand or remotely. It was noted the injection blemishes were equal in size for both the remote delivery injection site and that of the hand syringe. An exception to this was from subject # 930 who presented a golf ball size hematoma that was attributed to a hand syringe injection (Table 1).

Realizing the results may be similar on the scheduled second slaughter point of day 10 (Friday 3-2-18) it was collectively agreed to slaughter 100% of the group (twelve subjects in total) in an effort to collect adequate 10-day post-delivery sampling. In this instance there were little to no signs of injection site blemishes, impact trauma, nor wounds related to any type of injection (hand or remote) with the exception of subject # 824 (an RDD treatment type 2 candidate) which did display an injection site color variation similar to those we witnessed on day 3 post-injection (Table 2). Upon gross necropsy evaluation of both injection site regions, no significant lesions were observed. Upon evaluation by TVMDL (Accession: 180610053) no significant lesions were observed and no fibrosis was found.

Amendments to original protocol and schedule was needed to learn more since anticipating no injection site lesions would be detectable on the remaining 24 subjects originally assigned to slaughter time periods of 17 and 31 days post-injection.

On March 7, 2018, twelve (12) cattle were scheduled for euthanasia following injections received on March 6, 2018. After the first four (4) cattle were euthanized and necropsied, and no signs of injection site blemishes, impact trauma, or wounds were detected, (by hand syringe or remote), the remaining eight (8) cattle were injected again, according to their treatment protocol, and euthanized for analysis within 5 minutes of injection administration. Upon gross necropsy evaluation of animals 471, 480, 841, and 844, no significant lesions were observed. TVMDL evaluation (Accession: 180660644) showed some subcutaneous hemorrhage and dye, but no significant muscle lesions and/or fibrosis. In most, if not all, of the residual eight animals, the altered method of injection provided good results with the exception of subject 868 where an angular single-hand syringe approach showed signs of 1st level intramuscular injection (Table 3). All twelve RDD's were recovered and all twelve detonated with one falling short of full deployment by approximately 1 cc. What is also important to note is two of the residual eight subjects were of a "poor-doer" classification and showed vague signs (on the hide alone) of the blue dye prior day treatment. Upon gross necropsy evaluation of remaining eight animals, no significant lesions were observed except in the hand syringe injection where some hemorrhage, inflammation, and dye were observed in the subcutaneous facia and muscle. Evaluation by TVMDL (Accession: 180660644) showed some dye was noted in the subcutaneous and muscle areas from both the syringe injection and RDD injection.

The study was further amended by taking the last group of twelve subjects who were treated sixteen days prior and agreed all twelve animals should receive an angular single-hand syringe injection and the traditional RDD protocol of six RDD (darts) supporting ½-inch cannulas and six RDD (darts) supporting ¾-inch tri-port cannulas. Oddly on this group we had what looked like intramuscular injections by way of the facia when delivered via an RDD supporting ½-inch cannula on two of the subjects. This was more evident on this day than any day prior. Both treatment A subjects: 1151 and 958 showed signs of intramuscular injections, some of which looked to be facia influenced. Of the twelve RDD's delivered, eleven of the twelve detonated and fully deployed. One, on what is believed to be associated with subject 958, punctured through a fold in the subject's neck hide (most likely due to the position in the squeeze chute) never entering below the skin of the animal. One RDD did not deploy to full potential but did detonate, which is believed to be subject 462. Upon gross necropsy evaluation of these twelve subjects, some dye was noted subcutaneously and in subcutaneous facia. It is concluded that the dye followed the area of least resistance. Upon evaluation by TVMDL (Accession: 180670107), some dye was noted on the subcutaneous fat and muscle via facia. (Table 4).

On March 23, 2018, thirty-one days into the study, twelve additional cattle (net 60 subjects in total) were used for additional research of "poor-doer" classification, but not of chronic/dehydrated condition. These cattle were injected according to their assigned treatment, and within 5 minutes euthanized for tissue collection and analysis. Upon gross necropsy evaluation of these animals, dye was noted in the subcutaneous facia and muscle. Upon evaluation by TVMDL (Accession: 180820098), no significant lesions were observed (Table 5).

Of the total sixty-eight RDD's delivered sixty-eight detonated, while two of the sixty-eight partially deployed with one more so than the other.

Conclusion

The study objective, to evaluate a remote delivery device equipped with ½-inch 14-gauge versus a ¾-inch 14-gauge tri-port needle in comparison to a hand syringe injection equipped with a standard ½-inch 16-gauge needle, was met. The gross and histopathology results showed an RDD equipped with a ½-inch needle having good skin penetration thus providing subcutaneous injection with no muscle damage, whereas the ¾-inch tri-port needle had good skin penetration with majority subcutaneous injection: however, did have some minimal muscle penetration. Therefore, the remote delivery device equipped with a ½-inch 14-gauge needle is adequate for subcutaneous injections with least amount of muscle penetration and equal to that of a hand syringe injection if the hand syringe is not administered without proper care.

		RDD Right				Hand Syringe Left			
		Normal		Abnormal		Normal		Abnormal	
Tag Number	Treatment	Gross	Histopath	Gross	Histopath	Gross	Histopath	Gross	Histopath
2	A	NSL	NSL	NSL	NSL	NSL	NSL	NSL	1
541	A	NSL	NSL	NSL	2	NSL	NSL	NSL	NSL
686	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
930	B	NSL	NSL	NSL	NSL	NSL	NSL	3	NSL
933	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
935	A	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
946	B	NSL	NSL	NSL	4	NSL	NSL	NSL	NSL
949	A	NSL	NSL	NSL	5	NSL	NSL	NSL	NSL
1071	B	NSL	NSL	NSL	6	NSL	NSL	NSL	NSL
1093	B	NSL	NSL	NSL	7	NSL	NSL	NSL	NSL
1115	A	NSL	NSL	NSL	8	NSL	NSL	NSL	NSL
1196	A	NSL	NSL	NSL	9	NSL	NSL	NSL	NSL

Table 1. Day 3. February 23, 2018. On day 3, following the administration of the injection on the original forty-eight (48) cattle subjects, twelve (12) of the cattle subjects were euthanized and necropsied. Cattle in group A were administered the saline-dye mixture with a hand syringe on the left side of the neck, and a ½-inch cannula remote delivery device on the right side. Cattle in group B were administered the saline and dye mixture with a hand syringe on the left side of the neck, and a ¾-inch tri-port cannula remote delivery device on the right side. Normal and abnormal tissue samples were sent for each side of the cattle.

Necropsy visual observation was done by David T Bechtol, DVM

No blue dye was detected; however, injection blemishes in the form of a slight brownish-yellow area approximately the size of 3cm was detected for both remote delivery injection and hand syringe. # 930 had a golf ball size hematoma attributed to hand syringe injection but NSL (No Significant Lesion) by histopathology.
No muscle lesions were detectable.
Lymph node hyperplasia was detectable in #1196 on hand injection side. Sample collected for examination.

The pathologist commented on tissue submitted both grossly and histopathology.
Tissue was scored by pathologists at TVMDL as:

1: Multifocal neutrophilic and histiocytic inflammation with edema confined to intramuscular fat. The muscle itself is unremarkable. No fibrosis
2: Multifocal neutrophilic and histiocytic inflammation in both the muscle and intramuscular fat with edema and hemorrhage. No fibrosis
3: Noted discoloration on tissues
4: Multifocal neutrophilic and histiocytic inflammation with hemorrhage and edema in the intramuscular fat. No inflammation within the muscle. No fibrosis
5: Multifocal neutrophilic and histiocytic inflammation with hemorrhage and edema within the intramuscular fat. Muscle tissue unaffected. No Fibrosis

6: Focal neutrophilic and histiocytic inflammation within the muscle. Intramuscular fat has no significant lesions observed. No fibrosis
7: NSL in muscle. In skin locally extensive neutrophilic and histiocytic inflammation with hemorrhage, fibrin, edema and necrosis. No fibrosis in either tissue.
8: Diffuse, neutrophilic and histiocytic inflammation with hemorrhage and edema in the intramuscular fat. Muscle tissue normal, No fibrosis
9: NSL muscle tissue. Lymph node subcortical hemorrhage with lymphoid hyperplasia (hemolymph node)

		RDD Right				Hand Syringe Left			
		Normal		Abnormal		Normal		Abnormal	
Tag Number	Treatment	Gross	Histopath.	Gross	Histopath.	Gross	Histopath.	Gross	Histopath.
4	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
206	A	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
512	A	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
545	A	NSL	NSL	NSL	1	NSL	NSL	NSL	NSL
607	B	NSL	NSL	NSL	1	NSL	NSL	NSL	NSL
824	B	NSL	NSL	NSL	2	NSL	NSL	NSL	NSL
847	A	NSL	NSL	NSL	2	NSL	NSL	NSL	NSL
951	A	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
1086	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
1112	A	NSL	NSL	NSL	3	NSL	NSL	NSL	NSL
1121	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
1124	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL

Table2. Day 10. March 2, 2018. On day 10, twelve (12) of the remaining thirty-six (36) cattle subjects were euthanized and necropsied. Cattle in group A were administered the saline-dye mixture with a hand syringe on the left side of the neck, and a ½-inch cannula remote delivery device (RDD) on the right side. Cattle in group B were administered the saline and dye mixture with a hand syringe on the left side of the neck, and a ¾-inch cannula remote delivery device on the right side. Normal and abnormal tissue samples were sent for each side of the cattle.

Necropsy visual observations done by David T Bechtol, DVM

No dye was detected
No significant lesions were detected; even though, #824 did display injection site color variation similar to day 3 post-injection it was not significant.

No muscle lesions were detectible.

The pathologist commented on tissue submitted both grossly and histopathology.
Tissue was scored by pathologist at TVMDL as:

1: multifocal intramuscular fat hemorrhage
2: multifocal skeletal muscle hemorrhage without inflammation or fibrosis
3: focal skeletal muscle hemorrhage without inflammation or fibrosus.

		RDD Right				Hand Syringe Left			
		Normal		Abnormal		Normal		Abnormal	
Tag Number	Treatment	Gross	Histopath	Gross	Histopath	Gross	Histopath	Gross	Histopath
3	B	NSL	NSL	1	NSL	NSL	NSL	1	NSL
*471	A	NSL	NSL	3	2	NSL	NSL	NSL	NSL
*480	B	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
646	B	NSL	NSL	1	4	NSL	NSL	4/ 5	NSL
827	B	NSL	NSL	6	7	NSL	NSL	8	9
*841	A	NSL	NSL	10	11	NSL	NSL	NSL	NSL
*844	B	NSL	NSL	3	3	NSL	NSL	NSL	NSL
867	A	NSL	NSL	1	12	NSL	NSL	3	3
868	A	NSL	NSL	6	13	NSL	NSL	1	13
940	A	NSL	NSL	6	14	NSL	NSL	1	NSL
1152	B	NSL	NSL	6	6	NSL	NSL	1	NSL
1179	A	NSL	NSL	NSL	15	NSL	NSL	1	13

Table 3. Day 15. March 7, 2018. On day 15, four (4) cattle subjects injected on March 6, 2018 were euthanized and necropsied. These cattle are denoted with an * next to tag number. On March 7, 2018, Company injected the remaining eight (8) cattle subjects most recently injected on March 6, 2018. These eight (8) cattle were euthanized within 5 minutes following injection, and samples were sent at the same time for all cattle euthanized on this day. Cattle in group A were administered the saline-dye mixture with a hand syringe on the left side of the neck, and a ½-inch cannula remote delivery device on the right side. Cattle in group B were administered the saline and dye mixture with a hand syringe on the left side of the neck, and a ¾-inch tri-port cannula remote delivery device on the right side. Tissue samples of injection sites (classified as normal and abnormal) were collected and sent for each side of the cattle.

Necropsy visual observations done by David T Bechtol, DVM

*471, *480, *841 * 844 no significant lesions observed due injection delivered 24 hours prior to euthanasia.
It was noted that two of the remaining eight animals were of "poor doer" classification and a tint of blue dye was observed on the hide alone.
The remaining eight animals had no significant lesions observed.

The pathologist commented on tissue submitted both grossly and histopathology.
Tissue was scored by pathologists at TVMDL as:

1: Dye was observed in subcutaneous fat and muscle via facia delivery.
2: Locally extensive neutrophilic and histiocytic inflammation with edema and hemorrhage. No fibrosis. Haired skin with locally extensive neutrophilic inflammation with edema and hemorrhage.
3: Subcutaneous hemorrhage with no dye.
4: Locally extensive neutrophilic and histiocytic inflammation with hemorrhage and edema in the subcutaneous fat.

5: Reactive lymphoid hyperplasia with neutrophilic medullary cytosis. Dye in fat attached to lymph node
6: Dye in subcutaneous with hemorrhage
7: Focal histiocytic inflammation within the muscle.
8: Subcutaneous dye two locations
9: Multifocal histiocytic inflammation in muscle
10: Skin dye in dermis
11: Haired skin diffuse neutrophilic inflammation and edema in subcutaneous
12: Locally extensive subcutaneous hemorrhage and edema with basophilic blue streaming material
13: Lymph node reactive lymphoid hyperplasia with medullary neutrophilic cytosis and pericapsular hemorrhage
14: Hemorrhage in muscle
15: Focal muscle necrosis with hemorrhage and edema. SQ hemorrhage.

		RDD Right				Hand Syringe Left			
		Normal		Abnormal		Normal		Abnormal	
Tag Number	Treatment	Gross	Histopath	Gross	Histopath	Gross	Histopath	Gross	Histopath
462	B	NSL	NSL	1	NSL	NSL	2	1	NSL
519	B	NSL	NSL	NSL	NSL	NSL	NSL	1	NSL
533	B	NSL	NSL	3	3	NSL	NSL	1	NSL
687	A	NSL	4	1	3	NSL	NSL	1	NSL
845	B	NSL	NSL	5	NSL	NSL	NSL	1	NSL
922	A	NSL	NSL	5	5	NSL	NSL	1	NSL
937	B	NSL	NSL	NSL	NSL	NSL	NSL	1	NSL
943	A	NSL	NSL	1	NSL	NSL	NSL	5	NSL, 6
958	A	NSL	NSL	5	3	NSL	NSL	1	NSL
1082	B	NSL	NSL	5	NSL	NSL	NSL	1	NSL
1136	A	NSL	NSL	5	NSL	NSL	NSL	1	NSL
1151	A	NSL	NSL	5	NSL	NSL	NSL	1	NSL

Table 4. Day 16. March 8, 2018. On day 16, the remaining twelve (12) cattle subjects were injected, then euthanized within 5 minutes of injections. Cattle in group A were administered the saline-dye mixture with a hand syringe on the left side of the neck, and a ½-inch cannula remote delivery device on the right side. Cattle in group B were administered the saline and dye mixture with a hand syringe on the left side of the neck, and a ¾-inch tri-port cannula remote delivery device on the right side. Normal and abnormal tissue samples were sent for each side of the cattle.

Necropsy visual observations done by David T Bechtol, DVM

Dye was observed in both subcutaneous fat and muscle.
943 lymph node hyperplasia was noted and sample was collected.

The pathologist commented on tissue submitted both grossly and histopathology.
Tissue was scored by pathologists at TVMDL as:

1: Dye was observed in subcutaneous fat and muscle via facia delivery
2: Lymph node medullary hemorrhage
3: Hemorrhage in muscle
4: Focal hemorrhage in muscle
5: Dye in subcutaneous with hemorrhage
6: Lymph node reactive lymphoid hyperplasia with medullary neutrophilic cytosis and pericapsular hemorrhage

		RDD Right				Hand Syringe Left			
		Normal		Abnormal		Normal		Abnormal	
Tag Number	Treatment	Gross	Histopath	Gross	Histopath	Gross	Histopath	Gross	Histopath
187	A	NSL	NSL	1	NSL	NSL	NSL	1	NSL
356	B	NSL	NSL	NSL	NSL	NSL	NSL	1	NSL
456	A	NSL	NSL	NSL	NSL	NSL	NSL	1	2
504	B	NSL	NSL	1	NSL	NSL	NSL	3	NSL
555	B	NSL	NSL	1	NSL	NSL	NSL	1	NSL
556	A	NSL	NSL	1	NSL	NSL	NSL	NSL	NSL
620	A	NSL	NSL	4	1	NSL	NSL	1	NSL
1037	A	NSL	NSL	6	NSL	NSL	NSL	1	NSL
1078	B	NSL	NSL	1, 3	NSL	NSL	NSL	1	NSL
1095	B	NSL	NSL	1,3	NSL	NSL	NSL	1	NSL
1114	A	NSL	NSL	1,3	NSL	NSL	NSL	1	NSL
Red Bull	B	NSL	NSL	1	NSL	NSL	5	1	NSL

Table 5. Day 31. March 23, 2018. On day 31, twelve (12) cattle subjects were injected with product remotely and by hand syringe. Within 5 minutes following injections, cattle were euthanized for necropsy, tissue collection, and analysis. Cattle in both group A and group B were administered the saline-dye mixture with a hand syringe on the left side of the neck, and a ½-inch cannula remote delivery device on the right side. Normal and abnormal tissue samples were sent for each side of the cattle.

Necropsy visual observations done by David T Bechtol, DVM

Dye was observed in subcutaneous fat and muscle via facia delivery.
No significant lesions were observed.

The pathologist commented on tissue submitted both grossly and histopathology.
Tissue was scored by pathologists at TVMDL as:

1: Dye in subcutaneous
2: Focal histiocytic inflammation with intracellular amphiphilic material (presumed dye). Haired skin with locally extensive neutrophilic inflammation with edema and hemorrhage.
3: Dye in the muscle via facia delivery
4: Multifocal subcutaneous hemorrhage
5: Mild neutrophilic and histiocytic inflammation in the muscle and subcutaneous fat with focal areas of muscle degeneration.
6: Dye in subcutaneous with hemorrhage

REFERENCES

Cony, Ed, WSJ. Wall Street Journal 1959, New Gun Shoots Drug to Treat, Tranquilize Ill or Ornery Animals

CBW. Cattle Business Weekly. Issue 10-12-2016. Cattlebusinessweekly.com

McEwen SA, Fedorka-Cray PJ. Antimicrobial use and resistance in Animals. Clin Infec Dis. 2002:34 (Suppl 3): S93-106 [PubMed]

Palmer Chemical & Equipment Co, Inc. Short and long-range syringe projector. Trade catalogs. The National Museum of American History. 1900s. http://americanhistory.si.edu/collections/search/object/SILNMAHTL_28219

West, L. Stocker uses dart gun to medicate cattle. High Plains/ Midwest Ag Journal. Aug 16, 2004. http://www.hpj.com/archives/stocker-uses-dart-gun-to-medicate-cattle/article_0974bb4d-b93a-5a76-882d-395712917dbd.html