PAPERS AND ORIGINALS

Veterinary surgeons as vectors of Salmonella dublin

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Summary and conclusions

Salmonella dublin is an important bovine pathogen, causing dysentery, abortion, and death from septicaemia. *S dublin* dermatitis, a little-recognised occupational hazard for veterinary surgeons, does not cause serious disability or inconvenience. During a survey of brucellosis in south-west Wales four cases of *S dublin* dermatitis were seen in veterinary surgeons. One surgeon was reinfected three years later. On all five occasions the veterinary surgeons had not worn or had discarded polyethylene gloves.

An apparently healthy cow may serve as a latent carrier of *S dublin*. Thus when disease starts in a closed, protected herd reactivation of infection within the herd is usually blamed and its introduction by extraneous agents considered to be unlikely. Veterinary surgeons should be regarded as potential vectors of *S dublin*.

Introduction

Bovine salmonellosis is distributed world wide. It causes dysentery and death from septicaemia. In regions cleared of brucellosis after fungal infection it is also the main cause of contagious abortion, and *Salmonella dublin* is then more often implicated than *S typhimurium*.[1] Infection with any other salmonella serotype is uncommon and typically mild or subclinical, seldom becoming established in a herd.[2] Though *S dublin* is an important human pathogen,[3][4] it is noticeably host specific for cattle. Once infection is established in a herd there is ample opportunity for dissemination, for the organism thrives in faeces and products of conception and materials contaminated by these. The cow's mouth, conjunctiva, and respiratory tract are portals of entry, and calves are especially at risk.[5][6] Hepatic fascioliasis increases susceptibility,[7] and thus in Friesland the incidence of salmonellosis fell greatly after fluke control was introduced.[8] No proof exists of venereal spread, and the disease is common in dairy herds even when breeding is by artificial insemination.

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Except when new stock is introduced or an intermittent excretor is found, the way in which infection begins in a herd is usually unexplained. Feeding stuff is a source of salmonellae, but only rarely of *S dublin*. Serious outbreaks of abortion in sheep have been described,[9] although other farm animals are reluctant carriers.[10] They are, furthermore, under close surveillance within boundaries, whereas wild animals are not. *S dublin* has been isolated from the fox[10] and badger,[11] and from 8% of rats trapped on infected farms.[2] Canada geese,[9] pheasants,[10] and pigeons[12] are carriers, but other avian scavengers seemingly do not carry *S dublin*. For example, 429 samples of faeces from two inland colonies of herring-gull in south-west Wales, where bovine disease is rife, yielded 119 salmonella isolations, but *S dublin* was not among them.[13] Salmonellae passing from one generation of flies to the next,[14] and from effluent slurry to streams and rivers,[15] may also be a route of infection; but in routine veterinary practice other agents of transmission are rarely sought and indicted in place of the supposedly ubiquitous latent bovine carrier.[2][14][16] Man is a common migrant from farm to farm; his role as a vector of *S dublin* has not been examined.

Case reports

The following cases of *S dublin* dermatitis occurred during a survey of brucellosis in south-west Wales (table). One hundred and five veterinary surgeons were interviewed and examined and appropriate investigations arranged. Ninety were practising when first seen, and most attended several times.

CASE 1

On 7 July 1969 a veterinary surgeon attended for review.[17] He had no disabling symptoms and no abnormal signs apart from an eruption on both arms. This he described as a calving rash possibly due to brucellosis, as eight days earlier he had delivered a cow of a putrefying stillborn calf. He had not worn protective gloves but had washed with soap and a solution of povidone-iodine before, during, and after the procedure. The cow was slaughtered, a presumptive diagnosis of brucellosis made, and no tests performed. Two days later he had noticed itching of both arms and hands and several small, pale papules mostly on the forearms, which matured into dusky red painful nodules. He had remained at work throughout and had visited other farms to perform cleansings—that is, to remove placentas retained after abortion.

Details of Salmonella dublin dermatitis in four veterinary surgeons

Case No	Time rash occurred	Herd infection confirmed	Suspected bovine disease	Suspected cause of rash	Aseptic precautions taken
1	8 days after delivering stillborn calf	Yes	Brucellosis	Brucella allergy	No gloves. Povidone-iodine
1	10 days after a cleansing	Yes	S dublin abortion	S dublin infection	Gloves worn but tore. Benzalkonium chloride
2	3 days after delivering stillborn calf	Yes	Infection unlikely	Unknown	No gloves. Povidone-iodine
3	2 days after delivering stillborn calf	No, but cow died suddenly next day	Infection unlikely	Rash unnoticed	No gloves. Povidone-iodine
4	5 days after delivering stillborn calf	Yes	Malpresentation	Midge bites	No gloves. Chlorinated phenols

On examination several lesions were present on his arms and hands (fig 1). The largest, on the right forearm, was 12 mm in diameter, and the few that had remained papular were under 3 mm in diameter. Central pin-head pustules had already formed and discharged in four lesions, but in two, on the right forearm and left upper arm, the overlying epithelium was still intact. *S dublin* was isolated in pure culture from these two lesions.

FIG 1—Case 1. *S dublin* dermatitis on left forearm of veterinary surgeon eight days after he delivered stillborn calf.

When re-examined on 5 August he had no symptoms and the rash had cleared without scarring. Rectal swabs from the suspect herd had shown no evidence of infection, but one cow had aborted. *S dublin* was isolated from the fetal carcass.

On 7 July 1972 he requested a further appointment. Ten days earlier he had cleansed a cow; abortion due to *S dublin* had already been confirmed. He had worn disposable shoulder-length gloves after washing with soap and a solution of benzalkonium chloride. The gloves had torn early in the procedure, so he had discarded them. He had washed thoroughly several times during the procedure, and after it. Two days later he had noticed a painful lesion on the left wrist but had remained at work, avoiding obstetric procedures. On examination a dusky red nodule 7 mm in diameter with a central pustule 2 mm in diameter around a hair follicle was present on the lateral aspect of the left wrist. From aspirated pus *S dublin* was isolated in pure culture.

He was seen again, routinely, in August 1975. A pustular dermatitis had recurred in the spring. Though he had continued to use gloves, they often tore, especially during calvings.

CASE 2

A newly qualified veterinary surgeon attended on 28 August 1975. He had no symptoms apart from mild irritation of both arms, present for two days. On 25 August he had delivered a dead calf. The cause of death was unknown, but infection was not suspected. The procedure had lasted more than an hour. He had not worn protective gloves but had washed repeatedly using soap and a solution of povidone-iodine.

On examination numerous pale pink macules and papules less than 5 mm in diameter were present on both forearms and one above the right elbow (fig 2). Some lesions had small central pustules or scabs, and *S dublin* was isolated from one of these on the left forearm. When he was re-examined on 10 September the rash had cleared and he had no symptoms.

A vaginal swab from the cow had been sent to the veterinary investigations laboratory. *S dublin* infection was confirmed.
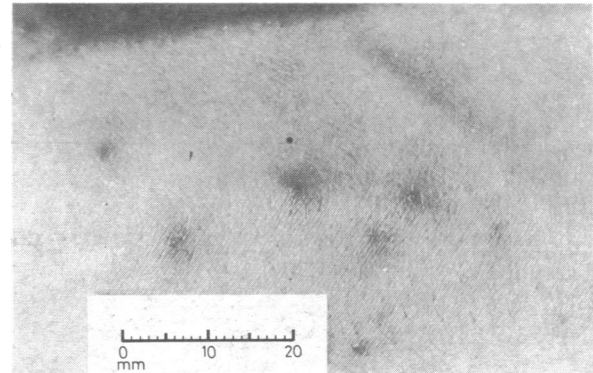

FIG 2—Case 2. Pustules in *S dublin* dermatitis, less than 5 mm in diameter, some with apical crusts.

CASE 3

A young practitioner attended on 7 September 1975. He denied all symptoms and was unaware of a rash on both arms (figs 3 and 4). Eight pale red macules and papules less than 5 mm in diameter were found on the flexor aspect of his left forearm, 11 on the dorsal aspect, two on the right upper arm, and three on the right wrist. Two lesions, on the right and left forearms, had minute central pustules, from
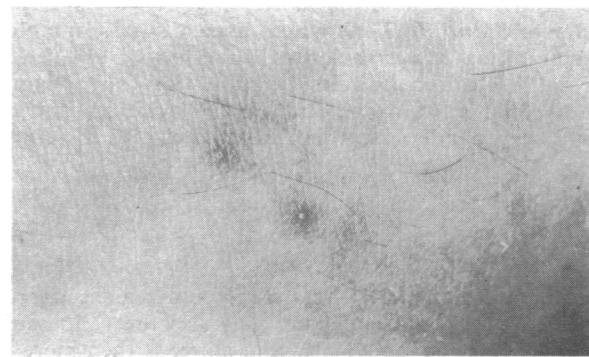

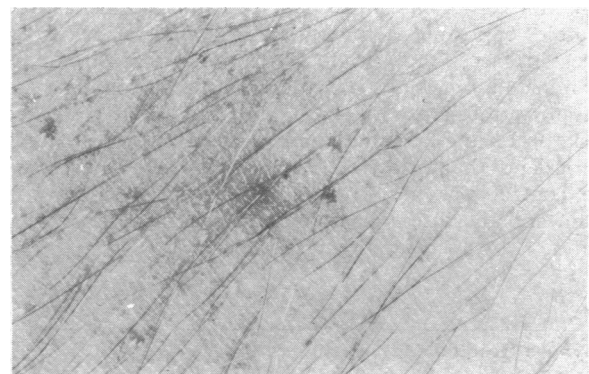FIG 3—Case 3. Two minute pustules in *S dublin* dermatitis discovered on routine examination.

FIG 4—Case 3. Infective papule in *S dublin* dermatitis.

which S dublin was isolated. Two days before, he had delivered an apparently healthy cow of a dead calf. The cause of death was uncertain, but infection was considered to be unlikely and no bacteriological tests were performed. The cow died unexpectedly the next day. Rectal swabs were subsequently taken from the two remaining cows in the herd, and S dublin was not isolated. He had not worn protective gloves, believing that washing with soap and a solution of povidone-iodine gave adequate protection. He was re-examined on 21 September. He had remained well and the rash had cleared.

CASE 4

A veterinary surgeon attended on 10 September 1975. He had no symptoms, although for three days he had noticed "bites" on his arms, due, he believed, to midges. He had had pustular rashes before, more often after calvings than cleansings. He did not wear gloves for calvings, maintaining that even during cleansings polyethylene gloves were apt to tear.

Five days before, he had delivered a putrefying dead calf; the presumed cause of death was malpresentation. Throughout the procedure he had washed thoroughly using soap and a solution of chlorinated phenols. The day before he had cleansed the same cow, on this occasion wearing gloves.

On examination pale red macules and papules 2-3 mm in diameter were present, 10 on the flexor aspect and two on the dorsal aspect of the right forearm and one above the right elbow. Fine desquamation was seen over the centres of some of the lesions. One, over the left shoulder, was pustular. A papule above the left elbow, 2 mm in diameter, had a faint erythematous halo but no visible pustule. Aspirate from this lesion yielded S dublin.

When recalled on 22 September he had no symptoms and the rash had cleared apart from slight residual staining at the site of aspiration. A vaginal swab from the cow had been sent to the veterinary investigations laboratory. S dublin was isolated.

Discussion

In veterinary obstetrics when help is given with calving or during removal of a placenta retained after abortion (cleansing), strenuous and prolonged intrauterine manipulation may be required. Experienced practitioners maintain that a rash on the exposed arm after calving or cleansing is a sign of brucellosis in the cow. Haxthausen and Thomsen noted a rash in 105 of 325 veterinary surgeons in Denmark.[18] Skin irritation preceded the appearance of papules, which matured in two days into nodules the size of lentils, vivid red with apical pustules then crusts. Pus from three cases was incubated in a medium of agar with dextrose and glycerin. In one case no growth resulted, but in two small colonies of cocci were assumed to be contaminants. The rash was therefore labelled allergic, a reaction to brucella toxin. Huddleson[19] also attributed a papular dermatitis to brucella allergy, but, though this explanation has gained acceptance,[20 21] investigation with modern enrichment and selective media might have shown that some of the eruptions were infective and due to bovine pathogens other than Brucella abortus. In an inquiry into the incidence of brucellosis in veterinary surgeons in south-west Wales 58 surgeons recalled calving or cleansing rashes: in 12 a diffuse erythema, in 13 discrete papules, and in 33 pustules as well as papules. Seven had assumed that the cause was brucellosis, and seven blamed repeated exposure to bactericides and detergents. None had sought advice, and bacteriological tests had not been performed.[22]

The incidence of S dublin dermatitis in veterinary surgeons in a high-risk area is unknown. Of five eruptions in the present series, four were discovered fortuitously on routine prearranged examination; one veterinary surgeon returned because he suspected a recurrence. Further cases, therefore, might have been found by recalling subjects immediately after contact with cows known to be infected, but the legal implications of a new inquiry were uncertain and informed consent from veterinary surgeons and their clients might not have been forthcoming.

Infective dermatitis may also follow exposure to S

typhimurium,[17] S abortus equi,[23] S saint-paul,[24] and Listeria monocytogenes.[25-28] Lesions may be large and painful or small and unobtrusive. There are few constitutional symptoms and no sequelae, but the risk of transferring infection, thus contributing to the spread of bovine contagions, has not been investigated.

In the early nineteenth century puerperal fever in women was contagious. Infection was introduced per vaginam by students commuting, unwashed, from necropsies to lying-in wards.[29] Veterinary obstetricians, however, reject the analogy, and thus in Britain, when brucellosis was still a serious zoonosis, a plea for asepsis during operations was dismissed as irrelevant.[30] The pathogenesis of bovine brucellosis has recently been reviewed.[31] The mouth provides the usual route for infection, though Bang[32] first identified Bacillus abortus after infecting pregnant cows vaginally. Outbreaks have also followed artificial insemination from infected donor bulls, the risk being greater when semen is deposited in utero than in the cervical canal. Infection is rare after natural service, which is claimed to obviate the need for asepsis during calvings and cleansings; and, though the unprotected arm becomes heavily soiled, its function as a vehicle for transferring Br abortus is not proved. An infective dermatitis due to this organism has not been described.

When the pathogenesis of salmonellosis is being considered, however, the veterinary surgeon must be regarded as a potential vector, for pustules in salmonella dermatitis are a source of viable organisms for several days. Applying an inoculum vigorously to the raw uterine bed after placental separation would seem a likely way to induce bacteraemia, but investigators have been reluctant to determine whether it also initiates disease. On the other hand, risk to the calf handled during delivery is acknowledged.[33] At one time 57 out of 63 veterinary surgeons in south-west Wales operated with arms uncovered, some blaming difficulty in separating placental cotyledons through polyethylene gloves.[17] The proportion has since fallen, but during calving especially gloves now manufactured are apt to tear, and bactericides advocated as an alternative barrier to contamination are unreliable. S dublin dermatitis is a trivial occupation hazard. Whether it contributes to the dissemination of bovine infection and is therefore epidemiologically relevant should be the subject of further investigation, but the initiative for this can come only from the veterinary profession.

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A pressure profile for elastic stockings

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Summary and conclusions

Special equipment to measure the circumferential compression exerted by an elastic stocking was used to determine the "pressure-girth profiles" of several types of elastic stocking. Once the pressure-girth profile has been determined, the pressure exerted at the ankle, calf, and thigh can be predicted for any size of limb without further pressure measurements. An excellent correlation ($r = 0.96$) was obtained when this method was compared with another well-established one of measuring the pressures exerted by stockings.

The method has several potential applications in quality control during stocking manufacture and, clinically, in determining whether a stocking exerts a graduated pressure on a particular limb.

Introduction

Elastic stockings have been used to treat varicose veins and their complications for over 150 years.[1] Recent workers have emphasised that elastic stockings need to exert a graduated compression on the leg to encourage the centripetal flow of blood.[2][3] Thrombo-embolic-deterrent stockings have recently been shown to be effective in reducing the incidence of postoperative deep venous thrombosis.[4][5]

Methods of measuring the compression of elastic stockings on a limb have been based on the insertion of a pressure sensor, in the form of a fluid- or air-filled balloon, between the stocking and the limb.[6][-][8] This balloon is connected to a manometer which records the pressure exerted by the stocking. Stockings may also be factory tested after manufacture for quality control

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by using "limb forms," usually made of wood, which have built-in electronic pressure sensing devices. A further method determines the circumferential tension of a segment of cloth after it has been cut out as a "window" from the stocking. Details of the last two methods have not been published.

All these techniques, however, have several intrinsic defects. Firstly, the pressure sensors may themselves distort the limb circumference and produce incorrect pressure measurements. Secondly, each patient requires time-consuming individual testing with a particular stocking for an accurate assessment of the stocking's circumferential compression. Thirdly, if the limb circumference changes, retesting and refitting is needed. Fourthly, as the limb dimensions of patients are infinitely variable, an infinite number of limb forms would theoretically be required to assess the corresponding compression for specific combinations of leg lengths and girths. Finally, excision of a square of cloth from a stocking to determine its tension ruins the stocking, is time-consuming, and prevents further testing for quality control.

The compressive effect of a stocking on a limb depends on the elastic tensile strength of the garment and the girth of the limb at different levels. A pressure-girth profile based on the compression at ankle, calf, and thigh will therefore assist the correct prescription of elastic stockings for different limbs.

We describe a new device for pressure grading elastic stockings, which overcomes these problems. It consists of an inflatable, elongated latex balloon which is placed inside the stocking to be tested. Gas under known pressure is then introduced into the balloon. Fig 1 shows the device schematically and shows a stocking in situ ready for testing.

Methods

Determination of pressure-girth profile—The stocking is placed on the device and stretched over the partially inflated balloon. At its upper end (thigh) the stocking is secured around a movable collar (fig 1). This collar may be positioned so as to give a leg length corresponding to that of a particular limb. Air is then admitted into the balloon under pressure. As the volume of the distended but unstretched balloon exceeds that of the largest size of stocking to be tested, the balloon merely acts as an airseal inside the stocking. Therefore no distortion