A survey of injection site lesions in fed cattle in Canada

Joyce Van Donkersgoed, Sue Dixon, Glenn Brand, Mary VanderKop

Abstract — During November 1996 to January 1997, a survey was conducted at 5 Canadian purveyors to measure the prevalence of injection site lesions in the top butt, boneless blade, outside round, inside round, and eye of the round. As trimmers were cutting these subprimals into steaks, technicians monitored each steak for grossly obvious scars. These scars were trimmed, weighed, and scored as either a "clear scar," "woody callus," or "cyst." All scars were subsequently examined histologically and classified as a "clear scar," "woody callus," "scar with nodules," "mineralized scar," or "cyst." Pieces were observed for broken needles while being processed and none were found.

The estimated prevalence of injection site lesions was 18.8% (95% CI, 16.4% to 21.2%) in top butts, 22.2% (95% CI, 18.8% to 25.7%) in boneless blades, 4.9% (95% CI, 3.6% to 6.3%) in the eye of round, 1.8% (95% CI, 1.1% to 2.9%) in the inside round, and 7.6% (95% CI, 5.6% to 9.8%) in the outside round. Some top butts originated from American fed cattle; the estimated prevalence of lesions was 9.0% (95% CI, 5.9% to 12.9%) in American top butts and 22.3% (95% CI, 19.4% to 25.3%) in Canadian top butts. The median weight of the lesions varied among subprimals and ranged from 64 g to 117 g. Histologically, 13% of the scars were clear scars, 47% were woody calluses, 5% were mineralized scars, 34% were scars with nodules, 0.2% were cysts, and 0.9% were normal fat infiltrations. An economic analysis estimated an average loss of $8.95 per fed animal processed or $19 million dollars annually to the Canadian beef industry from injection scars.

Résumé — Enquête sur les lésions de sites d'injections chez des bovins de boucherie du Canada. De novembre 1996 à janvier 1997, une enquête fut conduite auprès de cinq fournisseurs afin d'évaluer la prévalence des lésions de sites d'injections au niveau de certaines parties de la viande : «haute de croupe, palette désossée, extérieur de ronde, intérieur de ronde et œil de ronde.» Pendant que les pareurs découpaient ces coupes primaires dans la carcasse, les techniciens ont surveillé sommairement les cicatrices évidentes dans chacune de pièces. Ces cicatrices étaient parées, pesées et enregistrées telles que «cicatrices pâle,» «cal ferme,» ou «kyste.» Puis, les cicatrices examinées microscopiquement et classifiés telles que «cicatrice pâle,» «cal ferme,» «cicatrice avec nodules,» «cicatrice calcifiée,» ou «kyste.» Certaines portions furent examinées pour la recherche d'aiguilles brisées pendant les opérations de transformation et rien n'a été trouvé.

La prévalence estimée des lésions de sites d'injections était de 18,8 % (95 % CI, 16,4 % à 21,2 %) dans les hauts de croupe, 22,2 % (95 % CI, 18,8 % à 25,7 %) dans les palettes désossées, 4,9 % (95 % CI, 3,6 % à 6,3 %) dans l'œil de ronde, 1,8 % (95 % CI, 1,1 % à 2,9 %) dans l'intérieur de ronde, et 7,6 % (95 % CI, 5,6 % à 9,8 %) dans l'extérieur de ronde. La prévalence estimée de lésions de sites d'injections dans quelques hauts de croupe en provenance de bestiaux américains, étaient de 9,0 % (95 % CI, 5,9 % à 12,9 %) par rapport à 22,3 % (95 %, 10,4 % à 25,3 %) dans les hauts de croupe canadiens. Le poids moyen des lésions au niveau des coupes primaires a varié entre 64 g et 117 g. Microscopiquement, 13 % des cicatrices étaient classifiées cicatrices pâles, 17 % étaient cals

Alberta Agriculture, Food & Rural Development, 11 Bruns Road, Lacombe, Alberta T4L 1P1 (Van Donkersgoed); Box 571, Carstairs, Alberta T0M 0N0 (Dixon); Beef Information Center, 215, 6715-8th St. N.E., Calgary, Alberta T2E 7H7 (Brand); and Alberta Agriculture, Food & Rural Development, Animal Health Laboratory, 3115-5 Avenue, North, Lethbridge, Alberta T1J 4C7 (VanderKop).

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Correspondence to Dr. J. Van Donkersgoed.

Reprint requests to Canadian Cattlemen's Association, 215, 6715-8th St. N.E., Calgary, Alberta T2E 7H7.

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fermes, 5 % étaient cicatrices calcifiées, 34 % étaient cicatrices avec nodules, 0,2 % étaient kystes, et 0,9 % étaient des infiltrations de gras normal. Une analyse économique a estimé une perte moyenne de 8,95 $ par animal abattu ou 19 millions de dollars annuellement à l'industrie canadienne du bœuf pour des cicatrices d'injections.

(Traduit par docteur Daniel Perron)

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Introduction

Food quality and safety have received considerable attention lately from the beef industry, as it strives to improve both factors to remain competitive in a global marketplace. Processors have said that injection site lesions are a major quality defect that livestock producers can prevent. Results of the recent Canadian Beef Quality Audit found 1.3% observable surface injection site lesions in whole hanging carcasses (1). Results from audits in the United States have shown a much higher prevalence of injection site lesions in subprimals, ranging from 11% to 21% (2–5). These lesions were found in the muscle of top sirloin butts and rounds as they were being processed into steaks and roasts.

Since veterinarians and producers in Canada and the United States practice similar management and use similar animal health products, it is logical to assume that the prevalence of injection site lesions in Canadian beef is much higher than the 1.3% observed in the whole carcass audit. Many studies have shown that various animal health products and even saline, when injected IM, can produce a scar in muscle that persists for the life of the animal (6–10). These scars are a quality defect, because they result in trim loss from valuable cuts of meat and also affect the tenderness of the meat surrounding the lesion (2–10).

To improve the quality of Canadian beef through good production practices, it is necessary first to establish the baseline level of injection site lesions in fed beef and then to monitor this level over time to see if improvements have been made. The study described here is the 1st injection site survey conducted in Canada to determine the prevalence of injection site lesions in fed beef. It evaluates injection site lesions as a beef quality issue and not as a food safety issue.

Materials and methods

Sample collection

The Beef Information Centre identified 8 purveyors in Canada who processed enough subprimals daily to be included in this survey. Only large purveyors were contacted, for the practical reason of having enough cuts to make it cost efficient for the project. Seven purveyors agreed to participate in the survey, but data were collected from only 5 facilities because 1 plant did not process any fed beef during the time of the 1st survey and the scheduling of another was incompatible with the technicians' schedule. During November 1996 to January 1997, 2 purveyors in Ontario and 3 purveyors in Alberta were visited to collect data. These purveyors received Canadian subprimals from western and eastern Canada and American subprimals from Nebraska and Washington. Therefore, the subprimals assessed were geographically representative of Canadian beef but not geographically representative of American beef. Approximately 3 d were spent at each plant. Based on an estimated prevalence of 10% (2) and an allowable error of 2.5%, the sample size required to reliably determine the prevalence of injection site lesions in subprimals 95% of the time was approximately 576 subprimals (11).

At each plant, the butchers and trimmers were informed of the data collection process. Two technicians who trained together were used throughout the study to reduce diagnostic variability. Only top butts that included the biceps femoris and gluteus medius muscles were examined. The technicians and trimmers identified injection site scars as the subprimals were cut by hand or band saw into steaks. When injection site lesions were identified, they were trimmed by plant personnel and placed in bags. All trimmed pieces from a single subprimal were placed in the same bag, so that the amount of trim from each scar could be weighed. Simultaneously, the technicians scored the lesion as a clear scar, woody callus, or cyst, based on the predominant gross lesion. A clear scar was defined as clear fibrous tissue. A woody callus was defined as white scar tissue that looked like fat but was much harder on palpation. For the purpose of gross evaluation in this study, a cyst was defined as an encapsulated lesion containing fluid or pus. After scars were weighed, a sample from each was placed in 10% formalin for histological examination and classification according to the Colorado system (2,5). One pathologist examined all of the tissues to reduce diagnostic variability, and she was blind to the results of the lesion scores assigned by the technicians.

Histopathology

The muscle samples were received, fixed in 10% neutral buffered formalin and already identified with the plant number A-E and the subprimal cut from which the sample was collected. Each muscle section was examined and the lesion visually identified; a 0.5-cm thick slice was then taken along the greatest length of the lesion. The fixed sections were routinely processed, sectioned 5-um thick, and stained with hematoxylin & eosin.

All muscle samples were examined microscopically, and the lesions were categorized as cyst, scar with nodules, mineralized scar, clear scar, or woody callus, according to descriptions in the literature (2,5). The criteria used to define lesions in categories varied between the gross evaluation and microscopic examination, as described here. The category cyst was used for lesions with a clearly defined fibrous capsule and a cystic, empty center. These lesions were rare.

The category scar with nodules described sections with nodular inflammation. These nodules consisted of multifocal, coalescing infiltrates of lymphocytes and macrophages surrounding areas of either caseation

Table 1. Summary of injection site lesions observed in beef subprimals at 5 Canadian purveyors during November 1996 to January 1997

Outcome	Boneless blade	Top butt	Eye of round	Inside round	Outside round
n of subprimals	550	1050	980	936	603
% lesions	22.2	18.8[a]	4.9	1.8	7.6
95% CI[b]	18.8–25.7	16.4–21.2	3.6–6.3	1.1–2.9	5.6–9.8
trim weight (g)[c]	64	94	117	78	100
range	7–1380	7–634	25–725	15–343	7–398
type of scar %					
clear scar[d]	91	84	27	59	72
woody callus[e]	5	15	73	41	28
cyst[f]	4	0.5	0	0	0
trim weight median (g)					
clear scar	64	94	101	21	104
woody callus	37	84	128	144	82
cyst	101	353	NA[g]	NA	NA

[a]Prevalence (95% confidence interval) of lesions in top butts from Canadian beef was 22.3% (19.4% to 25.3%) and in American beef was 9.0% (5.9% to 12.9%)
[b]95% confidence interval
[c]Median weight (range) of trim from injection site lesions in grams
[d]Clear scar = on gross evaluation the lesion was clear fibrous scar tissue
[e]Woody callus = on gross evaluation the lesion was white scar tissue that looked like fat but was very hard on palpation
[f]Cyst = on gross evaluation the lesion was encapsulated and contained fluid or pus
[g]NA = not available

necrosis of muscle fibers or finely granular macrophages. Most often, the granularity represented fine mineralization, but this was not the predominant feature of the lesion and was not grossly detectable. Some lesions contained neutrophil infiltrates.

The category mineralized scars was reserved for lesions in which mineralization predominated over either inflammation or fibrosis; or cases, in which mineralization was severe enough to be grossly evident. This was a severe or advanced stage of the lesions observed in the scar with nodules category.

Clear scars were lesions with almost pure fibrous tissue and scant inflammation. While the fibroblasts were mature, the fibrous tissue often had a uniform, mucinous appearance. These were very distinctive lesions without overlap with the other types.

The category woody callus applied to lesions that showed adipose infiltration, mature fibrous tissue formation, and mild diffuse inflammation. This category was distinguished from normal fatty infiltration by fibroblast proliferation within the adipose tissue. Many lesions also showed focal, mild nonsuppurative inflammation.

Statistical analysis

All data were entered in a database (Reflex 2.0, Borland International, Scotts Valley, California, USA) and then transferred to analytical software (STATISTIX 4.1, Analytical Software, Tallahassee, Florida, USA). Simple descriptive statistics, such as prevalence and median weights of trim, were calculated by subprimal and type of lesion.

Economic analysis

For the economic analysis, average weights of subprimals were obtained from the 1993 National Carcass Cut Out and 4th quarter 1994 average carcass weight of 341 kg (personal communication, Lacombe Research Centre). The weights were also cross-referenced with Cargill box beef weight ranges. Retail prices were based on International Surveys Limited data for November 1996, December 1996, and January 1997. Assumptions were based on the authors' knowledge of industry practices.

Results

Prevalence and type of injection site lesions

The estimated prevalence of injection site lesions in top butts during November 1996 to January 1997 (Table 1) was 18.8% (95% CI, 16.4% to 21.2%), with an estimated prevalence of 22.3% (95% CI, 19.4% to 25.3%) in Canadian fed beef and 9.0% (95% CI, 5.9% to 12.9%) in American fed beef. The prevalence of lesions was similar in boneless blades, but much lower in the muscles from the round. The amount of muscle that was trimmed as injection site scars was highly variable and ranged from 7 g to 1.4 kg. Grossly, 77% of the lesions were clear scars, 22% were woody calluses, and 1.4% were cysts. Broken needles were not found during processing of the subprimals.

The histological classification of injection site lesions is shown in Table 2. The most common lesions were woody callus, scar with nodules, and clear scar. Mineralized scars and cystic lesions were rarely observed. Normal fat infiltration was only occasionally misclassified as an injection site lesion. The histological classification differed from the gross classification of lesions. The association between the gross and histological classifications could not be evaluated in detail, because individual scars were not uniquely identified and tracked to histopathology.

Economic losses

Top butts

The estimated prevalence of injection site lesions in top butts from Canadian fed cattle was 22.3%. In 1996, 2 151 192 fed cattle were processed in Canada (personal communication, CANFAX), which represents 4 302 384 top butts. Therefore, the estimated number of lesioned

Table 2. Percentage distribution of injection site lesions in each of 5 histological classifications by beef subprimal

Lesion	Boneless blade	Top butt	Eye of round	Inside round	Outside round	Overall
clear scar[a]	0.8	16	10	31	28	13
woody callus[b]	35	47	68	50	57	47
mineralized scar[c]	8	4	6	6	0	5
scar with nodules[d]	55	32	16	13	11	34
cyst[e]	0.08	0	0	0	0	0.2
no lesion[f]	0	1	0	0	4	0.9

[a]Clear scar = scars with predominantly a fibrous response that had mature fibroblasts, but less mature collagen, with a mucinous appearance and usually minimal fat infiltration and inflammation
[b]Woody callus = scars with mature fibrous tissue, intermingling of adipose infiltrates and generally mild, nonfocal inflammation
[c]Mineralized scar = scar with fibrous tissue containing sufficient mineralization to be a prominent feature of the scar
[d]Scar with nodules = scar with variable fibrosis and fatty infiltration, and the required element was nodular, multi-focal inflammation with macrophages and lymphocytes and generally small numbers of multinucleate cells
[e]Cyst = scar with necrotic cellular debris in an area of focal granulomatous inflammation
[f]No lesion = normal muscle and fat infiltration with no evidence of fibrosis or inflammation

top butts was 959 432 (4 302 384 × 22.3%). The average weight of a trimmed top butt is 5.86 kg. There are approximately 10, 1-inch steaks per butt, with an average weight per steak of 0.59 kg. We observed that 3 steaks were generally affected when an injection site lesion was present (3 × 0.59 kg = 1.77 kg). The retail price of sirloin steaks was $8.57/kg. Therefore, the loss was calculated to be 1.77 kg × $8.57/kg = $15.17 for a single injection site defect.

We assumed that 80% of purveyors cut out the lesion and discarded it (median weight of trim from survey was 94 g) and salvaged the rest as stew beef. The price of stew beef was $6.66/kg. The average cost of the salvage operation was $0.84 [2 min at $0.42/min (wage $25/h)]. Therefore, they recovered 1.77 kg − 0.94 g (trim) = 1.68 kg. This was sold at 1.68 kg × $6.66/kg = $11.19. The calculated net recovery was $11.19 − $0.84 (labor) = $10.35.

We assumed that 20% of purveyors did not salvage anything and the estimated loss was $15.17/butt. We assumed that 80% of purveyors salvaged the surrounding tissue and lost $15.17 − $10.35 = $4.82. The loss from injection site lesions in top butts was calculated to be [959 432 lesioned butts × 80% salvaged × $4.82] + [959 432 lesioned butts × 20% discarded × $15.17] = $6 610 486 or $3.07/head processed annually (6 610 486 divided by 2 151 192 fed cattle).

Boneless blade

The estimated prevalence of injection site lesions was 22.2%, which represents 955 129 affected blades, and the average trim from lesions was 64 g. The average retail price of boneless blade was $5.06/kg and the weight of the trimmed subprimal was 7.50 kg. There are approximately 19, 1-inch steaks per blade; thus, 0.39 kg/steak. We observed 5 steaks were generally affected when an injection site was found (5 × 0.39 = 1.95 kg), with an estimated loss of 1.95 kg × $5.06/kg = $9.87. This loss occurred 20% of the time. Eighty-percent of affected blade steaks were trimmed and the remainder were salvaged for regular ground beef at $2.75/kg, with a salvage cost of $0.84. They recovered 1.95 kg − 64 g = 1.89 kg and sold it at $2.75/kg = $5.20. The net recovery was $5.20 − $0.84 = $4.36. Estimated loss was $9.87 − $4.36 = $5.51. The total loss was calculated to be [955 129 affected blades × 20% × $9.87] + [955 129 × 80% × $5.51] = $6 095 633 or $2.83/head processed.

Outside and inside rounds

The estimated prevalence of lesions was 7.6%, which represents 326 981 affected outside rounds. We observed that 5 steaks were generally affected each time there was an injection site lesion, and the remainder following trim (100 g) were salvaged for regular ground beef at $2.75/kg. The retail price of outside rounds was $7.02/kg and the average weight of the trimmed subprimal was 7.66 kg. There are approximately 22, 1-inch steaks per outside round with an average weight of 0.35 kg/steak (5 × 0.35 kg = 1.75 kg × $7.02/kg = $12.28). We assumed that 80% were salvaged (1.75 kg − 100 g (trim) = 1.65 kg × $2.75/kg = $4.54 − $0.84 (labor) = $3.70; $12.28 − $3.70 = $8.58). The calculated total loss for outside rounds was [326 981 affected outside rounds × 20% × $12.28] + [326 981 affected outside rounds × 80% × $8.58] = $3 047 463 or $1.42/head processed.

There were an estimated 77 443 damaged inside rounds based on a 1.8% estimated prevalence of lesions. The average weight of trim was 78 g. The retail price of inside rounds was $8.86/kg, and the trimmed weight of the subprimal was 10.72 kg. There are approximately 16, 1-inch steaks per inside round or 0.67 kg/steak. During the study, we noted that there were approximately 5 steaks damaged with an injection site lesion (5 × 0.67 kg/steak = 3.35 kg). The estimated loss was $29.68. Eighty percent were assumed salvaged for regular ground beef (3.35 kg − 78 g (trim) = 3.27 kg × $2.75/kg = $8.99 − $0.84 (labor) = $8.15; $29.68 − $8.15 = $21.53) The calculated total loss for inside rounds was [77 443 affected inside rounds × 20% × $29.68] + [77 443 affected inside rounds × 80% × $21.52] = $1 793 580 or $0.83/head processed.

Eye of round

The estimated prevalence of lesions was 4.9%, which represented approximately 210 817 affected eye of rounds, with 117 g of trim. The average weight of the eye is 3.11 kg at $8.83/kg. We observed that 5 steaks were generally affected when there was an injection site lesion,

and when the lesions were trimmed, the remainder was salvaged for regular ground beef at $2.75/kg. There are approximately 14, 1-inch steaks per eye of round with an average weight of 0.22 kg/steak (5 × 0.22 kg = 1.1 kg × $8.83/kg = $9.71). Eighty percent were salvaged for regular ground beef (1.1 kg − 117 g (trim) = 0.98 kg × $2.75/kg = $2.70 − $0.84 (labor) = $1.86; $9.71 − $1.86 = $7.85). The calculated total loss was [210 817 affected eyes × 20% × $9.71] + [210 817 affected eyes × 80% × $7.85] = $1 733 337 or $0.80/head processed.

The financial loss to the beef industry from injection site lesions was thus estimated to be $8.95 per fed animal processed ($3.07 + $2.83 + $1.42 + $0.83 + $0.80). In total, this results in an estimated loss of $19 253 168 annually to the Canadian beef industry. This economic loss does not include lost sales from tough beef caused by injection site scars.

Discussion

Packer speculation regarding the severity of injection site lesions in Canadian beef as a quality defect was confirmed in this survey. The prevalence of injection site scars in Canadian top butts was similar to that observed in top sirloin butts in the United States in July 1991 (2). Following strong campaigns for beef quality assurance programs at the feedlot and ranch, American producers have been able to reduce the prevalence of injection site lesions in top butts by 50% (2,4,5). An injection site audit conducted November 1996 in the United States indicated a prevalence of 9.1% in top sirloin butts [(personal communication, National Cattlemen's Beef Association (NCBA)]. This prevalence is similar to the prevalence observed in American top butts that were further processed at Canadian purveyors concurrently during this survey. The most recent NCBA audit in March 1997 showed a prevalence of injection site lesions of 7.5% in top sirloins in fed cattle (personal communication, NCBA).

The estimated prevalence of injection site lesions in the round varied by muscle and was 1.8% for the inside round (semimembranosus muscle), 3.9% for the eye of round (semitendinosus muscle), and 7.6% for the outside round (biceps femoris muscle), with a median lesion trim of 78 g to 117 g. This prevalence is slightly different than that reported in an American audit, where the estimated prevalence of injection site lesions was 6.0% in the inside (top) round, 6.23% in the eye of round, and 6.67% in the outside (bottom) round (3). American round cuts had an average lesion trim of 212 g (3). The prevalence of injection site lesions may be lower in Canadian rounds than in American rounds, because more Canadian producers and veterinarians may still be using the top hip as the preferred site for administering animal health products, IM.

Boneless blade steaks are difficult to monitor for injection site lesions, because of the connective tissue normally present in the muscles. Thus, the estimated prevalence of injection site lesions in the boneless blade steaks may underestimate the true prevalence. Similarly, injection site lesions may have been missed in other subprimals that were monitored, particularly when thick steaks (1 inch) were processed.

A 2nd Canadian audit is being conducted in April and May 1997. It will be interesting to note if the prevalence of lesions has dropped in top butts and rounds and increased in boneless blades as a result of quality assurance initiatives that promote neck injections rather than hip or round injections (13). Neck injections are preferred, because the value of the cuts from the neck are less than those from the butt and round. Additionally, the cranial neck muscles are generally ground for hamburger; thus, a tenderness problem (3–6,10) associated with injection site scars in neck muscles would not be as detrimental as in sirloin or round steaks.

Gross and histological classification of injection site blemishes indicated that the majority were clear scars, woody calluses, and scars with nodules. It is important to categorize the lesions, since the category may reflect the duration of the lesion or the type of irritant causing the lesion. It could correlate with the extent of trim that might accompany a lesion or the impact on the tenderness of surrounding meat. It could also correlate to the site of the lesion, with some muscle groups being more likely to generate a mineralized lesion, perhaps those with more motion. It might also reflect the vascularity of the muscle tissue, with more inflammation occurring with greater vascularity. There is limited information in the literature documenting an association between these factors (10). Published data suggests that clear scars and woody calluses are mature lesions, occurring at branding or weaning age, while scars with nodules or cysts are less mature lesions, occurring later in the finishing period (2–6,10). The results of a current Canadian study looking at the histological appearance of injection sites in calves with known injections and substances will be examined; they may help to answer some of these questions.

While it has been reported that a clear scar is a stage between scar with nodules and woody callus, we speculate that the clear scars could also occur where there is little irritating or persistent antigen in the injected substance, resulting in a scar that has little cellular inflammation and almost pure fibrosis.

The scar with nodules clearly shows significant muscle damage by the injected substance along with a persistent antigenic stimulus. These scars would be expected to have an impact on surrounding tissue tenderness due to the extent of the lesion (3–6,10). Since the edges of the lesion are poorly circumscribed, they may not be completely removed during trimming and the inflammatory components may result in taste alteration in the surrounding meat and decreased tenderness, depending on the product administered (3–6,10).

The impact of the woody callus would be trim loss and reduced tenderness of surrounding muscle, if the scar were incompletely removed. Research at Colorado State University has clearly shown that injection site lesions reduce the tenderness of the meat up to 3 inches away from the center of the grossly visible lesion and that even when lesions are not grossly visible, shear force values are increased and more variable in injected subprimals than in the contralateral uninjected controls (3–6,10). Injection site lesions affect the tenderness of cuts significantly, by severely disrupting the muscle tissue constituents and architecture and by increases

in collagen concentrations (3–6,10). The lesions and toughness appear to persist for the life of the animal and do not resolve with time (6,10). Even normal saline and vitamins ADE solution will cause injection site lesions and increase overall shear force measurements (10). Two animal health products that have been identified as causing severe tissue damage are clostridial vaccines and long-acting oxytetracycline (6–10,12). Even when clostridial vaccines are administered, SC, as is the current recommendation, there is inflammation of the surrounding dermis, subcutaneous adipose tissue, and underlying musculature (8,12). However, this damage is much less severe than when the vaccine is administered, IM (8,12). The NCBA has recommended that IM injections be eliminated (10) and that nonirritating animal health products be used by veterinarians and producers. Pharmaceutical companies are being urged to modify existing animal health products and create new products that can be administered, SC, or by the topical, oral, or IV route.

General recommendations of the *Canadian Cattlemen's — Quality Starts Here Program* to reduce injection site scars in beef have been previously described (1,13). Additional recommendations include: 1) use clean needles, 2) use transfer needles to reconstitute products, 3) never go back into the drug bottle with the same needle used to inject the animal, 4) give all clostridial vaccines, SC, in the neck, 5) avoid the use of dart or projectile guns for treating cattle, 6) use 18- or 16-gauge, 1/2″ or 3/4″ needles for SC injections; 18- or 16-gauge 1″ or 1 1/2″ needles for IM injections, and 14-gauge, 1 1/2″ or 2″ needles for IV injections, 7) do not combine different vaccines or antimicrobials in the same syringe, and 8) label syringes for different products clearly and clean syringes thoroughly prior to use of other products. By following these recommendations, the prevalence of injection site lesions in beef and the associated dollar loss of $19 million from trim and devaluation of subprimals can be reduced.

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