Investigation of an Outbreak of Unusual Skin Rash at a New School

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BACKGROUND

In November 2007, students and staff attending a newly opened school complained of a rash which resembled mild sunburn affecting the face, neck, hands and lower arms but also unexposed areas. A dermatologist considered the rash to be consistent with an allergic reaction. Some cases also reported skin irritation and headaches; one reported breathing difficulties. Parental concern was growing and some children were being kept out of school.

The campus housed a senior school for 450 students and a smaller primary school. The site was adjacent to an electronics factory which used various volatile chemicals and was next to an area of land previously thought to have been contaminated by an oil spillage. Ventilation was by 'trickle' vents built into windows or by opening windows themselves. The school heating system had been giving problems; up until early November the school had been too cold, then adjustments resulted in the school becoming overheated. The first reports of skin rash occurred after the episode of overheating.

A multi-agency investigation team visited the school. One team member developed the rash within hours. A strong smell of hydrocarbons was noted, later confirmed as contamination of a nearby stream with red diesel from an unknown source. It was concluded that a systematic epidemiological and environmental investigation was required to try and identify the cause.

INVESTIGATION METHODS

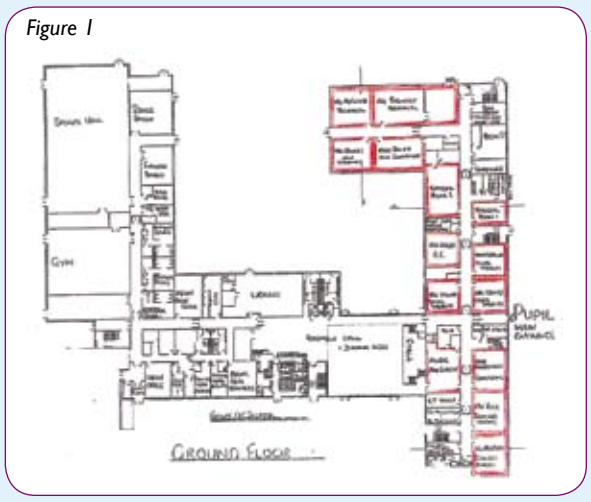
A case was defined as a student or staff member who developed an unexplained skin rash localised to individual sites or generalised affecting numerous sites, with or without additional symptoms between 19 November and 21 December 2007, while attending the school premises.

Epidemiological Investigation

The cases' epidemiological characteristics were reviewed and a case-control study was undertaken to identify any factors associated with the rash onset.

Self-completed questionnaires were used to obtain details of: symptoms experienced, timetable information, siblings, allergies, travel routes (indicated on maps of the area and plans of the school layout – see Figure 1), eating/ drinking habits, activities, foreign travel and use of cosmetic/chemical products. Additionally, cases were asked to describe the distribution of the rash via a diagram, and give details of its appearance.

Figure 1



Controls were selected to compare individuals who were as similar as possible apart from not having had the rash, matching for age, sex and by school year to allow for different patterns of room use by different year cohorts (e.g. a 12 year-old S1 girl was matched with another 12 year-old S1 girl). For cases that were staff, another staff member, preferably of the same gender, was used as the control. Statistical analyses were carried out using SPSS.

Environmental Investigation

Limited environmental/indoor air quality sampling was carried out by local authority Environmental Health staff supported by Glasgow Scientific Services.

RESULTS

Forty-four cases; 42 school students and 2 members of staff met the case definition. Thirty-nine controls were obtained, giving 39 case-control pairs.

Characteristics of the Case Cohort:

The rash affected multiple sites: exposed and unexposed skin and occurred most often in morning class periods P3 and P4. The incidence was 9/100 for students with an overall 3:1 female to male ratio. Year 2 had the highest attack rate (27%) followed by S6 (15%), S3 (8%), S5 (4%), with S1 and S4 the lowest (1%). Class 2K (a second year class) had the highest attack rate (40%). 10/42 student cases reported a sibling at the school as also having the rash and 5/36 cases reported another family member, not at school, as having a similar rash around the same time.

A room attack rate was calculated taking the number of cases developing the rash per room, divided by the total number of students using that room on the same day. Four rooms had relatively high attack rates: G36, G41, F42 and G56. G56 was the music room and was the one without any external windows, having a forced air ventilation system taking air directly from outside.

Case-Control Study Analysis:

There were no significant differences in the mean ages of cases and controls and no associations between being a case and: home address postcode; history of asthma, hay fever, allergies or prior skin conditions; contact with pets or other animals; field sports, walking, horse riding, swimming, use of the gym or use of school showers; use of a new washing powder, domestic household chemicals or use of cosmetics; foreign travel; drinking tap water; mode of travel to school or use of a footbridge across the polluted stream; use of staircases, corridors or rooms for breaks or lunch or registration rooms.

Significant associations found:

- a significant positive association with being a case and use of room G56 (the music room); odds ratio 3:4 (CI 1.08 – 10.88) for being in G56 at the time of rash onset or one or two periods before.
- a significant positive association between being a case and having an affected sibling ($p = 0.002$)
- cases reported additional symptoms of itching skin, headache, itchy/sore eyes, feeling hot, dizziness significantly more than controls (Table 1):
- strong negative associations (i.e. protective) were identified between being a case and:
  - use of a new type of perfume ($p = 0.002$)
  - use of a new type of shower gel ($p < 0.000$)
- Negative associations (i.e. protective) were seen with:
  - use of a new type of deodorant ($p = 0.033$)
  - use of a new type of moisturiser ($p = 0.021$)

Environmental Investigation Results

In rooms tested, average temperatures fluctuated between 20-22°C with peaks of 24°C or more in certain rooms. One room had relatively low humidity levels and CO_2 levels in some rooms were relatively high. Limited sampling for VOCs failed to identify abnormal levels.

Table 1

reporting symptom	% cases reporting symptom	% controls reporting symptom	p-value
Itching skin	96%	26%	<0.000 *
Headache	77%	34%	<0.000 *
Feeling hot	61%	18%	<0.000 *
Itchy/sore eyes	46%	13%	0.002 *
Dizziness/faintness	36%	3%	<0.000 *
Sneezing	25%	11%	0.151
Nausea	25%	8%	0.075
Sore muscles	18%	13%	0.563
Respiratory problems (wheezing and/ or difficulty breathing)	18%	5%	0.097

** Statistically significant results at the 5% significance level*

DISCUSSION

Initial hypotheses included:

- parvovirus infection
- psychogenic illness
- allergic reaction to an unidentified substance
- UV induced
- reaction to poor indoor air quality

The skin rash had some features suggestive of Parvovirus infection but was not typical; no serological evidence of recent Parvovirus infection was found.

Symptoms affecting clusters of students have been reported previously as 'psychogenic' illness, defined as a group of symptoms affecting people who believe there to be an external cause for their symptoms. Common features include: a predominance of females, clusters within classes, association of cases by proximity, 'line of sight' and symptom type (1,2,3). Such events may have an environmental trigger such as, in this case, the diesel odour from the contaminated stream nearby (4,5). Although there was a 3:1 female to male ratio and clustering of cases in certain classes, this outbreak was not a classical 'psychogenic' episode. The distribution across year groups and the appearance and attributes of the rash, confirmed by independent observers suggested that a psychogenic explanation alone was not adequate.

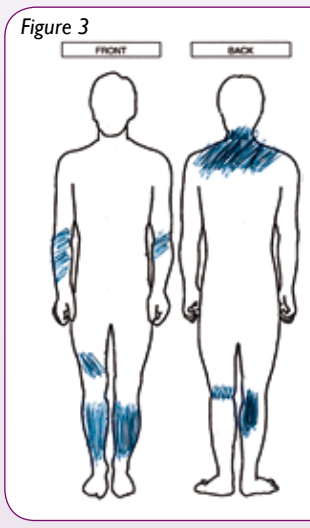
The case-control study did not reveal any association between cases and past history of allergy although there was a borderline significant association with self-reported food allergy ($p=0.057$). There was no evidence of association with furnishings, fabrics, plants or water via showers. Both exposed and unexposed areas were affected, suggesting that natural or artificial UV exposure could not alone explain the pattern. Mercury lamps were used in communal areas but there was no evidence to suggest these were faulty or leaking mercury vapour.

The rash onset in multiple locations over the period could be consistent with an airborne agent. The late morning peak in onset times suggests a possible time/dose/exposure relationship. The rash had some resemblance to heat-related urticaria or 'heat rash' but was atypical being more erythematous with large confluent areas affected, rather than typically urticarial and there was an absence of skin swelling (an example of a case is shown in Figure 2). Limited indoor air sampling suggested problems in some rooms with high peak temperatures, low humidity and relatively high CO_2 levels, however there was insufficient data to incorporate into the case-control study.

Figure 2

The outbreak proved challenging to investigate. The school was on an island, creating access issues for the investigation team. Resources available to carry out indoor air quality testing were limited. The matched case-control study design, chosen following statistician advice, was complex. The need to obtain information on personal movement within the school and other potential exposures resulted in the questionnaire being very detailed. Use of the body diagram and school layouts was helpful in characterising the rash distribution and case movements (see Figure 3 for an example of a completed body diagram). The case-control study perhaps generated more questions than answers; the negative (protective) associations were difficult to interpret. The main finding of interest was the positive association with room G56 (the music room), which had no natural ventilation, suggesting that indoor air quality could be a significant factor. The cohort analysis also identified other rooms that had high 'attack rates'. Ideally, comprehensive air sampling in all rooms would have enabled correlation of air quality variables with attack rates. The contaminated stream and the nearby electronics factory were not considered to be significant aetiological factors, due to the absence of plausible source pathway/receptor/ linkages.

Figure 3



CONCLUSION

The case-control study was inconclusive but helped eliminate a number of factors. The cause of the rash remains unknown. On balance, the most likely explanation for the phenomenon was sub-optimal indoor air quality, possibly combined with other airborne factors with a possible psychogenic amplification component.

The outbreak ended when the school broke up for the end of year holiday. Work was carried out on the heating and ventilation system before the new term to try to optimise the system and ensure better air exchange rates. A few new cases were reported in the new term but the phenomenon did not persist. A more detailed air quality survey is being considered to provide objective evidence of the adequacy of ventilation and air exchange.

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