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Group A streptococcal skin infection outbreak in an abattoir: lessons for prevention

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SUMMARY

During a group A streptococcus (GAS) outbreak 21 abattoir workers developed skin infections. The unusual outbreak strain (*emm* 108.1) was cultured from five workers and four persons in the community with links to the abattoir. The attack rate was 26% in the lamb line. Communal nailbrushes were neither routinely disinfected nor changed, and had high bacterial counts. A cohort study found a higher risk from working in the gutting area and getting cuts on hands more than weekly. Despite high bacterial counts daily nailbrush use had a lower risk, as did always wearing disposable gloves. Working in the gutting area (OR 11·44) and nailbrush use at least once a day (OR 0·04) were significant in the multivariate model. Transmission of infection is likely to have occurred on carcasses. GAS infection among abattoir workers was once common. Simple hygiene measures, such as nailbrush use, may reduce the impact of future outbreaks.

INTRODUCTION

During the 1970s and 1980s outbreaks of skin infections due to group A β-haemolytic streptococcus (GAS), *Streptococcus pyogenes*, among abattoir workers were widely reported in both the United Kingdom [1, 2] and also in the United States [3, 4]. A working group produced guidance for the United Kingdom on the control of streptococcal infection in meat handlers in 1982 [5] and in recent years reports of such outbreaks have been rare [6], probably due to the implementation of Meat Hygiene Regulations [2].

GAS skin sepsis in abattoir workers has had an autumn predominance which has been attributed to increased slaughter and meat handling at this time of year [5]. Infection is often associated with co-infection with *Staphylococcus aureus*. Outbreaks have tended to be self-limiting, although in one establishment the same serotype caused outbreaks for three consecutive years [5]. In this paper we present an outbreak of an unusual strain of tetracycline-resistant GAS among workers in a lamb abattoir.

DESCRIPTION OF THE OUTBREAK

Tetracycline-resistant GAS was isolated from three workers from an abattoir in West Wales, in the second week of September 2004. Public health

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specialists from the National Public Health Service for Wales visited the abattoir to identify further cases, undertake epidemiological investigations, and recommend immediate action to control the outbreak. With the assistance of the abattoir managerial team we identified a total of 21 workers who had clinical skin infections with purulent discharge. Five of these were confirmed as having tetracycline-resistant GAS and two had co-infection with *S. aureus*. One who had already undergone treatment for a skin infection cultured *S. aureus* only.

Four persons in the community developed skin infection with the outbreak strain of GAS. Three were children who were close relatives of infected abattoir workers. The last was a close friend of an infected worker.

A case was defined using a clinical case definition as 'a person with skin infection working in the abattoir with onset date from 24 August 2004'. Erythema, abscess, purulent discharge or lymphadenitis was considered indicative of infection.

METHODS

Environmental

The abattoir was inspected by a public health physician, a public health nurse and a microbiologist. Working practices were reviewed.

Microbiological

Eleven microbiological skin/wound swabs were taken from 10 workers who either had active infection or healing wounds (even if they had undergone antibiotic treatment) at the time the public health staff visited the abattoir. Three pharyngeal swabs were also taken from persons with sore throats. Standard processing of swab cultures included use of 5% horse blood agar with the option to use Staphylococcus/Streptococcus selective agar (5% horse blood agar containing colistin and nalidixic acid).

Environmental swabs (Enviroscreen TS5-42; Technical Service Consultants Ltd, Heywood, Lancashire, UK) were taken from the areas where cases had occurred, 11 days after the onset of the last case. Swabs were returned to the laboratory and processed within 4 h of collection. Cultures for total aerobic colony counts were performed on plate count agar (Oxoid CM 0325), incubated at 30 °C for 72 h. Cultures for GAS were performed using selective blood agar containing 5 mg/l nalidixic acid + 7·5 mg/l colistin sulphate (Oxoid CNA medium PB 0308A), incubated anaerobically for 24 h at 37 °C.

GAS isolate characterization

Nine GAS isolates (five cases among workers, and four community isolates) were submitted to the HPA Streptococcus and Diphtheria Reference Unit (SDRU) for typing. All isolates were non-typable by conventional serotyping methods and were all opacity factor negative [7].

The strains were typed further by the amplification and sequencing of the *emm* genes as described previously [8]. The *emm* sequences were obtained according to the recommendations by Facklam and colleagues [9] and aligned with sequences on the CDC *emm*-type database [10].

Epidemiological

Face-to-face and telephone interviews were conducted at the workplace with infected workers to assess the nature of infection, and the type of work undertaken. Further in-depth face-to-face interviews took place with two of the workers to assist in hypothesis generation.

The population at risk was identified with the help of the managerial team.

A cohort study was undertaken of those working on the lamb line between 23 August and 23 September 2004. A structured, written questionnaire was used to identify where respondents worked on the line, their use of gloves and nailbrushes, the frequency of sustaining cuts on their hands whilst at work, as well as predisposing factors that might put them at risk of infection.

Data analysis was undertaken using the χ^2 test, and the χ^2 test for trend. Backwards stepwise logistic regression was performed on all variables that were significant ($P < 0{\cdot}05$) on univariate analysis.

RESULTS

Environmental

After slaughter, carcasses entered the lamb line for skinning and gutting (evisceration), and were then transferred to the chill room. Carcasses underwent electrical stimulation (to increase tenderness, and reduce time spent in the chill room), and remained in the chill room for at least 24 h before entering the boning hall via the loading bay. Carcasses were again

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Table 1. *Total viable colony counts (TVCs) from environmental swabs taken*

	Highest counts		Lowest counts	
Area	Source	TVC	Source	TVC
Hygiene area outside lamb line	Nailbrush	1 440 000	Boot-wash control button	<100
Hygiene area at lamb line	Nailbrush	440 000	Wash hand basin	2000
Lamb line equipment	Knife steel	208 000	Various	<100
Carcasses	Rectal area	32 000	Brisket	<100
Boning hall	Nailbrush	880 000	Wash hand basin	1200

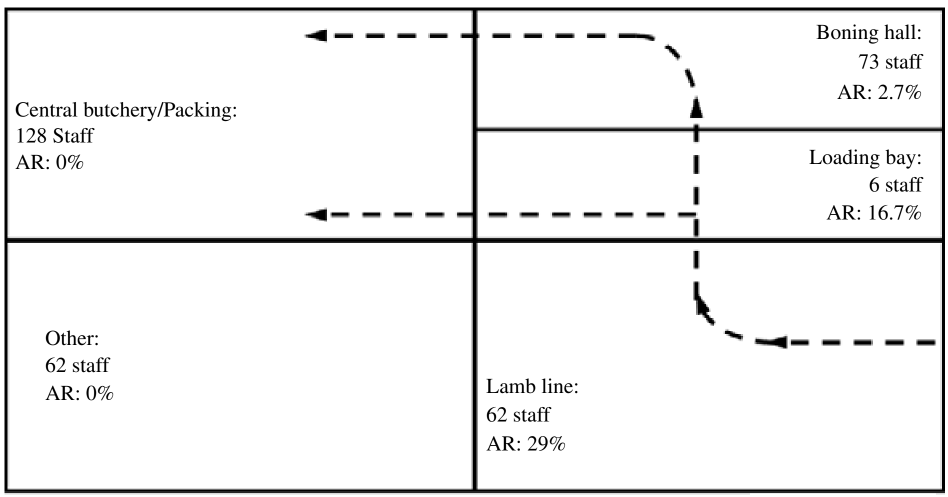

Fig. 1. Attack rates in different areas of the abattoir. Overall: 331 staff; attack rate (AR) 6·3%. ◄---, Carcass transport.

inspected in the boning hall and then boned by butchers. Meat for direct supermarket distribution was separated, butchered and packed on site.

Although there were hand-washing facilities with knee-operated taps and paper towels both inside and outside the entrance to the lamb line, communal nailbrushes in the sinks were neither routinely disinfected nor replaced. Work undertaken on the lamb line depended on the worker's grade, and thus many involved in skinning were not involved in gutting. However, there was hourly rotation of position within a given skill grouping.

Workers did not share equipment, and each used their own knives, and steels (for sharpening knives). Overalls were laundered once a day. Boots and helmets were left in the changing room, and had visible soiling on them. Factory policy stated that all those working on the lamb line should wear disposable gloves; however, it was not clear that sufficient gloves were supplied to achieve this. Although the gloves were designed for single use it was evident that many workers did not use them in this way. Some would carry used gloves in their pocket for subsequent re-use.

Microbiological

All cultures positive for GAS were sequenced as *emm* 108.1, an unusual strain, not prevalent in the community. Group G streptococcus was cultured from the throat swab of one of the workers.

Results of environmental swabs are shown in Table 1. The highest colony count was measured from the nailbrush in the hygiene area at the entrance to/exit from the lamb line. GAS was not recovered from any environmental swabs, although coagulase-positive staphylococci were isolated (from the ribcage of a carcass and from the liquid soap dispenser) and group G streptococcus was also isolated from a knife steel and the conveyer belt in the lamb line.

Epidemiological

There were 21 cases among the 320 employed by the abattoir and 11 Meat Hygiene Service staff working

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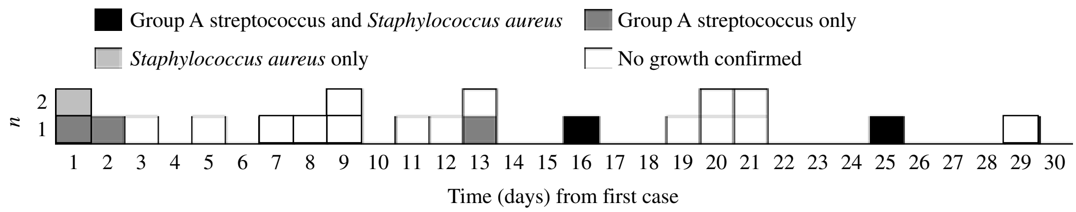

Fig. 2. Onset dates for clinical cases and microbiologically confirmed cases of GAS.

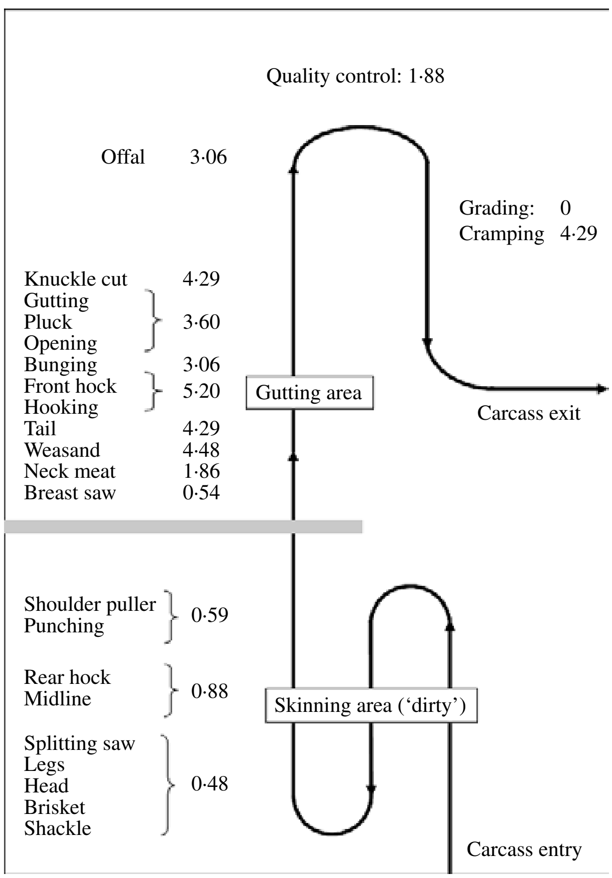

Fig. 3. Schematic diagram of lamb line showing relative risks associated with undertaking different activities (excludes supervisors and cleaners who may undertake activity on any part). Arrows indicate direction of travel of carcass.

in the plant, giving an overall attack rate of 6·3%. Of these, 18 cases worked in the lamb line (Fig. 1). Infection involved the hand or wrist for all cases, and eight workers also had infections at other sites, e.g. neck, thigh. Ten workers described symptoms of lymphadenopathy or lymphangitis. Cases were confined to three areas of the plant. The packing areas were unaffected. The onset dates of cases were between 24 August and 21 September (Fig. 2). Attack rates by location on lamb line based on the skill of workers demonstrates a higher risk among those trained to undertake work in the gutting area (Fig. 3).

Cohort study

Sixty-eight workers worked in the lamb line during the period of interest. Of these, 10 (15%) were not contactable as they no longer worked on the lamb line at the time of the investigation. Of the remaining 58, responses were received from 50 (86%). There were 14 (28%) cases. None of the workers had medical conditions or were on medications likely to predispose them to skin infections.

Infected workers were slightly younger than others in the cohort (mean age 34·2 *vs.* 38·5, $P=0·16$). Almost all the cohort was male (100% among cases, and 94% among others, $P=1·0$). Of those that responded 20 worked in the gutting area, of whom nine also worked in other areas within the lamb line. Working in the gutting line was associated with a higher risk of infection than not working the gutting line [11/20 (55%) *vs.* 3/30 (10%); relative risk (RR) 5·5, $P=0·001$].

Forty-five workers reported wearing single-use disposable gloves always or most days (90%). Always wearing gloves was associated with a significantly lower risk of developing infection [7/37 (19%) *vs.* 7/13 (54%); RR 0·35, $P=0·03$]. However, intermittent glove use was not protective (Table 2; χ^2 for trend, $P=0·06$). More frequent re-use of gloves increased risk of infection among those who always wore gloves, although this was not significant (χ^2 for trend, $P=0·23$). Similarly, failing to change gloves immediately after they tore was associated with a non-significant increase in risk (RR 1·90, $P=0·67$) among these individuals.

Most (90%) of those on the lamb line used nailbrushes at least once a day. Using a nailbrush less than daily was associated with a higher risk of infection [4/5 (80%) *vs.* 10/45 (22%); RR 3·60, $P=0·02$]. Risk of infection increased with longer intervals between nailbrush use (χ^2 for trend, $P=0·04$).

Eighteen percent of respondents reported sustaining a cut on their hands at work at least once a week. Sustaining such cuts more frequently was associated with a higher risk of infection (χ^2 for trend, $P=0·005$).

Table 2. *Relative risk of different exposures in cohort study, univariate analysis*

Variable	Category	Infection	No infection	RR*	95% CI*	*P*†	*P* for trend
Part of the lamb line you work in	Skinning only	2	16	1·00			
	Gutting only	7	4	5·73	1·44–22·79	0·01	
	Both	4	4	4·50	1·03–19·75	0·05	
	Other‡	1	12	0·69	0·07–6·85	1·00	
Wear disposable gloves	Always	7	30	1·00		—	0·06
	Most days	5	3	3·30	1·40–7·78	0·02	
	Rarely/never	2	3	2·11	0·60–7·48	0·29	
Discard gloves§	At least daily	2	15	1·00		—	0·23
	2–4 times per week	1	5	1·42	0·15–12·95	1·00	
	At the end of the week	3	8	2·32	0·46–11·72	0·35	
	Less often	1	2	2·83	0·36–22·30	0·40	
If gloves get torn do you usually get a new pair?§	Immediately	2	14	1·00		—	
	Later	5	16	1·90	0·42–8·58	0·67	
When you wash your hands at work how often do you use a nail brush?	Both on entry and leaving	6	22	1·00		—	0·04
	Less often, but at least daily	4	13	1·10	0·36–3·34	1·00	
	Less than daily	4	1	3·73	1·62–8·59	0·02	
How often do you usually get a cut on your hands at work?	Less often than once a month	6	28	1·00		—	0·005
	Between once a week and once a month	2	5	1·62	0·41–6·42	0·61	
	At least once a week	6	3	3·78	1·60–8·93	0·01	

* RR, Relative risk; CI, confidence interval.
† Fisher's exact two-tailed test.
‡ One individual without infection also worked on the gutting line.
§ For those who always wear gloves.

The risk for those sustaining cuts at least once a week was 3·78 (Table 2, $P=0·01$) relative to those sustaining cuts monthly or less frequently.

Working in the gutting area remained statistically significant in the logistic regression model [$P=0·006$; odds ratio (OR) 11·44, 95% confidence interval (CI) 1·99–65·82] as did nailbrush use at least once a day (OR 0·03, 95% CI 0·002–0·71). Always wearing gloves was not significant in this model (OR 0·10, 95% CI 0·04–1·34).

DISCUSSION

We describe an outbreak of tetracycline-resistant GAS sequence type *emm* 108.1, rarely observed within the United Kingdom. This occurred primarily among abattoir staff. Several persons in the community were also identified as being infected with the same strain. Each of these was in close (skin-to-skin) contact with abattoir workers with known infections during the relevant incubation period, confirming the abattoir as the primary source of the outbreak. Most cases occurred in the lamb line, the area used immediately after slaughtering lambs. As staff did not share equipment the mode of spread of the organism was not obvious.

It was postulated that the nailbrush may have provided a reservoir for infection. Although the nail-brushes had very high colony counts no GAS was cultured from them and epidemiologically there was a decreased risk associated with their use. It may be the case that nailbrush use assisted the removal of transitory pathogenic bacteria (such as GAS) while remaining colonized with low-grade environmental or commensal organisms. This protective effect was increased with higher frequencies of nailbrush use and was statistically significant for trend; nailbrush use at least daily was significant in the logistic regression model. There is evidence to demonstrate the value of using a nailbrush to remove organisms as part of hand washing [11]. As nine of the 14 workers who had acquired infection said they used the nail-brushes every time they left the lamb line this intervention alone is not sufficient to prevent infection. Nonetheless, the provision and use of nailbrushes within the abattoir setting is a simple measure that may be of benefit in preventing the spread of outbreaks in future.

Unsurprisingly, workers sustaining higher frequencies of cuts at work had higher risks of infection which, although not included in the final regression model, was significant for trend on univariate analysis. It was unclear if using disposable gloves would be of benefit, e.g. protect staff from exposure to bacteria that may be on the meat surface, or harmful, as they may reduce the workers' grip with resultant increased risk of cuts. Published literature did not support either hypothesis. Disposable gloves were protective on univariate analysis, but this was not statistically significant either for trend or in the logistic regression model. This may be related to the small numbers in the study. Similarly inappropriate re-use of gloves gave a higher risk of infection which was not statistically significant. The evidence on the use of disposable gloves to prevent infections in this setting is inconclusive. If gloves are used, manufacturer's guidelines on their disposal should be followed.

Transfer of the organism on the carcass has been postulated previously as the mode of spread of this organism [3], and the spread of abattoir outbreaks to other meat handlers in the community [12] further substantiates this as a potential mode of spread. During an outbreak of GAS infection in Oregon, USA, the epidemic strain was cultured from meat in the plant [4]. Unlike the Oregon outbreak, in our study no GAS was cultured from the meat, or other environmental sources. However, there was a delay between the taking of environmental swabs and the last documented case. The pattern of attack rate seen in the abattoir (Fig. 1), combined with the absence of any other evident means of transfer of the organism (e.g. equipment sharing), is suggestive that the carcass may also have been the vehicle of transmission for infection in this outbreak. Electrical stimulation and chilled storage may have reduced the bacterial load on carcasses resulting in fewer infections in later parts of the plant. Given the potential for transmission via carcasses, it is important that infected individuals are identified and treated rapidly, ensuring that they do not handle raw meat when they may be infected.

This outbreak occurred in the early stages of meat processing, a part of the plant that is particularly warm and humid. It has been suggested elsewhere that GAS skin infection may be more likely to occur in humid conditions [13], and humidity may play a role in abattoir outbreaks. Our cohort study demonstrated an increased risk of infection associated with working in the gutting area. This is an area where workers are particularly prone to acquire cuts on their hands, mainly from the brisket during manual evisceration.

The cohort investigated was small. There were frequent relocations of abattoir workers within the plant and substantial staff turnover. As a result it was difficult to get exact denominator data for workers in different areas, and the overall response rate to the questionnaire was not as high as might be desired. As there was no occupational health service for the abattoir, notification of a problem to the health protection team occurred late and indirectly via an alert clinical microbiologist. As a result many workers had undergone treatment through their family doctor without prior wound swabbing. Therefore, there was no microbiological confirmation for many cases. Environmental swabs also failed to culture GAS. Workers were not asked in the questionnaire whether or not they always washed their hands before or after leaving the line, as it was thought unlikely that any of them would admit to not undertaking hand washing. It may be the case that some of the risk associated with not using the nailbrush may be associated with not washing hands; however, due to the nature of the work involved, this was deemed unlikely.

There is little evidence of what interventions are effective in preventing outbreaks of GAS among meat workers. Whilst the Oregon [4] study reported that those infected were no more likely to share gloves than those not infected, they did not report on glove use or nailbrush use. The authors have recommended more research into how such outbreaks could be prevented. Our study is valuable for identifying key interventions associated with reduced risk of GAS infection in an outbreak setting.

The abattoir in our study employed a large proportion of temporary staff and many employees spoke poor English which may have resulted in difficulty with appropriate hygiene training. The abattoir had no occupational health service. Workers who took up to 3 days sick leave from work received no pay. This may have lead to workers being reluctant to come forward with infected wounds.

Public health action taken to control the outbreak included giving advice on hygiene, hand washing, correct glove use, and monitoring of hands for cuts and infections. The use of nailbrush dispensers where each worker uses a clean, heat-disinfected nailbrush was also recommended. General practitioners in the area were asked to swab suspicious lesions on all those presenting and remain alert to connections with the abattoir. Occupational health services as well as remuneration for staff excluded from work for public health reasons were recommended.

GAS in abattoirs was originally highlighted as a problem by Fraser *et al*. [1], and 13 such outbreaks were reported to the Communicable Disease Surveillance Centre, London between 1975 and 1982 [2]. Since the late 1980s there has been only one published report of a GAS outbreak in abattoir workers, and a second outbreak (in 1993) is also referred to in this publication [6]. As in this investigation, the strains typed were not prevalent in the community. With a highly transient workforce and increased movement of workers throughout Europe there may be an increased risk of such outbreaks in future. There is a need to remain alert to the risk of GAS among abattoir workers, the impact of which can be reduced by adherence to simple in-plant hygiene measures.

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DECLARATION OF INTEREST

None.

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