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COMMENTARY

A survey of the distribution of glass on clothing

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During a two year survey, 432 items of clothing were examined for the presence of glass fragments. Physical measurements made on the fragments, including RI, ΔRI, and surface measurements, were recorded, and the effect of grouping the RI data into sources of glass by use of a computer programme was examined. The results of the survey demonstrated that whenever seven or more fragments of glass were located on clothing, they had originated from at least 3 sources. The largest number of fragments from a single source located on one garment was six. A subsequent paper will report the results of the chemical analysis of the fragments.

Key Words: Glass; Distribution on clothes; RI; Survey.

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Introduction

Finding glass fragments on the clothing of a suspect has long been recognized as a valuable means of providing a connection between the suspect and broken glass at the scene of a crime. Instrumental methods of analysis provide the scientist with physical and chemical information on the origins of glass fragments recovered from the clothing of a suspect. Initial discrimination between crime fragments and the control glass is normally achieved by refractive index (RI) or density determinations. Annealing routines help to identify the thermal history of glass fragments, permitting discrimination between toughened and non-toughened sources [1]. The chemical composition of the fragments can be determined by various instrumental methods, including Scanning Electron Microscopy linked with Energy Dispersive X-ray Analysis (SEM/MCA) [2], X-ray Fluorescence (XRF) [3] and Inductively Coupled Plasma/Atomic Emission Spectrometry (ICP/AES) [4]. The microscopic examination of surface features can reveal if the fragment has originated from a flat or curved surface and provide some information regarding the process by which it was manufactured [5].

Statistical analysis plays a role in the interpretation of results, and computer programs such as RUNG [6] have encouraged a rethinking of the criteria used to determine whether or not crime fragments can be considered as "matching" a control glass. The option exists within RUNG to test the significance of matching fragments against different environments of multiple controls and non-matching groups. The application of a Bayesian approach [7] to the interpretation process has focussed attention on the circumstances surrounding the location of glass fragments.

Whilst techniques for the identification and discrimination of glass have advanced, work to determine the significance of locating glass on clothing has not kept pace. A review of the literature examining glass distribution on clothing (excluding footwear) reveals only two references of note, namely a survey of 100 trousers and jackets submitted to dry cleaners, by Pearson *et al.* [8], and a survey carried out by Harrison and co-workers, of glass fragments recovered from persons suspected of involvement in crime [9].

Neither of these works has reported the thermal history of the recovered glass fragments. The former examined the distribution of glass in pockets and turn-ups but did not record glass distribution on the surface of clothing. The latter examined a very restricted group of people. It has been the experience of caseworkers within this laboratory that persons suspected of a crime involving breaking glass may recently have been associated with other similar incidents, and consequently the background levels of glass on their clothing could be disporportionately high. Interpretation of glass distribution on the basis of this work alone may therefore be misleading.

This laboratory recognized the need for a survey which would provide information on the distribution of glass on the clothing of a more general group of people, together with the identification of surface features, thermal history and chemical composition of the fragments recovered. A survey such as this would also provide a useful comparison for those examining a more specific group such as suspects.

This paper reports the physical data acquired from an examination of glass fragments removed from clothing, together with information regarding the distribution of that glass.

Survey organization

A review of laboratory statistics revealed that 88 per cent of the suspects implicated in crimes involving broken glass were aged between 16 and 30 years. The clothing examined during a one-year period originated exclusively from males. Sixty per cent of the trousers examined were denim jeans, and jackets tended to be of the "blouson" or "parka" casual styles, with a smooth cotton exterior which would have very poor glass-retentive properties.

The survey was organized to reflect these casework features and was therefore restricted to male clothing and to denim/corduroy jeans and casual jackets. It was felt impractical with a survey of limited size to take account of various social backgrounds and consequently no attempt was

made to control these parameters. The clothing examinations and experimental measurements were undertaken by two students, each working on a one-year industrial placement with the laboratory. Each student underwent a comprehensive training course including all aspects of clothing and debris search, together with extensive training on the measurement and recording of surface detail and RI and ΔRI values on recovered glass fragments.

In the early stages of the survey, a local youth club with a large male membership in the age group 16–30 years was the major source of clothing, with a small number of items from friends and relatives of staff at the laboratory. In the latter stages, garments were received from two sources. Part-time members of the Ulster Defence Regiment report to their barracks in everyday civilian dress and then change into uniform, and the clothing from these participants was examined and returned whilst they were on duty. The second source was recruits into the Royal Ulster Constabulary who, as part of their training, attend a local residential course.

Participants were supplied with two paper bags, of the type used in casework, and asked to place a pair of jeans in one and a jacket in the other. Trousers and jackets from the same individual were identified as a pair and examined as such. The participant was also supplied with a questionnaire form, and asked to give details of the garments' history, and any possible previous contact with broken glass.

Experimental

Examination of the clothing followed normal casework protocol. Debris was dislodged from the surface by shaking the garment over paper sheets and then transferred into smaller folded paper packages. The contents of the pockets were individually brushed onto paper sheets. At this stage the retentive property of the host garment was estimated, ranging from poor to very good depending on the fabric. The debris removed from the clothing was examined under a stereomicroscope (Wild M7A, Wild Heerbrugg Ltd) fitted with annular illumination (Volpi Intralux 500-H, Volpi AG Urdorf, Zurich) and working at magnifications of between $\times 15$ and $\times 30$. Only glass fragments bearing sharp fracture edges were recorded and examined further.

Original surfaces

An initial search of the debris was made using the stereomicroscope to locate any glass fragments bearing original surfaces. Fragments with possible surface features were located by noting specular reflections from the illuminating source. The fragment was recovered from the debris, the presence of an original surface was confirmed and its surface contour identified under an interference objective using the 2-microscope system described by Locke [5]. A UV attachment fitted to the stereomicroscope in the system permitted the identification of float surfaces by observing the fluorescence at 254 nm [10]. The size, shape and colour of all fragments present in the debris were recorded.

RI determinations

All RI measurements were made on GRIM (Foster and Freeman Ltd, Evesham, England) whose operation and calibration has been described previously [11]. Silicon oils DC710, DC704 and DC550 were used for all measurements, although only a very small number of determinations fell outside the range of the DC710 oil. Fragments of glass were removed from the debris on the point of a fine steel probe, placed directly into a spot of DC710 oil on a flat 75 mm × 20 mm slide and covered with a 13 mm diameter cover slip. Whenever no suitable measurement edge could be located, or whenever the edge counts fell below 10 units, the fragment was broken in order to obtain suitable edges for reliable determinations. Edge counts of less than 10 are rejected in casework samples as it is felt that this represents an unacceptably low contrast in the image, resulting in poor reproducibility.

Fragments to be broken were located on the microscope slide using a polarizing light microscope (Wild M8, Wild Heerbrugg Ltd. Switzerland). The cover slip was removed and the fragment broken *in situ* in the oil with the edge of a blade. All fragments were placed directly into DC710 oil for initial measurements and if this oil was unsuitable the fragment was recovered on the point of a fine steel probe, washed in acetone, dried and placed into the appropriate oil. All RI measurements were recorded to 4 decimal places, although for clarity all histograms display measurements to 3 decimal places.

ΔRI determinations

Following the initial RI measurements, fragments were removed from the oil and placed into a metal boat for annealing in a Carbolite mini tube furnace (MFT10/15) with 812 controller (Carbolite Furnaces Ltd., Sheffield, England). The annealing schedule used was that described by Winstanley and Rydeard [12]. No attempt was made to remove oil from the fragments as it has been established by experiment within this laboratory that this is an unnecessary stage in the procedure. A standard glass was included in each batch of fragments so as to monitor variations within the method and to check that annealing had indeed taken place.

ΔRI was calculated by subtracting the original RI value from the annealed RI value, a convention which ensures that toughened glass fragments have positive ΔRI values. It was found necessary in almost every redetermination of the RI following annealing to break the fragments to yield edges suitable for GRIM analysis.

Chemical examination

This laboratory employs SEM/MCA (Camscan Series 4 microscope/Link 860 series 2 analyser) for the determination of the chemical composition of glass fragments in casework. The method requires that fragments be presented planar to the instrument and a method was therefore developed for casework samples in which fragments were mounted in a block of epoxy based resin (Epomet, Banner Scientific Ltd) and polished. This method imposes restrictions on the size of fragment which can be handled, and the majority of fragments recovered in the survey were too small to allow the use of this routine. As a consequence, work has been undertaken to develop a method which will cater for the examination of untreated fragments, and this will form the basis of a further paper.

Grouping

When sufficiently large numbers of fragments were recovered from any item, the RI measurements were grouped using the RUNG computer programme, using a standard deviation of 0·00005, to indicate the number of glass sources present.

Results and discussion

All results have been transcribed to a data base within the Home Office Forensic Science Service Central Research and Support Establishment (CRSE) PRIME computer. The database has been constructed in such a way as to permit searching for any of the attributes: RI, ΔRI, position on the clothing from which the fragment was recovered, and number of sources, or any combination of these.

In total, 432 items of clothing were examined, comprising 216 trousers, 191 jackets and 25 pullovers. The garments yielded 631 fragments of glass. Seventy-one per cent of the trousers, fifty-eight per cent of the jackets and fifty-six per cent of the pullovers had no glass present.

The largest number of fragments recovered from one jacket was 59 with RI indicating 27 sources. Similar figures were 36 from 27 sources for trousers, and 18 from 5 sources for pullovers. Eighty-four trouser/jacket pairs carried no glass, representing 39% of the pairs examined.

In the first year of the survey, 162 items of clothing were examined (81 trouser/jacket pairs) and 256 glass fragments were recovered. This figure of 256 excludes 220 mg of glass which were located inside a zipped pocket of a blouson-style jacket. RI measurements made on 30 of these fragments, and subsequent grouping on RUNG, suggested that they originated from a single source having a mean RI value of 1·5164. A number of the fragments were found to possess original surfaces which were consistent with patterned glass. These results were not further included with the survey data as the means by which the glass found its way into the pocket was unclear.

In the second year, 270 items were examined, comprising 135 trousers, 110 jackets and 25 pullovers. These items generated 375 glass fragments. Pullovers were included with the survey, as a significant number of participants appeared to wear pullovers in preference to jackets. Of the 25 pullovers, 14 (56%) carried no glass, 8 carried 1 fragment, 2 carried 2 fragments and 1 carried 18 fragments from 5 sources. The data relating to pullovers was included with that for jackets.

Amongst the jackets was a garment which contained large quantities of glass in each of the 2 pockets; approximately 320 fragments in one pocket and 70 in another. No glass was noted on the surface. Measurements made on 40 fragments suggested that a number of sources were present and that most of the glass was toughened. Further information received from this participant revealed that the jacket had been exposed to breaking windscreens on a number of occasions during his previous employment as a delivery van driver. The garment had never been cleaned, yet all of the glass which must have found its way onto the outside of the jacket had apparently been dislodged. His last recollection of contact with a broken windscreen was 6 months prior to sampling. These details were omitted from the histograms.

RI measurements

Figure 1 displays the overall RI distribution for the 631 fragments examined. This distribution was further broken down into that for jacket/pullover surfaces and pockets, and for trouser surfaces and pockets (Figure 2). The RI distribution of fragments recovered from the surface of garments was compared with that of fragments from the pockets using a Chi-squared test. Before applying the test, the results were standardised by conversion to percentages and some adjacent RI intervals combined to provide sufficient data for comparison. The results of this comparison at the 95% confidence interval gave a Chi-squared value of 47, suggesting that there was a significant difference between the two distributions at this level. It would be tempting, on the basis of this analysis, to suggest that the differing distributions may be the result of different exposure mechanisms. The comparison was repeated for the grouped data in the following section.

Grouping

The individual RI measurements were then grouped into glass sources using the RUNG computer programme as previously described, and the plots were redrawn with RI plotted against glass sources (Figures 3–4). In these plots each glass source was weighted equally and the skewed distribution resulting from disproportionately large numbers of fragments, all from the same source, was removed. The effect can be seen by comparing Figure 2a with Figure 4a, where a frequency maximum at 1·521–1·522 in the plot of individual RI was transformed to a maximum at 1·519–1·520 when glass sources were used.

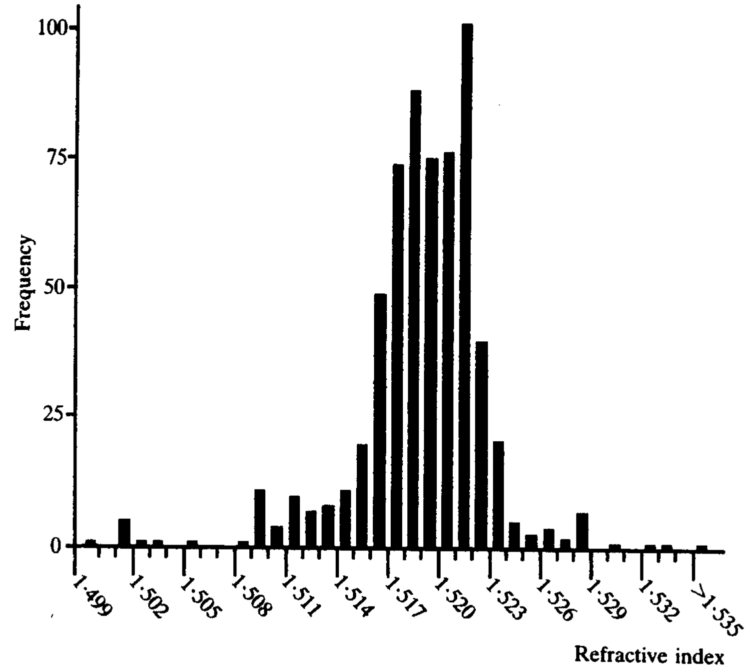

FIGURE 1 **Refractive index distribution of glass from 432 items of clothing.**

The Chi-squared test was repeated for the grouped data, again comparing the distribution of glass from the pockets with that from the surfaces. The results of this comparison gave a Chi-squared value of 10 which, at the 95% confidence interval, suggested that there was no significant difference between the distributions. The effect of grouping the data has therefore been to suggest that there is no underlying difference between the sources of broken glass to which pockets and surfaces are exposed.

Figures 5a and 5b display the number of individual glass fragments located per garment and a comparison of these results with those for the grouped data in Figures 6a and 6b shows little variation, suggesting that whenever multiple fragments have been recovered, they tend to have originated from multiple sources. This effect is demonstrated more clearly in Figure 7 in which the frequency of occurrence of fragments from 1, 2 or 3 or more sources is plotted. From this it can be seen that when 7 or more fragments were located they came from at least 3 sources. The largest number of fragments found on any one garment, all of which originated from a single source, was 6.

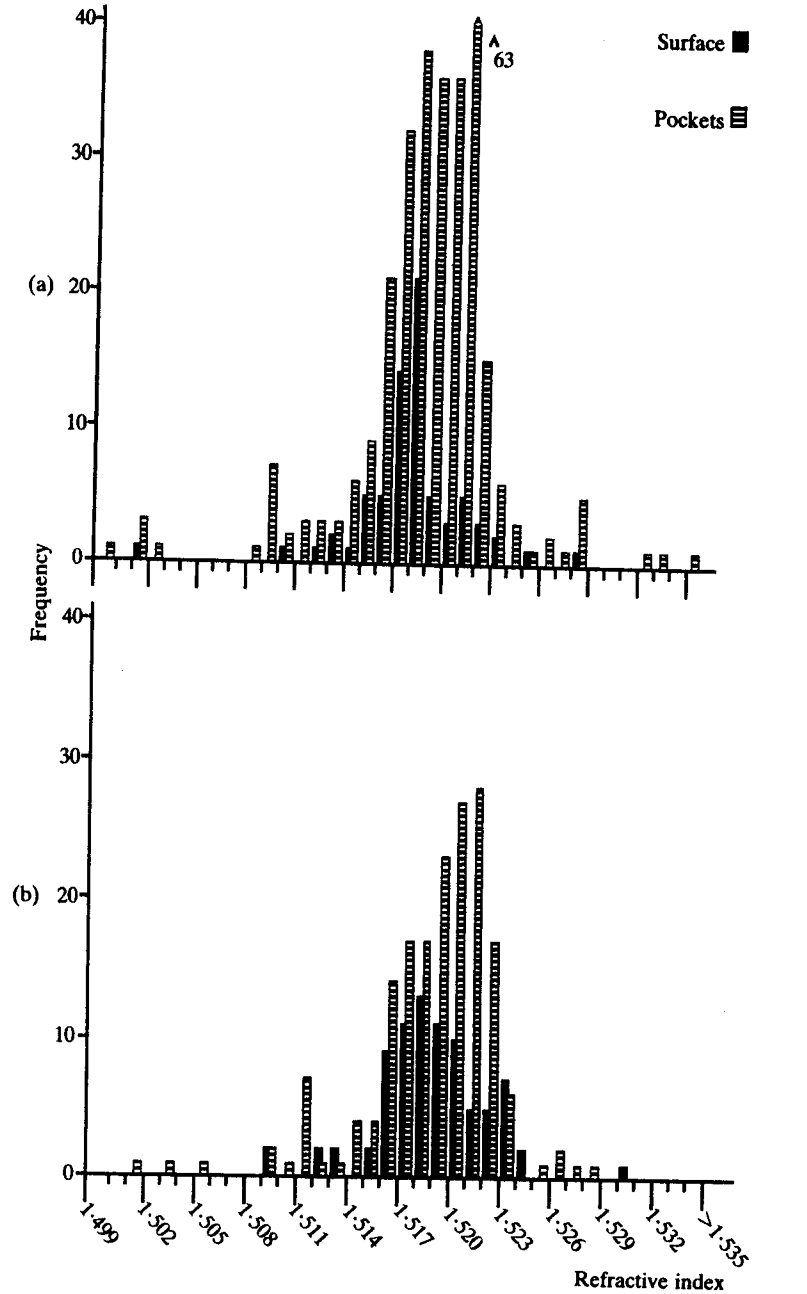

FIGURE 2 **Refractive index distribution of glass from (a) 191 jackets and 25 pullovers; (b) 216 trousers.**

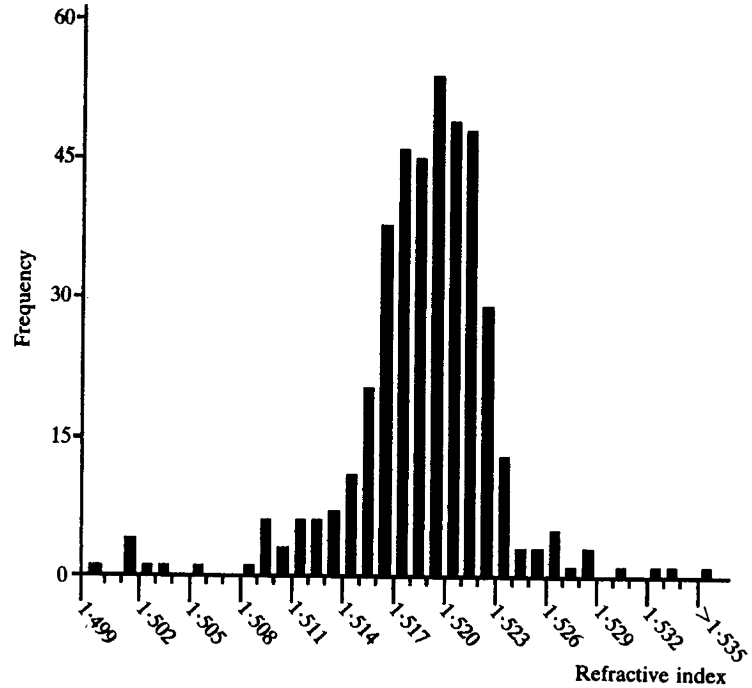

FIGURE 3 **Grouped refractive index distribution of glass from 432 items of clothing.**

RI Values

The frequency of occurrence of ΔRI values has been recorded in Figure 8. The interval chosen to display the data was purely for clarity as the reproducibility of the ΔRI values for the standard glasses was poor (Table 1). It was apparent that a significant proportion of the fragments (20%) had ΔRI less than 0.

Negative ΔRI values have been observed in casework control data (Underhill, personal communication) and have been associated with window, container and glasses for specialist use, so that no conclusions can be drawn as to the origins of the particular fragments. The work of Locke *et al.* [13] suggested that a ΔRI of greater than 100 is a characteristic of a glass from a toughened source; consequently 19% of the glass in this survey could be described as originating from such a source.

Colour

Forty-six fragments of coloured glass were noted, of which forty-three were amber, one blue, one green and one red glass.

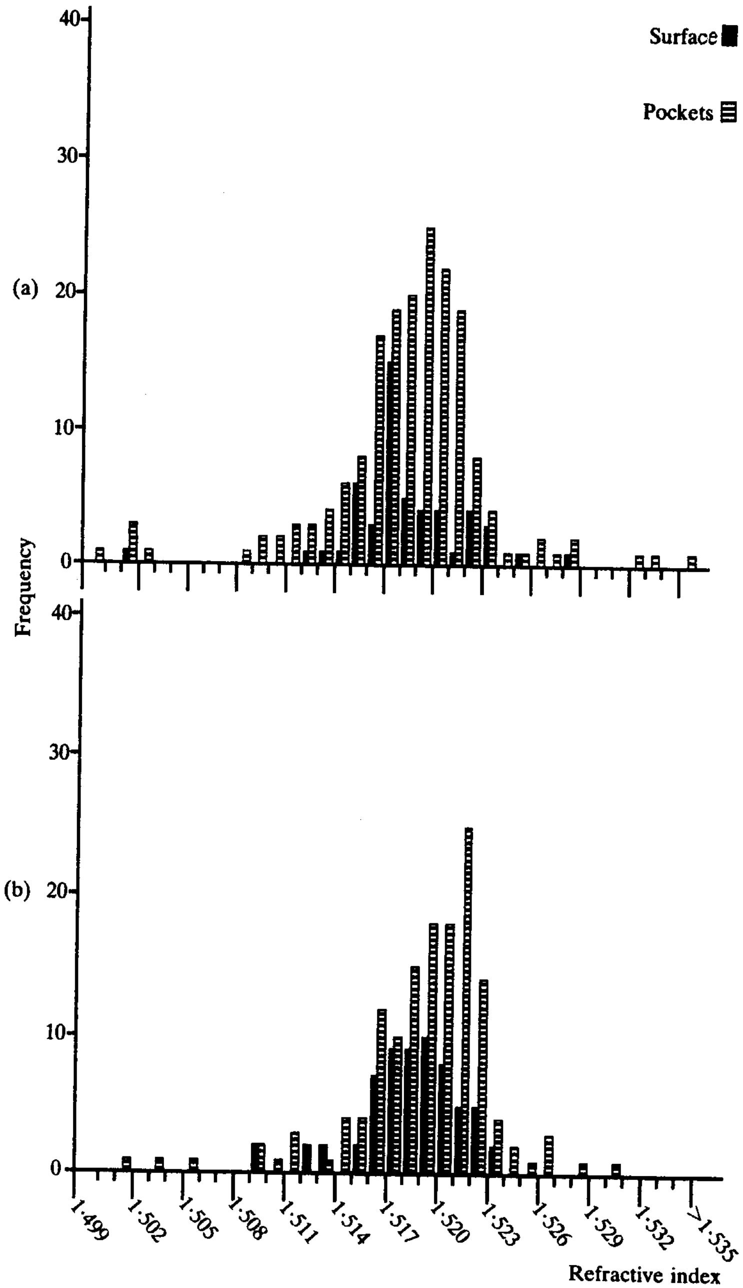

FIGURE 4 Grouped refractive index distribution of glass from (a) 191 jackets and 25 pullovers; (b) 216 trousers.

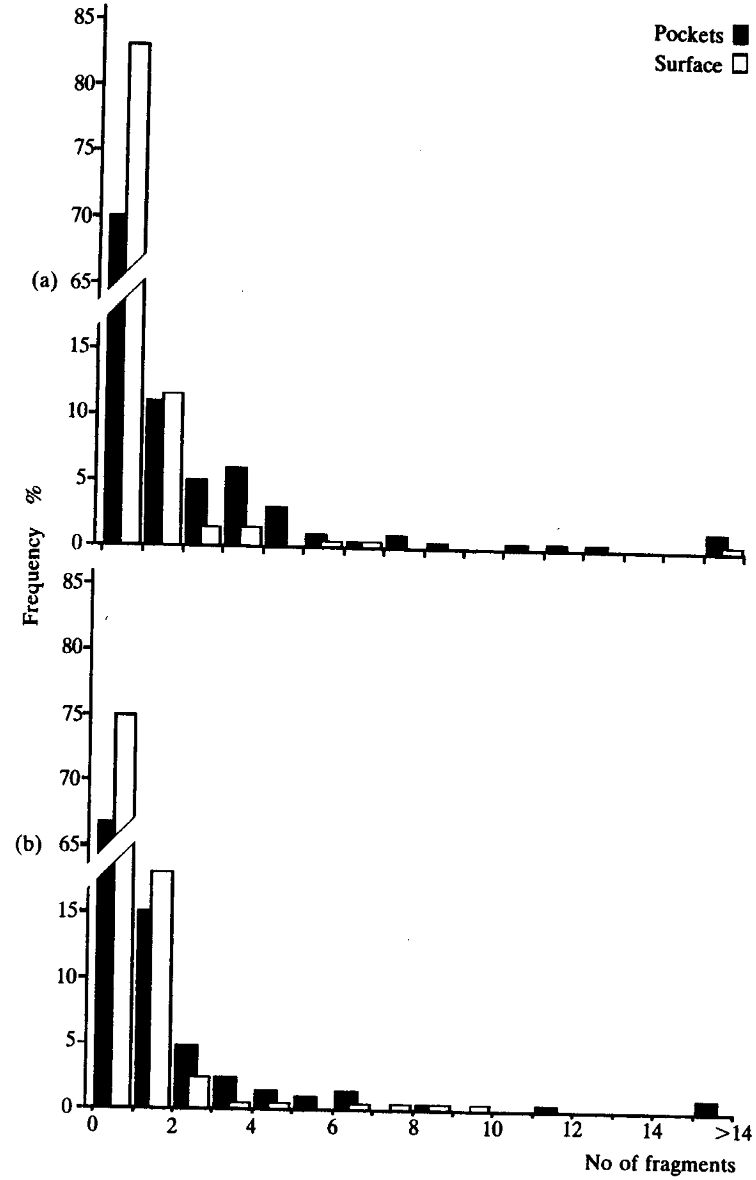

FIGURE 5 Distribution of glass fragments amongst (a) 191 jackets and 25 pullovers; (b) 216 trousers.

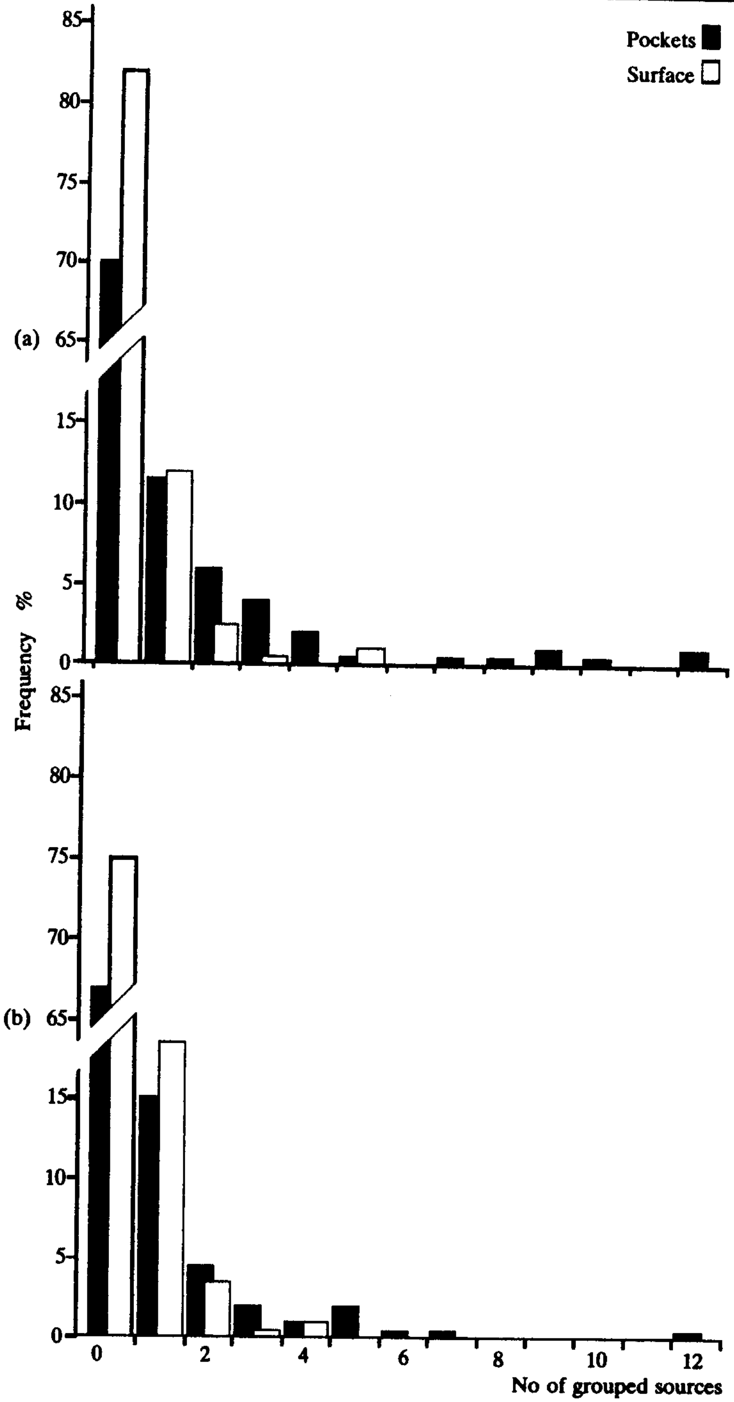

FIGURE 6 Distribution of glass sources amongst (a) 191 jackets and 25 pullover; (b) 216 trousers.

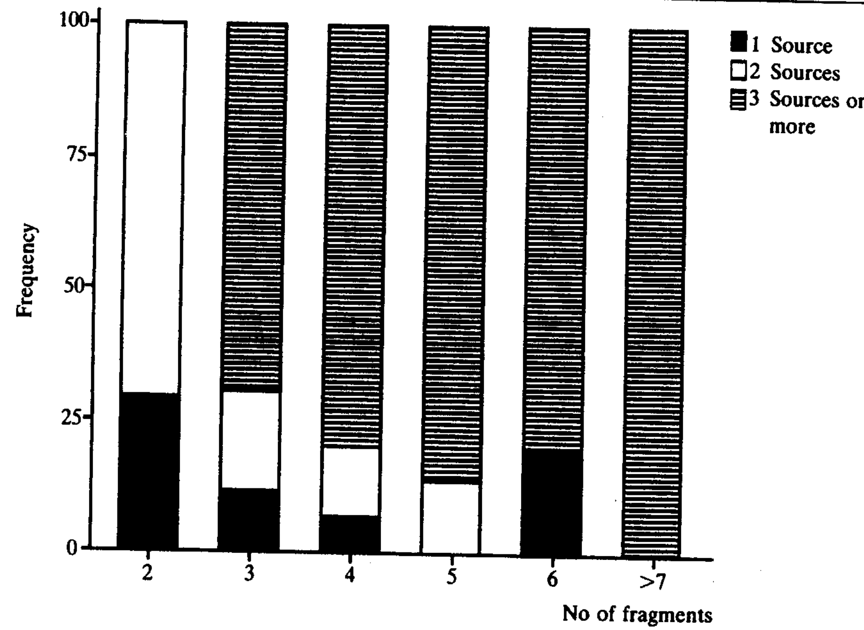

FIGURE 7 Frequency of occurrence of glass from 1, 2, and 3 or more sources.

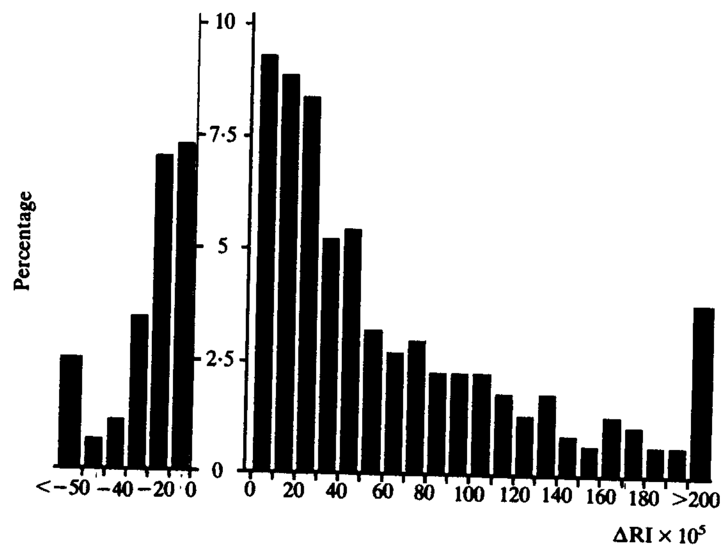

FIGURE 8 Distribution of the change in refractive index produced by annealing, as described by Winstanley and Rydeard [12].

TABLE 1. Variation in refractive index of standard glasses subjected to annealing as described by Winstanley and Rydeard [12]

Glass	Δ *Mean RI* × 10^5	*SD* × 10^5
Standard		
K7	−167·33	4·967
KF3	−112·781	3·457
BK7	−278·11	4·332
PK2	−282·33	6·616
PK50	−417·00	2·708
KF9	−105·22	3·881
KZF2	−164·56	6·618
Toughened	137·11	4·864

Surface features

Surface features were present on 51 fragments and of those 34 were flat and 16 curved. The remaining fragment was identified as originating from a source of patterned glass. These fragments were noted in debris from the surface and pockets of both jackets and trousers. Float surfaces were detected on 7 fragments.

Size

Figure 9 shows the size distribution of fragments located on garment surfaces and pockets. From this it can be seen that 73% of the fragments recovered from surfaces were less than 0·3 mm in size compared with 46% of fragments from pockets. Only 6% of fragments from surfaces were greater than 0·5 mm with none greater than 1 mm in length, whilst 32% from pockets were greater than 0·5 mm, and 5% greater than 1 mm. These results confirm the theory that larger fragments are lost more readily from garment surfaces and suggest that finding a fragment of greater than 1 mm may be very significant in terms of timing the exposure to the breaking source.

Conclusions

In surveys of this nature there will always be room for debate on the most appropriate source of clothing for study and therefore it is suggested that the results presented here be used to complement those of other surveys. The results of this present survey demonstrate that it is unusual to find more than 6 glass fragments from the same source on clothing from this section of the population. When large number of glass fragments have been found, they tend to originate from multiple sources. There appears to be no difference between garments pockets and surfaces in terms of the sources of broken glass to which they are exposed.

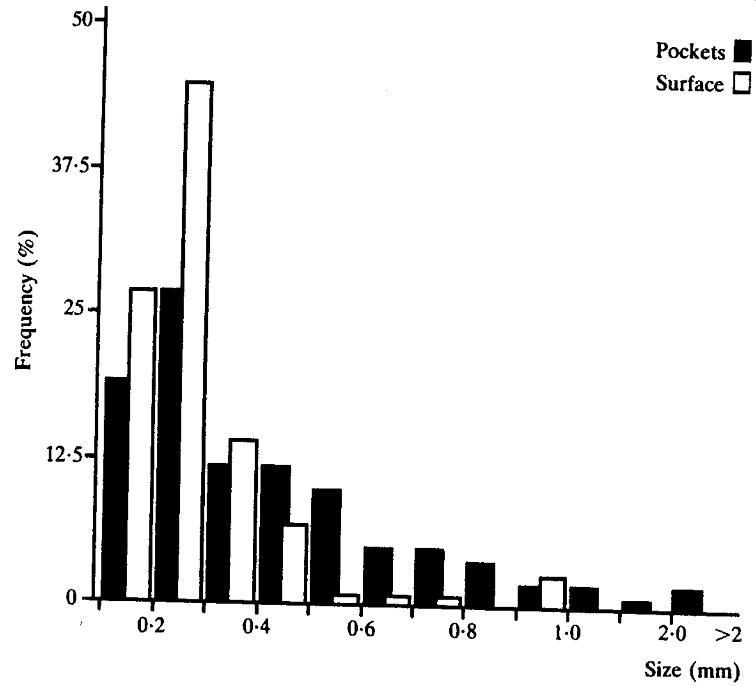

FIGURE 9 Size distribution of glass from pockets and surfaces of 432 items of clothing.

Many areas of Northern Ireland are undergoing redevelopment with old housing stock being refurbished and modernised. This level of activity, together with a sustained terrorist bombing campaign, results in what could arguably be a very high exposure to broken glass. That being the case, it could also be argued that a similar survey undertaken in a less troubled part of the world could result in the location of fewer fragments. The percentage of clothing without glass is similar, however, to that found in the original work by Pearson *et al.* in 1971 [8], and consequently the findings of this work are not significantly removed from work undertaken on clothing from a rural area of England. From this point of view there would appear to be no significant overestimate of glass occurrence if this work were to be used for interpretation of findings in other parts of the world.

This project is continuing into its second phase when the compositional data of the fragments will be examined.

Acknowledgements

The authors wish to recognize the contribution of Mr S Hayes who carried out some of the experimental work described here during his attachment to NIFSL as a sandwich student from the University of Ulster, Jordanstown; also the valuable assistance given by Mr P Clarke and Mr C Brown of CRSE at Aldermaston in the construction of the database.

References

1. Winstanley R and Rydeard C. Observations on re-annealing very small particles of glass. Glass International 1984; 55: 2–3.
2. Hickman DA. Linking criminals to the scene of the crime with glass. Analytical Chemistry 1984; 56: 844–852.
3. Howden CR, Dudley RJ and Smalldon KW. The analysis of small glass fragments using energy dispersive X-Ray fluorescence. Journal of the Forensic Science Society 1978; 18: 99–112.
4. Catterick T and Hickman DA. Sequential multielement analysis of small fragments of glass by atomic-emission spectrometry using an inductively coupled radiofrequency argon plasma source. Analyst 1979; 104: 516–524.
5. Locke J and Zoro JA. The examination of glass particles using the interference objective. Forensic Science International 1983; 22: 221–230.
6. Evett IW and Lambert JA. The interpretation of refractive index measurements IV. Forensic Science International 1984; 24: 149–163.
7. Evett IW. A Bayesian approach to the problem of interpreting glass evidence in forensic science casework. Journal of the Forensic Science Society 1989; 29: 317–324.
8. Pearson EF, May RW and Dabbs MDG. Glass and paint fragments found in men's outer clothing—report of a survey. Journal of Forensic Sciences 1971; 16: 283–298.
9. Harrison PH, Lambert JA and Zoro JA. A survey of glass fragments recovered from clothing of persons suspected of involvement in crime. Forensic Science International 1985; 27: 171–187.
10. Locke J. A simple illuminator for detecting the fluorescence of float glass surfaces. The Microscope 1987; 35: 151–158.
11. Locke J and Underhill M. Automatic RI measurement of glass particles. Forensic Science International 1985; 27: 247–260.
12. Winstanley R and Rydeard C. Concepts of annealing applied to small glass fragments. Forensic Science International 1985; 29: 1–10.
13. Locke J, Winstanley R, Rockett LA and Rydeard C. A comparison of long and short schedules for the annealing of glass particles. Forensic Science International 1985; 29: 247–258.

COMMENTARY

Minimum respiratory function for breath alcohol testing in South Australia

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The aim of this study was to determine if inability to complete a breath alcohol test successfully, using a Lion Alcolmeter SD-2 or Drager Alcotest 7110, was related to any of the standard parameters obtained from the lung function spirometry test. A total of 153 subjects referred to a clinical laboratory for routine lung function testing were tested using the Alcolmeter, 158 using the Alcotest, with 69 subjects completing tests on both instruments. Of the 153 patients who volunteered to use the Alcolmeter, 49 (32%) were unable to produce a valid test effort on this instrument. One subject failed to complete a satisfactory test using the Alcotest, and one was unable to master the technique. There was considerable overlap of the minimum value for each of the lung function parameters of those subjects who could or could not successfully complete the breath alcohol test. It is recommended that changes are made to both of the instruments, the techniques used and the legislation, to minimize the number of breath alcohol testing failures and to reduce the variability of the results.

Key Words: Breath alcohol analysis; Spirometry; Forced Vital Capacity; Forced Expiratory Volume in one second.

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Introduction

Failure to provide a roadside breath sample to police on request has been classed as an offence in South Australia since the introduction of random breath alcohol analysis. Previous studies using different types of breath alcohol analysers have suggested lower limits for Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second ($FEV_{1.0}$) [1–4]. The degree of pulmonary disability that would prevent an individual from being able to perform successfully on either of the two roadside breath alcohol analysis units used in South Australia is not known.

The aim of this study was to document the minimum flow rates and resistance to breathing in the two standard devices, the Lion Alcolmeter SD-2 and Drager Alcotest 7110, and to determine if inability to complete the test successfully was related to any of the standard parameters obtained