ELECTROIMMOBILIZATION IN RED DEER

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INTRODUCTION

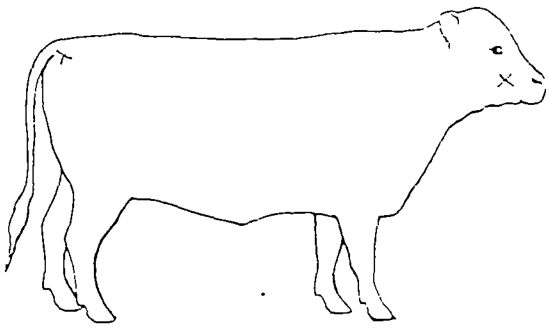
The use of electroimmobilization (EI) as a means of restraint in farm animals has been surrounded with controversy since its original use in the 1970's (Rowley, 1991, Houpt, 1991) The electronic cattle immobilizer unit ("Stockstill") produced by the Australian Merino Wool Harvesting Company is recommended as a safe and reliable way of immobilizing range cattle for castration, dehorning and branding However the effect of EI on animals is considered by many to be inhumane

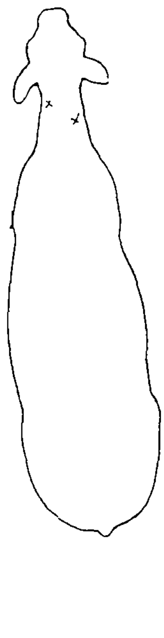
The "Stockstill" unit is a constant current pulse generator giving DC pulses of approximately 1 0ms in duration with a pulse repetition frequency of 50Hz It delivers a range of current up to 240ma. The current passes between two electrodes placed in the animal and produces a state of immobility. The electrodes may be positioned

(a) in the cheek and caudal fold of the tail,
(b) on both sides of the neck or
(c) half way down the back and caudal fold of the tail (Figure 1)

Figure 1. **The positions of electrodes used in different methods of electroimmobilization.**

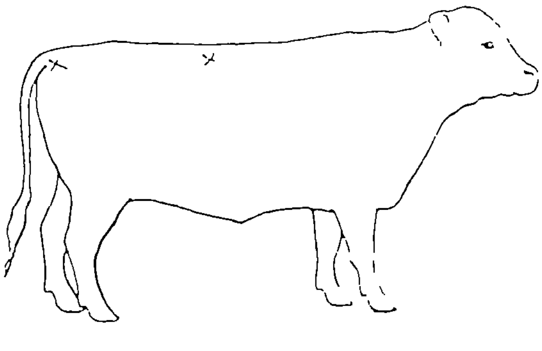
a) Cheek to tail





b)Neck

c) Mid back to tail



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When the electrodes are placed in the cheek and the tail fold the voluntary muscles are excited by the electrical pulse and the animal goes into a state of tetany If the electrodes are positioned on both sides of the neck in a diagonal manner involving at least 2 or 3 vertebrae the skeletal muscles are not put into a state of tetany but the animal is immobilised. Cattle are partially immobilised if the electrodes are placed in the middle of the back and tail fold but the portion of the body anterior to the cranial electrode is mobile

EI is a cheap and effective method of restraining animals However the doubt which exists concerning the humaneness of its use raises a few questions -

1 Is EI painful?
2 Does EI induce analgesia?
3. Does the use of EI reduce the stress or pain induced by management procedures such as dehorning, castration, branding, mulesing or shearing?
4 Does the effectiveness of EI justify its use in particular situations?

A series of papers have been produced in the last twenty years reporting the effects of EI on animals These will be briefly reviewed in an attempt to answer the 4 questions listed above

1 **Is EI painful?**

To determine if EI is painful four different experimental techniques have been utilised

a) The monitoring of animal behaviour before, during and after EI

During the induction of head to tail EI, 33% of cattle bellowed when the current was applied (Carter *et al* , 1983) Furthermore, vocalisation was reported in 6 of 10 calves and 8 of 9 pigs when EI was induced (Lambooy, 1985) The state of rigidity seen in cattle subjected to head to tail EI was considered disturbing by Carter *et al* (1983), but cattle started to feed when given hay 30 minutes after EI When squeeze-tilt table restraint was compared with EI, sheep would accept a feed quite readily after table restraint but only reluctantly after EI (Grandin *et al* 1986) Feeding after EI is probably not a useful criterion of the degree of stress involved as feeding occurs in stressed animals (Duncan, 1974). It has been speculated that the muscle tetany of EI produced muscle soreness, but lameness after EI has not been reported There is a short period after EI is induced when breathing is impaired due to tetany of the skeletal muscles. This enforced apnoea may be a cause of distress Increasing the period of apnoea increases the aversiveness of the procedure whereas increasing the duration of EI *per se* does not (Rushen, 1986a) When the electrodes were placed in the mid-back to tail position it was found that instantaneous application of EI caused either bellowing or vigorous shuffling movement of the forequarters and head in all cattle However, if the current was applied slowly over 45 seconds a state of hindquarter rigidity developed without any movement suggestive of distress. Animals partially immobilized in this manner did not react when castrated or hot branded on the hind leg (Kuchel, personal communication)

b) The monitoring of physiological parameters such as heart rate and blood levels of various hormones.

Electroimmobilization caused an increase in blood cortisol levels in cattle, sheep and pigs (Lambooy, 1985; Jephcott *et al* 1986, 1987, 1988). The cortisol levels remained elevated 20 minutes after EI in pigs and cattle (Lambooy, 1985) and for up to 45 minutes in sheep (Jephcott *et al* 1986) In sheep, plasma cortisol levels increase in response to stresses such as shearing (Kilgour and de Langen, 1970) and handling (Fulkerson and Jamieson, 1982) There is some debate about the usefulness of plasma cortisol as a parameter of stress However, it is generally accepted as being one useful parameter of stress and is now widely used for this purpose (Mellor and Murray, 1989). The possibility that EI caused an increase in plasma cortisol levels by direct electrical effect on the pituitary and or adrenal glands has been discounted by Jephcott *et al* (1986) In contrast Seamark (1978) found no significant increase in plasma cortisol levels (they remained below 8nmol/litre) in one ewe subjected to EI using 240ma, which is about 4 times the recommended amperage for ewes Seamark concluded that sheep were not subjected to significant stress by EI Beta-endorphin and beta-lipotrophin increased significantly after EI but prolactin did not (Jephcott *et al* 1986) These hormones have been associated with stress in some species

c) The monitoring of the behavioural response of animals to repeated EI

The assessment of the welfare implications of any animal husbandry procedure should attempt to determine the animals' perception of the procedure itself If a procedure is unpleasant it could be expected that in future, animals would avoid locations and circumstances associated with the procedure In a trial carried out by Rushen (1986a, b) sheep were moved through a race and into a catching device where they were subjected to EI This was repeated twice daily for 4 days After being electroimmobilized three times the time taken to move the sheep into the catching device (transit time) increased significantly in the sheep subject to EI (375sec) and was much greater than in the sheep which were held manually in the device (200 sec). Furthermore, 12 weeks later the sheep subjected to EI were still more reluctant to move into the device than other sheep The unpleasantness of EI to sheep as exhibited by the increase in transit time was influenced more by the current used than by the duration of electroimmobilization i.e the higher the current the greater increase in transit time (Rushen, 1986a, b). Rushen (1986a) suggested that the period when the sheep are unable to breathe may be a significant factor contributing to the distress caused by EI. Some adaption to the procedure does develop, after being electroimmobilized 5 to 7 times the transit time decreased slightly (300 sec)

Cattle electroimmobilized several times over a period of days took significantly longer to move into the stanchion where EI was carried out (48 sec) and their heart rate recorded before EI increased (130 beats-min) in comparison with cattle that were not electroimmobilized (28 sec, 60 beats-min) (Pascoe and McDonell, 1985, 1986). In this particular trial a high pitched noise was made before EI was induced. Nine months later the cows subjected to EI responded to the high pitched noise by backing up in the stanchion, shaking their heads, tail waving and forceful exhalation whereas the control animals did not react

d) Carrying out EI on humans

Reports on the pain experienced by human volunteers subjected to EI are contradictory. One report concluded that it was a little uncomfortable (Baxter, 1987), but this was disputed by others who claimed that it was agonizing when the muscles of the arm assume a strongly contracted state (Carter, 1987) and very disagreeable (Grandin quoted by Rushen, 1987) Whether the pain experienced by humans is a useful parameter to investigate how sheep experience EI is debatable but it does seem a reasonable means of investigation

These findings would indicate that head to tail EI is an unpleasant and probably painful procedure and one which stock remember and attempt to avoid However, many procedures which we perform on animals and indeed on humans are painful and would be avoided if possible. It may be useful therefore to compare the reaction of livestock to EI and to some common management procedures.

Using blood cortisol levels as a parameter Jephcott *et al* (1987) demonstrated that EI and shearing produced a similar response but Rushen and Congdon (1986a) demonstrated using the "Transit time" technique that sheep found shearing less noxious than electroimmobilization In similar trials Grandin *et al* (1985, 1986) demonstrated that sheep found EI more aversive than squeeze-tilt table restraint Kuchel (personal communication) found that the cortisol response of lambs to EI was lesser than to mulesing or tail docking using rings He considered that EI caused less perturbation that the other procedures In cattle using heart rate and behavioural responses Pascoe (1986) found that EI caused a significantly greater response than a 10ml intramuscular injection of saline.

2 **Does electroimmobilization induce analgesia?**

Electrical currents are used to produce analgesia for dental procedures (Savage, 1982) and it has been suggested that EI causes a degree of analgesia (Kuchel *et al* 1990) The mechanisms whereby EI might produce analgesia have been discussed briefly by Jephcott *et al* (1986) Many stressful stimuli act to produce a degree of analgesia It has been suggested that opiate and non-opiate mechanisms may be involved in this stress-induced analgesia ("battlefield analgesia") However, whether EI induces stress induced analgesia in animals has not been demonstrated thought it should be possible to demonstrate post EI analgesia quite easily if it occurs

Lambooy (1985) indicated that 15 of 29 experimental animals responded to painful stimuli while under EI but he did not define either the painful stimuli used or the pain responses When cattle were dehorned whilst electroimmobilized they showed eye movement and flinching of the head and neck (Carter *et al* 1983) These activities were considered by the authors to demonstrate that the cattle felt the removal of horns and that EI did not produce sufficient analgesia to prevent this appreciation of pain The ability of electroimmobilized cattle to move their heads at all has been queried but eye movements are certainly possible.

However, as stated above, it has been observed by Kuchel (personal communication) that cattle electroimmobilized with electrodes placed midback and tail did not react when castrated or hot branded on the rump. They did not bellow or exhibit signs of pain Further research into this type of EI is required to determine if this is genuine analgesia and whether it is local analgesia or some form of stress induced analgesia Electroacupuncture with the needles placed in the area of the pelvis has produced analgesia sufficient to allow laparotomy to be carried out in cows (White *et al* 1985)

The consensus at present seems to be that if you wish to use EI you should assume that it does not cause analgesia and use a local analgesic.

3 Does the use of EI reduce the stress or pain induced by management procedures such as dehorning, castration, branding, mulesing or shearing?

In a dehorning trial no difference in plasma cortisol levels were found between cattle dehorned using EI, local analgesic or no analgesic (Carter *et al* 1983) This trial was poorly designed and more blood samples should have been taken for cortisol analysis before the results could be accepted. Further research using the "transit time" technique has demonstrated that EI did not influence the aversiveness shown by sheep to shearing (Rushen and Congdon, 1986b, c). Grandin *et al* (1985, 1986) comparing the aversiveness of table squeeze-tilt restraint with EI concluded that "it is unlikely that the aversiveness of even painful experiences under squeeze-tilt table restraint would exceed that of EI alone" Kuchel (personal communication) found that the cortisol response to mulesing and docking was not reduced by EI Amend (1983) believed that EI provides a sufficient distraction to diminish the overall perception of discomfort in an animal and this may be a widely held view amongst users of EI However, if EI is a major discomfort *per se* its ability to distract may be because it is a more severe discomfort itself.

4 Is the use of EI justified in any situation

The answer to this question is dependent at least partially upon resolution of the three previous questions The answers provided in the literature to date indicate that head-to-tail EI is painful, there is no evidence that it causes analgesia and it does not appear to reduce the pain or stress of other procedures From the veterinary perspective there are at least three important aspects to the question of whether EI should be allowed as a means of restraint. These are welfare, restraint and the likely uses of EI.

It is unlikely that head-to-tail EI could be justified for use in situations where practical and easily available alternative methods of restraint and analgesia are available. It is painful of itself and does not cause analgesia

However, the restraint of range cattle is always vigorous even in a crush or with ropes Head-to-tail EI makes restraint of these "wild" cattle a lot easier and safer for stockmen and allows a degree of control during castration and dehorning which might not be there with physical restraint EI in reality may be an improvement on the present situation of vigorous physical restraint The noxious effect of EI on "wild" stock has not been quantified and it may not be significantly greater than physical restraint

The use of midback-to-tail EI may have a place in cattle medicine and surgery if claims of its painless application are confirmed If, in addition, it produces a degree of analgesia it may be recommended for use in management procedures where local analgesia is not usually utilised i.e. castration, branding and mulesing. It is imperative that further research be carried out into midback-to-tail EI.

The problem as to what uses EI may be put to if freely available is a problem which could be considered with regard to crushes and ropes

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It has been suggested that EI might be useful as a means of restraint in deer to facilitate velvetting and other management procedures. EI is being used on deer and is being used during velvetting in Australia and New Zealand.

No reports describing investigations carried out to examine the effect of EI on deer are available to date.

The following reports the results of a trial to determine if deer identify EI as an aversive stimulus.

Materials and Methods

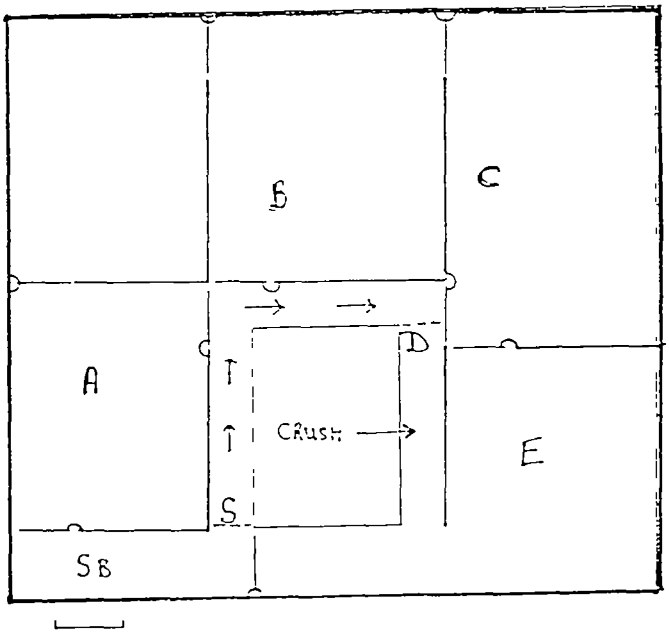
a) **Animals**

Thirty nine 11-12 month old deer (20 red and 19 wapiti x red) were used Thirty six were stags and 3 hinds Each animal had a numbered eartag for identification The deer were between 60 and 80 kg liveweight during the trial On day 1 of the trial 3 stags were velvetted using xylazine and local anaesthetic The other stags were growing velvet, but were not velvetted during the trial

b) **Trial Design**

Each day the deer were brought in from pasture to a deer shed where they were divided into 3 groups of about 13 animals and placed in pens A, B and C (Figure 2)

Figure 2. **The pens, route and crush system used in the trial.**



<u>**Day 1**</u> Each deer was moved from the starting box (SB), through the race into the crush (C) and then into the release pen (E) This was carried out twice to familiarise the deer with the route

When the animals in group 1 located in Pen A had all moved into Pen E The deer in pen B were moved into A and those in C and E were moved into B and C, respectively (Figure 2)

Day 2 and 3 The deer were moved through the route twice as on day 1 but the time ('Transit Time") taken to move from the starting position into the crush was measured. The time was measured from when the hind legs had crossed the starting line (S) until these limbs were in the crush (D)

In addition, the degree of encouragement required to move them along the route was recorded on a scale of 1 to 4 where 1 was equated with a person walking slowly behind the animal, 2 was a gentle push with the hand on the rump usually required at the crush mouth, 3 was pushing from the starting point until entry into the crush and 4 was when the animal turned in the crush or required energetic physical handling to get it into the crush.

One person (KS) walked behind the deer throughout the trial. Only the authors were present during the trial

Day 4. Each deer was moved through the route once and restrained in the crush ("crushed") Every second deer was subjected to EI using an experimental "Stockstill" unit In all, 10 red deer and 9 wapiti crosses were electroimmobilized All deer were held in the crush for 2 minutes

Day 5 and 6 Deer treated as on day 2 and 3

Day 7, 8 and 9 Deer treated as on day 4

Day 10. Deer treated as on day 2 and 3

c) **EI Technique**

The EI electrodes, a large needle held in large crocodile clamps were placed in the right or left cheek and in the tail fold The electrodes were placed in hibitane between animals

EI was carried out using a pulse duration of 2 5ms with a frequency of 65HZ The initial amperage was in the range of 80 to 100ma to induce immobilization and it was immediately reduced to about 60 to 80ma until respiration resumed Deer were electroimmobilized for one minute

Results

The trial was carried out without difficulty

Deer subjected to EI were certainly immobilized. Being "crushed" in a standard drop floor deer crush the pressure on the thorax may have hindered the resumption of breathing after EI was induced and the amperage was reduced The deer did not resist the placement of electrodes. The deer subjected to EI did not behave differently in the crush than the control animals Electroimmobilization was carried out a total of 76 times On induction of EI vocalisation (moaning-bellowing-groaning) was heard 12 times.

Wapiti cross deer were easier to cut out of the group in pen A and to move into the starting box.

The transit time did not change significantly during the trial and there was no significant difference between the animal which were electroimmobilized and those that were not (Table 1; Figure 3)

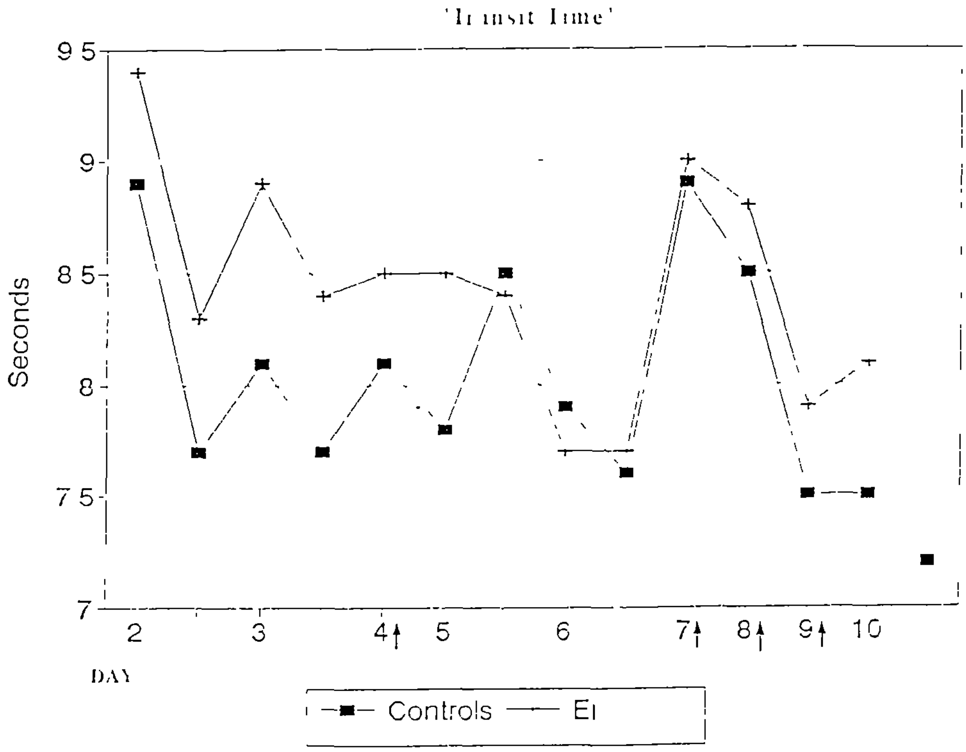
Table 1. **The mean "transit time" (in seconds) taken by deer to move through the route and into the crush. Deer were either restrained in the crush (C) or restrained and electroimmobilized (EI) on days 4,7 8 and 9 after the "transit time had been measured.**

Day	2		3		4	5		6		7	8	9	10	
Red Deer														
C[1]	8 8	7 6	8 3	8 0	7 7	8 1	8 8	8 1	8 1	9 1	8 2	8 1	8 2	7 2
EI[1]	10 1	9 1	8 4	9 4	9 5	9 1	9 0	8 1	8 0	9 3	9 2	9 0	[illegible]	7 7
WapitixRed Deer														
C[1]	8 9	7 7	7 8	7 4	8 4	7 5	8 2	7 7	7 1	8 7	8 7	6 8	[illegible]	7 1
EI[2]	8 6	7 5	9 3	7 2	7 4	7 8	7[illegible]	7 3	7 3	8 6	8 3	6 7	7 0	6 7

[1] mean of 10 animals
[2] mean of 9 animals

Deer were moved through the route twice on days 2, 3, 5, 6 and 10

Figure 3. The mean "transit time" for the electroimmobilized and control deer. Electroimmobilization was carried out on day 4, 7 8 and 9 (↑) after "transit time" had been measured. "Transit time" was measured twice on days 2, 3, 5, 6 and 10.



There was an increase in the level of encouragement required to get the red deer which had been subjected to EI into the crush from days 4 to 5 but not the wapiti crosses (Table 2, Figure 4)

Table 2. **The mean degree of encouragement required to move deer through the race and into a crush. In the crush deer were restrained (c) <u>or</u> restrained and subjected to electroimmobilization (EI) on days 4, 7, 8 and 9 after the degree of encouragement had been measured.**

Day 2		3		4	5		6		7	8	9	10	
Red Deer													
C[1] 1 2	1 2	1 0	1 0	1 1	1 3	1 4	1 4	1 3	1 0	1 3	1 4	1 6	1 2
EI[1] 1 2	1 3	1 2	1 2	1 3	1 7	1 6	1 8	1 8	1 6	1 5	1 8	1 2	1 5
WapitixRed Deer													
C[2] 1 2	1 0	1 0	1 0	1 1	1 1	1 1	1 2	1 0	1 1	1 2	1 2	1 0	1 1
EI[2] 1 0	1 0	1 0	1 0	1 0	1 1	1 0	1 0	1 0	1 4	1 1	1 4	1 1	1 1

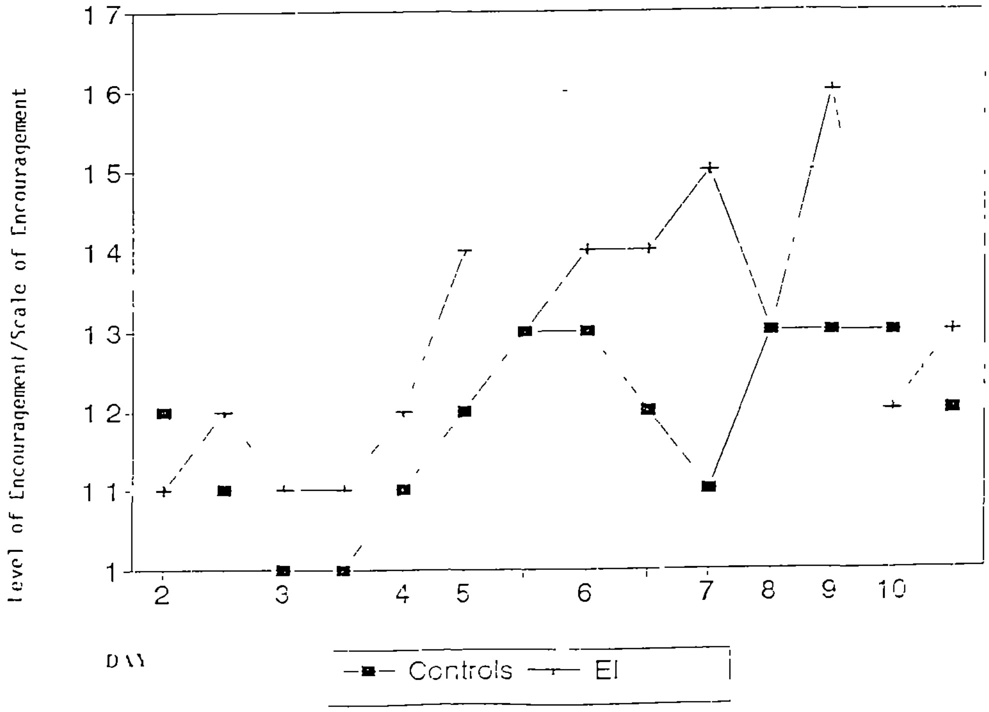
mean of 10 animals
[2] mean of 9 animals

Encouragement was graded from 1 to 4 where 1 equates with a person walking slowly behind the animal, 2 equates with a gentle push with the hand on the rump 3 equates with a push from the entry into the route until entry into the crush and 4 equates with the animal turning in the route or energetic manhandling to get the deer into the crush

Deer were moved through the route twice on days 2, 3, 5, 6 and 10

Figure 4 **The mean level of encouragement required to move the two groups of deer (control, subject to electroimmobilization) through the route and into the crush**

Electroimmobilization was carried out on days 4, 7 8 and 9 after the degree of encouragement had been measured. Encouragement was measured twice on days 2, 3, 5, 6 and 10.



After EI the electrodes were removed and the deer were released The EI animals "jumped" out of the crush more frequently than the others Mouth breathing was seen 8 times after EI (10%) but never in the control animals. The mouth breathing lasted for 5 to 10 minutes after the animals were released from the crush Each day when the trial was over the animals were being moved back into the paddock no difference was noticed in movement or behaviour between EI animals and the controls on casual observation

Discussion

During this trial the "transit time" did not change significantly for deer which were "crushed" or "crushed" and electroimmobilized This does not mean that the deer did not find the procedures aversive Deer may react in a different way to aversive stimuli than sheep or cattle (Rushen, 1986a; Pascoe and McDonell, 1986) In a previous study investigating the behavioural and physiological responses of deer to a range of management procedures including crushing and velvetting Matthews *et al* (1990) found no difference in the degree of encouragement required to move deer into a crush throughout a trial of 18 crush entries whether the deer were subjected to velvetting or not Pollard (personal communication) observed no increase in "transit time" but did demonstrate an increase in heart rate before removal of a second antler on the day following removal of the first (Pollard *et al*, 1991) This latter finding indicates a possible anticipation of velvetting Pollard's findings would indicate that deer can anticipate a painful-noxious stimulus but will not demonstrate it in the "transit time" type trial Perhaps a trial to investigate the heart rate before repeated EI would indicate better whether deer anticipate the procedure.

One criticism of the present trial would be that EI should have been carried out more frequently to determine if the "transit time" would change However with cattle and sheep the "transit time" was obviously longer after the third exposure to EI (Rushen, 1986a, Pascoe and McDonell, 1986)

It might be useful in this type of trial to determine whether deer subjected to EI or other management procedure were more difficult to cut out of the group in the pen A into the starting box (SB) We had the impression that the deer subjected to EI were more difficult to get into the starting box than the controls but did not quantify this observation

The vocalisation of deer in 16% of the electroimmobilization indicated that EI was probably painful. In addition, EI in our hands was certainly stressful as indicated by the mouth breathing.

CONCLUSIONS

A review of the published literature indicates that head-to-tail EI is painful and does not cause any analgesia Its potential humane use would probably be limited to use in "wild" cattle where stockman safety is an important consideration It would be interesting to determine if "wild" cattle responded like deer in not demonstrating an increased "transit time" after repeated exposure to EI.

EI appeared to be stressful to deer but demonstration of its aversiveness may require heart rate monitoring using the methodology of Pollard (personal communication). The use of xylazine, EI and local analgesia for velvetting of deer is being suggested but whether this has any advantages over xylazine and local analgesia is unclear

The use of midback-to-tail EI however, seems to have practical possibilities if it can be proven to be painless in induction and does produce analgesia This particular technique deserves further investigation.

In addition to the papers published in scientific journals a series of reports to and from various organisations were read. These reports in general added little to the published literature and with the exception of Seamarks (1978) report were not quoted

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