The effect of extinguishing powder on the possibility of finding biological traces and determining the genetic profile

major
Justyna Laskowska
e-mail:
justyna.laskowska@po.policja.gov.pl
ORCID: 0009-0008-7792-307X

sergeant
Kamila Janka
ORCID: 0009-0004-8406-1034

sergeant
Jolanta Szewczyk
ORCID: 0009-0004-0227-9022

2nd lieutenant
Emilia Korbanek
ORCID: 0009-0009-0808-1881

sergeant
Wirginia Wojtczak
ORCID: 0009-0006-9139-6005

senior police constable
Konstancja Kujawa
ORCID: 0009-0009-3601-6227

major
Sergiusz Błażejczak
ORCID: 0009-0005-3515-1735

2nd lieutenant
Dawid Dembczyński
ORCID: 0009-0001-5679-8491

retired warrant officer class I
Mariusz Grzyb
ORCID: 0009-0007-2218-3329

All author are from Forensic Laboratory of the Police Headquarters in Poznań

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Abstract

Forensic genetics, as one of the fastest growing fields of research in forensic science, among other things, emphasises genetic identification and linking the perpetrator to the crime. A key element is the finding and securing of biological traces, followed by their genetic analysis. The aim of forensic genetics testing is to identify the type of biological substance and determine the genetic profile on the basis of laboratory analyses. Testing has been carried out in two stages: under laboratory conditions and under near-real conditions. The experimental results obtained allow us to conclude that in the event of an attempt to obliterate biological traces by using fire extinguishing powder, it is possible and reasonable to find them and secure them for genetic testing.

Keywords: fire extinguishing powder, biological traces, DNA profile

Introduction

The purpose of forensic genetic testing is to carry out laboratory analyses that will result in, among other things, the identification of the type of biological substance and the determination of the genetic profile of the person who left the material. However, the most essential piece of the forensic puzzle is the found and properly secured forensic trace.

Perpetrators of crimes often use various ways and means to destroy traces left at the scene of an incident. In practice, one encounters attempts to obliterate traces by washing away, setting fires, using explosives or using fire extinguishers.

As the authors Andrew O'Hagan and Rebecca Calder report, there are a number of different stages of fire, each of which has a different impact on the preservation and finding of both fingerprints and DNA. Soot and smoke deposits can act as a protective layer against the damaging effects of a fire, such as flames, very high temperatures and fire extinguishing media. Soot can prevent DNA ‚evaporation' by adhering to the surface to which it is applied. Soot removal techniques have been developed that cause as little damage as possible to potential traces. Some techniques are very expensive and time-consuming and are therefore not suitable for cleaning large areas. A low-cost alternative, for both porous and non-porous surfaces, is to use ‚light brushing', which is a quick and easy way of getting rid of excess soot. Given the experience of the authors of the publication in soot removal, a proprietary ‚gentle sweep' method has been developed to remove the extinguishing powder in the experiment described below. Furthermore, a comparison was made between this proprietary method and the effects produced by the use of a vacuum cleaner.

Officers from the Forensic Laboratory of the Provincial Police Headquarters in Poznań, including the Biology and Genetics, Dactyloscopy and Traseology and Chemistry Sections, conducted an experiment to investigate the effect of fire extinguishing powder on the possibility of finding biological traces and determining the genetic profile. It has become necessary to work out a method of dealing with these types of cases and then transfer the knowledge to forensic technicians.

Fire extinguishing powders, i.e. crushed solids (inorganic salts), due to their physical and chemical properties, are among the most popular and important extinguishing media used in fire protection (next to water and aqueous foaming solutions). They are used in hand-held firefighting equipment and fixed powder extinguishers, and are also found on fire engines with specialised fittings for their administration. Extinguishing powders are characterised by short extinguishing times, very good extinguishing efficiency and applicability to most types of fire. Based on one criterion, extinguishing powders are divided into carbonate, phosphate, urea and chlorine powders.

The experiment used a freely available PG1-B powder extinguisher (made by ANAFGROUP) with 1 kg of extinguishing medium, consisting mainly of chemical compounds such as sulphates and phosphates. It is designed to extinguish flame and flameless fires and fires from the following groups:

A - fires of solid materials usually of organic origin whose normal combustion occurs with the formation of glowing coals;

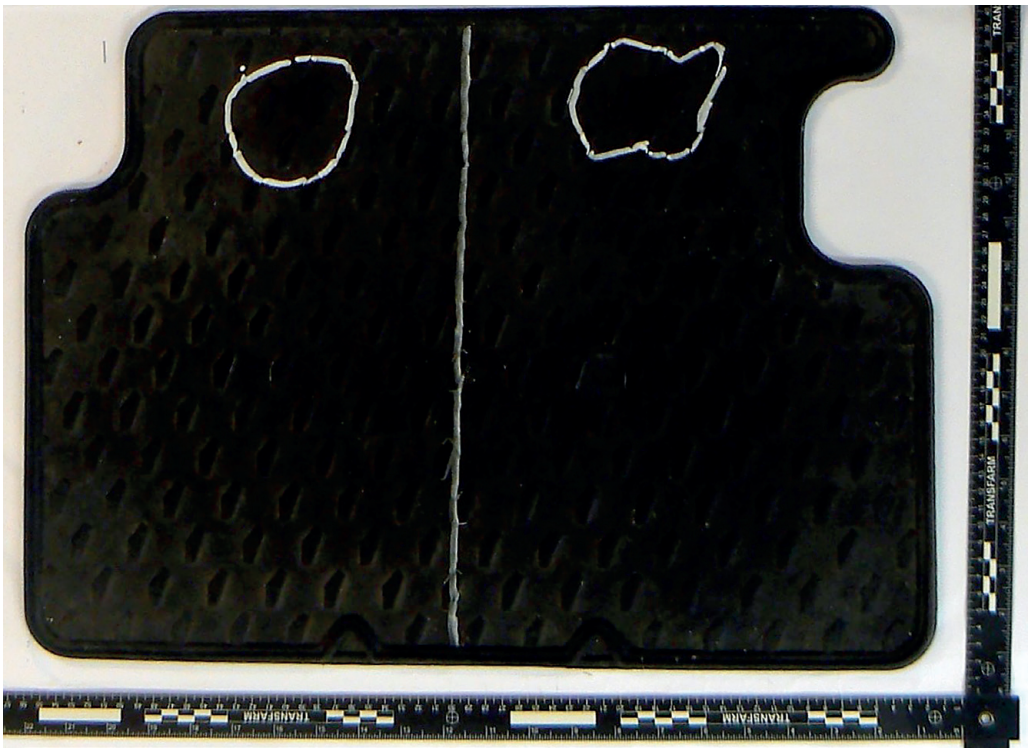
B - liquid and solid melting fires;

C - gas fires.

The source of the biological material was blood from a male identified as proband I and contact traces from a male identified as proband II. First, tests were carried out under laboratory conditions (at the Biology and Genetics Section of the Forensic Laboratory of the Provincial Police Headquarters in Poznań) using equipment from a previously used car: the steering wheel and a headrest. The experiment was then continued on the military training ground in Biedrusko, under conditions similar to those prevailing in the real incident sites using a Fiat Albea passenger car used previously.

Materials and methods

2.1 Material preparation and sampling. The first part of the experiment performed under the laboratory conditions at the Biology and Genetics Section.



ryc. 1 Rubber floor mat after application of blood traces.

ryc. 3. The fire extinguisher used in the experiment.

The first stage of the experiment was the decontamination of the previously used headrest and steering wheel, on which proband II left his contact marks. A 1.08% chlorine solution (Medicarine from ECOLAB) and operation of a UV lamp (40 minutes) were used for this purpose. The samples taken from the decontaminated medium were called zero samples. The genetic testing of the traces secured from the headrest yielded DNA mixtures, and the testing of the traces secured from the steering wheel resulted in isolation of a negligible amount of DNA. Obtaining such results may be related to the long-term use of the above-mentioned car equipment and the type of surfaces tested, i.e.: absorbent (headrest) and non-absorbent (steering wheel). The absorbent surface was difficult to decontaminate effectively.

Proband II then applied his contact traces to the surface of the headrest and the steering wheel for 15 minutes by touching them with both hands. As a result of the genetic testing of the samples taken from the headrest, DNA mixtures were determined in which the genetic profile features of proband II were found. The genetic profile of proband II was determined in samples taken from the steering wheel.

THE RESULTS ARE SUMMARISED IN TABLE 1.

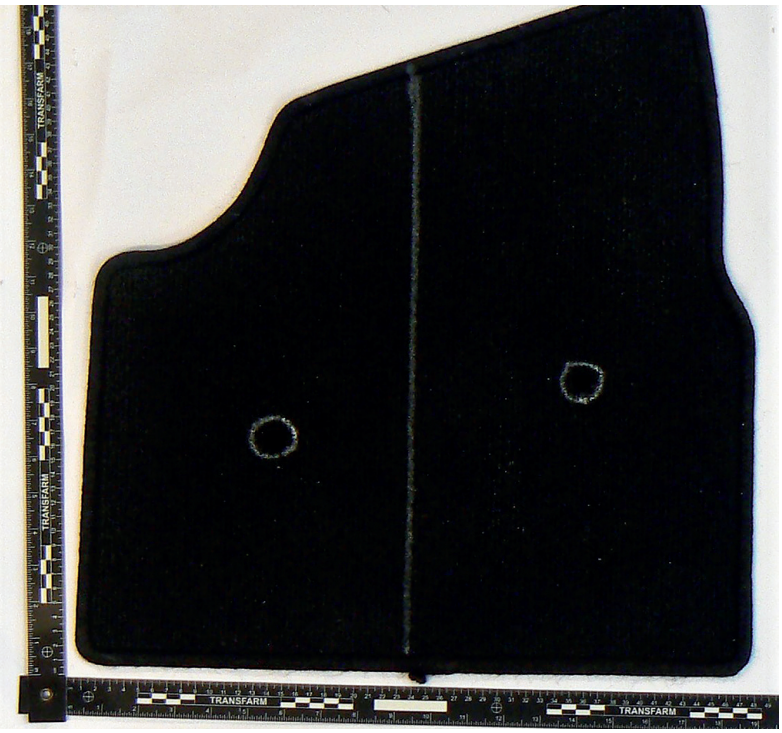
The next step was to determine the possibility of determining the genetic profile of proband I and proband II from the samples taken from blood and contact traces from the surface of the headrest, the steering wheel and the rubber and textile floor mats after the use of a fire extinguisher. Due to the previous use of the car equipment components, they were decontaminated with a 1.08% chlorine solution and operation of a UV lamp (40 minutes). Proband II applied contact traces and blood traces according to the following procedure:

1. **contact traces for 15 minutes, in a manner similar to driving a car;**
2. **blood traces by applying 100 µl of blood (from proband I) to work gloves and then touching the test surfaces for 5 minutes, in a manner similar to driving a car.**

In addition, 100 µl of blood was applied to the surfaces of rubber and textile floor mats, each of which was divided into two areas.

The surfaces of the above items were subjected to the operation of one vehicle fire extinguisher (type PG1-B from ANAFGROUP, with a capacity of 1 kg) at an ambient temperature of 22 °C, outdoors, and the tested material was then transferred to the laboratory.

Sampling was performed 24 hours after the use of the extinguisher. The extinguishing powder was removed mechanically in two ways: by suction with a 1200 W vacuum cleaner, the working end of which was decontaminated each time with a 1.08% chlorine solution, and by the, gentle sweeping' method using a dustpan sweeper, the bristles of



ryc. 2 Textile floor mat after application of blood traces

which were applied each time with a disposable glove. The samples were taken on swabs and on forensic film.

THE RESULTS ARE SUMMARISED IN TABLE 2.

MATERIAL PREPARATION AND SAMPLING. The second part of the experiment performed on the military training ground.

The second part of the experiment was carried out on the military training ground in Biedrusko under conditions similar to real incident sites. For this stage, a Fiat Albea car was used, the interior of which was decontaminated with a 1.08% chlorine solution and operation of a UV lamp for 15 minutes.

Application of traces

PROBAND II applied blood traces on the driver's seat and contact and blood traces on the passenger's seat according to the following procedure:

- **driver's seat: 100 µl of blood (from proband I) was applied to work gloves, worn on the hands of proband II. Proband II rubbed the palm parts of the gloves one against the other and spread the blood on their surfaces. Subsequently, 200 µl of blood (from proband I) was applied to the soles of both shoes of proband II and spread over their entire surface. Simulating driving for 15 minutes, proband II held a conversation and performed the following activities:**
- **opened the car door using the handle on the outside of the driver's door;**
- **sat down on the seat, closed the door using the handle on the inside of the driver's door;**
- **adjusted the seat using the driver's seat adjustment handle and adjusted the headrest;**
- **fastened his seat belt;**
- **turned the key in the ignition;**
- **switched on the lights;**
- **opened and closed the window using a crank handle;**
- **'steered' the car by touching the steering wheel, the indicator levers, the gear lever, the wiper switch and the handbrake, and pressing the clutch, brake and accelerator pedals;**
- **got out of the car using the handle on the inside of the driver's door.**

the passenger seat: 200 µl of blood (from proband I) was applied to the soles of proband II's shoes and spread over their entire surface. In the passenger seat, proband II was not wearing gloves. While staying in the car for 15 minutes, proband II conducted a conversation and performed the following activities:

- **opened the car door using the handle on the outside of the passenger door;**
- **sat down on the seat, closed the door using the handle on the inside of the passenger's door;**
- **adjusted the seat using the passenger's seat adjustment handle and adjusted the headrest;**
- **fastened his seat belt;**
- **opened and closed the glove box;**
- **opened and closed the window using a crank handle;**
- **got out of the car using the handle on the inside of the passenger's door.**

The interior of the vehicle was subjected to the operation four car fire extinguishers (type PG1-B from ANAFGROUP, with a capacity of 1 kg) at an ambient temperature of 27 °C, outdoors. Then the car was closed.

Sampling was performed 24 hours after the use of the extinguishers. The extinguishing powder was removed mechanically in two ways: by suction with a 1200 W vacuum cleaner, the working end of which was decontaminated each time with a 1.08% chlorine solution, and by the 'gentle sweeping' method using a dustpan sweeper, the bristles of which were applied each time with a disposable glove.

THE RESULTS ARE SUMMARISED IN TABLE 3.

Substrate	Sampling site	Sample no.	Decontamination method	Sample type	Sampling method	Amount of DNA [ng/µl] large/small DNA	Result	LR
headrest 1	front/centre	Z/0/1	chlorine solution, UV for 40 min.	zero sample without application of new biological material	film	0.002/0.0023	DNA mixture from at least 2 persons	-
headrest 1	side surface	Z/0/2	chlorine solution, UV for 40 min.	zero sample without application of new biological material	film	0.0026/0.0105	DNA mixture from at least 3 persons	-
headrest 1	front/centre	Z/1/1	-	sample with application of contact traces by the proband for 15 minutes	film	0.3003/0.2866	DNA mixture from at least 3 persons	8.24×10^{10}
headrest 1	side surface	Z/1/2	-	sample with application of contact traces by the proband for 15 minutes	film	0.1934/0.1331	DNA mixture from at least 2 persons	3.00×10^{11}
steering wheel 1	wheel rim	K/0	chlorine solution, UV for 40 min.	zero sample without application of new biological material	2 swabs	0.003/0.0009	negligible amount of DNA	-
steering wheel 1	wheel rim	K/1	-	sample with application of contact traces by the proband for 15 minutes	2 swabs	0.0146/0.0387	genetic profile of proband II	1.36×10^{28}

tab. 1. The test results.

Preliminary testing and genetic testing

HemoPhan test papers from ERBA Lachema and the FOB test from BioLine, Hydrex Diagnostics Sp. z o.o. were used to detect the presence of blood.

All samples collected were subjected to magnetic DNA extraction using the QIAsymphony DNA Investigator Kit reagents kit and QIAsymphony SP workstation from Qiagen. Evaluation of the amount of DNA in the samples was carried out using Applied Biosystems' Quantifiler Trio PCR Reagents kit and Applied Biosystems' 7500 Real Time PCR system and HID Real-Time PCR Analysis Software v.1.3. The resulting extracts were amplified using the GlobalFiler™ reagent kit from Applied Biosystems and the Veriti®96 - Well Thermal Cycler from Applied Biosystems. PCR reaction products were subjected to electrophoresis in the POP 4 polymer using a Genetic Analyser 3500 sequencer from Applied Biosystems. An analysis of the results obtained was carried out using the GeneMapper ID-X Version 1.6 software. The statistical analysis of the genetic testing results was carried out with the assumption of two alternative hypotheses: the prosecution hypothesis (Hp) and the defence hypothesis (Hd) relating to the origin of the DNA in the sample. The statistical analyses carried out estimated the probability of a genetic test result, with the prosecution hypothesis assuming that the source of the biological material is the DNA of proband I or proband II versus the defence hypothesis assuming that the source of the DNA is an unknown, unrelated individual from the population. The calculations were carried out with the LR reliability quotient using the LRmix Studio ver. 2.1.5 - CommunityEdition software. The statistical calculations were performed using the allele frequencies for the Caucasian population (GlobalFiler TM PCR Amplification Kit user guide. 2016 Thermo Fisher Scientific Inc.).

Results

3.1 After the first part of the experiment, carried out under the laboratory conditions of the Biology and Genetics Section, the genetic test results obtained from the samples taken from the contact traces after the use of a fire extinguisher, from the headrest and the steering wheel, were analysed:

- **in three samples: a mixture of DNA from at least two persons;**
- **in three samples: a mixture of DNA from at least three persons.**

In all mixtures, genetic profile traits consistent with those found in the genetic profile of proband II were found. The genetic results obtained provide extremely strong support for the prosecution hypothesis compared to the defence hypothesis. The genetic test results obtained from the samples taken from the blood traces after the use of a fire extinguisher, from the headrest and the steering wheel:

- **in four samples: a mixture of DNA from at least two persons;**
- **in two samples- a mixture of DNA from at least three persons.**

In all mixtures, genetic profile traits consistent with those found in the genetic profile of proband I were found. The genetic results obtained provide extremely strong support for the prosecution hypothesis compared to the defence hypothesis. Only in the case of one sample does the DNA test result strongly support the prosecution hypothesis in comparison with the defence hypothesis.

For all samples a positive result was obtained in the non-specific blood test, regardless of whether fire extinguishing powder was removed with a vacuum cleaner or the ‚gentle sweep' method. For one sample, taken from the steering wheel, a positive result was obtained in the test for the presence of human blood.

With this in mind, it can be concluded thatthe amount of blood applied to the gloves (100 µl) was sufficient to determine the genetic profile, but not sufficient to obtain a positive result confirming the presence of human blood in all the samples analysed.

After the first part of the experiment carried out in the laboratory conditions of the Biology and Genetics Section of the Forensics Laboratory of the Provincial Police Headquarters in Poznań, the results of the genetic tests, obtained from samples taken from blood traces after the use of a fire extinguisher, from the floor mats, were analysed: (I increased the font).

- **rubber floor mat: in two samples, a genetic profile consistent with that of proband I;**
- **textile floor mat: in two samples, a genetic profile consistent with that of proband I.**

The sampling sites for the genetic testing were selected on the basis of chemiluminescence after using a luminol solution. These areas were tested with non-specific tests for the presence of blood and specific tests for the presence of human blood, yielding positive results for all samples in both of these tests.

After the second part of the experiment conducted at the Biedrusko military training ground, the results of the genetic tests obtained from samples taken from contact traces after the use of a fire extinguisher, from elements of the car's equipment, were analysed:

ryc. 4 The steering wheel after the use of the fire extinguisher.

- **in two samples: a mixture of DNA from at least two persons;**
- **in two samples- a mixture of DNA from at least three persons;**
- **vin one sample - a mixture of DNA from at least four persons;**
- **in two samples - a negligible amount of DNA.**

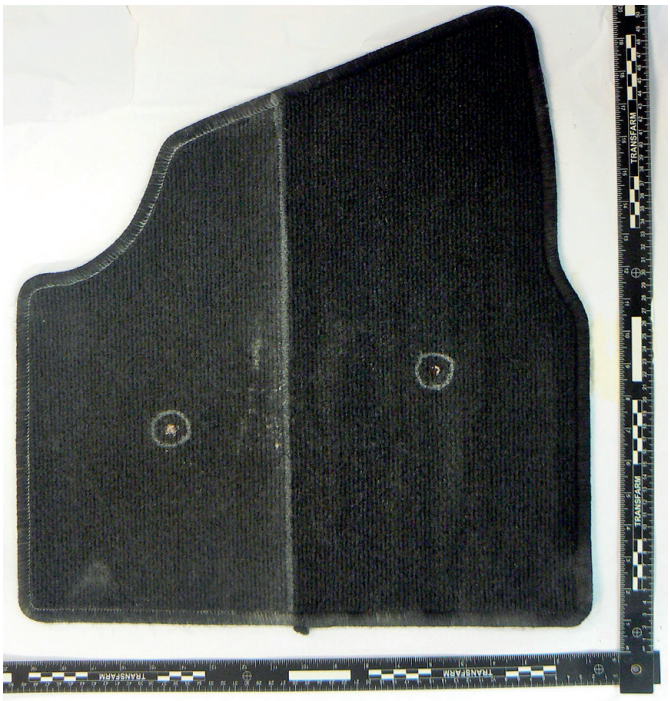
In two mixtures, the genetic profile features of proband II were found to be present. The genetic results obtained provide extremely strong support for the prosecution hypothesis compared to the defence hypothesis. For three samples, the genetic test results provide weak support for the prosecution hypothesis compared to the defence hypothesis.

The results obtained for the samples taken from the blood traces after the use of a fire extinguisher from the car equipment elements that were touched with blood-soiled gloves (excluding floor mats and pedals):

- **in two samples: a mixture of DNA from at least three persons;**
- **in eleven samples - a negligible amount of DNA;**
- **in one sample: a negative result.**

ryc. 5 The headrest after mechanical and manual removal of the fire extinguishing powder.

ryc. 6 Removal of the extinguishing powder with a vacuum cleaner - the rubber floor mat.



ryc. 7 The textile floor mat after the application of traces and the mechanical and manual removal of the fire extinguishing powder.

In one mixture, the genetic profile features of proband I were found to be present. The result of the genetic testing provides moderate support for the prosecution hypothesis compared to the defence hypothesis.

In the above samples, the concentration of DNA is low, regardless of how the extinguishing powder was removed. This translates into genetic test results obtained that are mostly ineligible for identification.

In eleven out of fourteen samples, positive results were obtained in the non-specific test for the presence of blood. In no sample was a positive result obtained for a test for the presence of human blood.

After the second part of the experiment carried out at the Biedrusko military training ground, the results of the genetic tests obtained from the samples taken from the blood traces after the use of a fire extinguisher, from elements of the car's equipment that came into contact with the blood-soiled shoes (pedals and floor mats) were analysed:

- **in two samples - a mixture of DNA from at least two persons;**
- **in five samples - a mixture of DNA from at least three persons.**

In six mixtures, the genetic profile features of proband I were found to be present. The genetic results obtained provide extremely strong support for the prosecution hypothesis compared to the defence hypothesis.

Substrate	Sampling site	Sample no.	Type/amount of material/time	Cleaning method	Sampling method	Amount of DNA [ng/µl] large/small DNA	Luminol	Hemophan	FOB	Result	LR
Steering wheel 1	half of the steering wheel	K2	contact trace/15 min.	vacuum cleaner	2 swabs	0.0067/0.0254	not tested	not tested	not tested	mixture from at least 2 persons	3.37×10^{15}
Steering wheel 1	half of the steering wheel	K3	contact trace/15 min.	brush	2 swabs	0.0148/0.0288	not tested	not tested	not tested	mixture from at least 3 persons	3.21×10^{10}
Headrest 1	front/centre	Z/1/3	contact trace/15 min.	vacuum cleaner	film	0.0417/0.0539	not tested	not tested	not tested	mixture from at least 3 persons	5.64×10^{11}
Headrest 1	side surface	Z/1/4	contact trace/15 min.	vacuum cleaner	film	0.0078/0.0143	not tested	not tested	not tested	mixture from at least 3 persons	6.87×10^{10}
Headrest 1	front/centre	Z/1/5	contact trace/15 min.	brush	film	0.0058/0.0095	not tested	not tested	not tested	mixture from at least 2 persons	8.48×10^{15}
Headrest 1	side surface	Z/1/6	contact trace/15 min.	brush	film	0.0019/0.0047	not tested	not tested	not tested	mixture from at least 2 persons	3.51×10^{15}
Steering wheel 2	half of the steering wheel	K4	blood / 100 µl - gloves/5 min.	vacuum cleaner	2 swabs	0.0041/0.0086	not tested	positive result	positive result	mixture from at least 2 persons	2.00×10^{15}
Steering wheel 2	half of the steering wheel	K5	blood / 100 µl - gloves/5 min.	brush	2 swabs	0.0047/0.0101	not tested	positive result	negative result	mixture from at least 2 persons	1.31×10^{16}
Headrest 2	side surface	Z/1/7 F	blood / 100 µl - gloves/5 min.	vacuum cleaner	film	0.0023/0.0029	not tested	positive result	negative result	mixture from at least 2 persons	1.52×10^{14}
Headrest 2	side surface	Z/1/7 W	blood / 100 µl - gloves/5 min.	vacuum cleaner	2 swabs	0.0008/0.0013	not tested	positive result	negative result	mixture from at least 2 persons	4.63×10^{4}
Headrest 2	side surface	Z/1/8 F	blood / 100 µl - gloves/5 min.	brush	film	0.0091/0.0111	not tested	positive result	negative result	mixture from at least 3 persons	2.21×10^{11}
Headrest 2	side surface	Z/1/8 W	blood / 100 µl - gloves/5 min.	brush	2 wymazówki	0.0079/0.0092	not tested	positive result	negative result	mixture from at least 3 persons	2.59×10^{9}
Rubber floor mat	chemiluminescence site after luminol	DG1	blood / 100 µl - directly	vacuum cleaner	2 swabs	0.4184/0.3982	positive result	positive result	positive result	genetic profile of proband I	2.78×10^{27}
Rubber floor mat	chemiluminescence site after luminol	DG2	blood / 100 µl - directly	brush	2 swabs	2.3223/2.2504	positive result	positive result	positive result	genetic profile of proband I	2.78×10^{27}
Textile floor mat	chemiluminescence site after luminol	DT1	blood / 100 µl - directly	vacuum cleaner	2 swabs	0.3557/0.3419	positive result	positive result	positive result	genetic profile of proband I	2.78×10^{27}
Textile floor mat	chemiluminescence site after luminol	DT2	blood / 100 µl - directly	brush	2 swabs	0.8322/0.6394	positive result	positive result	positive result	positive result	2.78×10^{27}

tab. 2. The results of the first part of the experiment performed under laboratory conditions at the Biology and Genetics Section of the Forensic Laboratory of the Provincial Police Headquarters in Poznań.

Substrate/sampling site	Sample no.	Type/quantity of material	Cleaning method	Sampling method	Amount of DNA [ng/µl] large/small DNA	Luminol	Hemophan	FOB	Result	LR
driver's door - exterior door handle	1G	blood /100 µl - gloves	vacuum cleaner	2 swabs	UN/0.0006	not tested	positive result	negative result	negligible amount of DNA	-
passenger door - exterior door handle	2G	contact trace	vacuum cleaner	2 swabs	UN/0.0004	not tested	not tested	not tested	negligible amount of DNA	-
driver's door - interior handle + window crank	3G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0003/0.0064	not tested	positive result	negative result	negligible amount of DNA	-
steering wheel - upper part	4G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0012/0.0055	not tested	positive result	negative result	negligible amount of DNA	-
steering wheel - lower part	5G	blood /100 µl - gloves	brush	2 swabs	0.0033/0.0117	not tested	positive result	negative result	mixture from at least 3 persons	6.18×10^{2}
key	6G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0009/0.0028	not tested	positive result	negative result	negligible amount of DNA	-
turn signal levers	7G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0004/0.0026	not tested	positive result	negative result	negligible amount of DNA	-
wiper switch	8G	blood /100 µl - gloves	vacuum cleaner	2 swabs	UN/0.0006	not tested	positive result	negative result	negligible amount of DNA	-
light switch	9G	blood /100 µl - gloves	vacuum cleaner	1 swab	UN/0.0002	not tested	positive result	negative result	negligible amount of DNA	-
gearshift knob	10G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0009/0.0031	not tested	positive result	negative result	negligible amount of DNA	-
handbrake lever	11G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0002/0.0032	not tested	negative result	not tested	negligible amount of DNA	-
driver's seat adjustment lever	12G	blood /100 µl - gloves	vacuum cleaner	2 swabs	UN/0.0004	not tested	positive result	negative result	negative	-
driver's seat belt + fastener	13G	blood /100 µl - gloves	vacuum cleaner	2 swabs	0.0003/0.0006	not tested	positive result	negative result	negligible amount of DNA	-
driver's headrest - right side	14G	blood /100 µl - gloves	vacuum cleaner	film	0.011/0.0233	not tested	negative result	not tested	mixture from at least 3 persons	3.28×10^{-17}
driver's headrest - left side	15G	blood /100 µl - gloves	brush	film	0.0009/0.0048	not tested	negative result	not tested	negligible amount of DNA	-
pedals	16G	blood / 200 µl each - shoes	vacuum cleaner	2 swabs	0.0119/0.019	not tested	positive result	positive result	mixture from at least 3 persons	6.98×10^{10}
driver's floor mat/ chemiluminescence area after luminol	17G	blood / 200 µl each - shoes	vacuum cleaner	4 swabs	0.3021/0.4031	positive result	positive result	negative result	mixture from at least 3 persons	9.78×10^{-4}
driver's floor mat/ chemiluminescence area after luminol	18G	blood / 200 µl each - shoes	brush	4 swabs	0.0082/0.0121	positive result	positive result	negative result	mixture from at least 2 persons	7.66×10^{16}
driver's floor mat/ chemiluminescence area after luminol	19G	blood / 200 µl each - shoes	brush	3 swabs	0.0063/0.0084	positive result	positive result	negative result	mixture from at least 2 persons	3.01×10^{14}
passenger door - interior handle + window crank	20G	contact trace	vacuum cleaner	2 swabs	0.0037/0.0132	not tested	not tested	not tested	mixture from at least 3 persons	8.00×10^{7}
glove box handle	21G	contact trace	vacuum cleaner	2 swabs	0.0059/0.0237	not tested	not tested	not tested	mixture from at least 4 persons	5.18×10^{1}
passenger seat adjustment lever	22G	contact trace	vacuum cleaner	2 swabs	0.0024/0.009	not tested	not tested	not tested	mixture from at least 2 persons	3.51×10^{1}
passenger seat belt + fastener	23G	contact trace	vacuum cleaner	2 swabs	0.0015/0.0054	not tested	not tested	not tested	negligible amount of DNA	-
passenger headrest - right side	24G	contact trace	vacuum cleaner	film	0.0023/0.008	not tested	not tested	not tested	mixture from at least 3 persons	4.02×10^{7}
passenger headrest - left side	25G	contact trace	brush	film	0.0021/0.0081	not tested	not tested	not tested	mixture from at least 2 persons	5.02×10^{1}
passenger floor mat/ chemiluminescence area after luminol	26G	blood/ 200 µl each - shoes	vacuum cleaner	3 swabs	0.0148/0.0234	positive result	positive result	positive result	mixture from at least 3 persons	4.65×10^{9}
passenger floor mat/ chemiluminescence area after luminol	27G	blood/ 200 µl each - shoes	vacuum cleaner	3 swabs	0.0348/0.0523	positive result	positive result	positive result	mixture from at least 3 persons	1.23×10^{9}
passenger floor mat/ chemiluminescence area after luminol	28G	blood/ 200 µl each - shoes	brush	3 swabs	0.0159/0.0174	positive result	positive result	positive result	mixture from at least 3 persons	5.98×10^{11}

Tab. 3. The results of the second part of the experiment performed on the military training ground.

ryc. 8 The interior of a Fiat Albea before the use of a fire extinguisher.

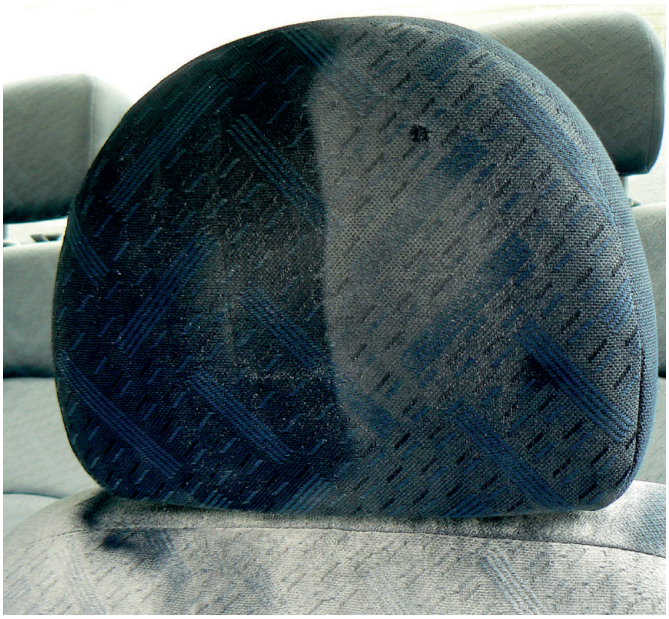
ryc. 9 Decontamination of the vehicle components.

ryc. 10. Applying blood to gloves.

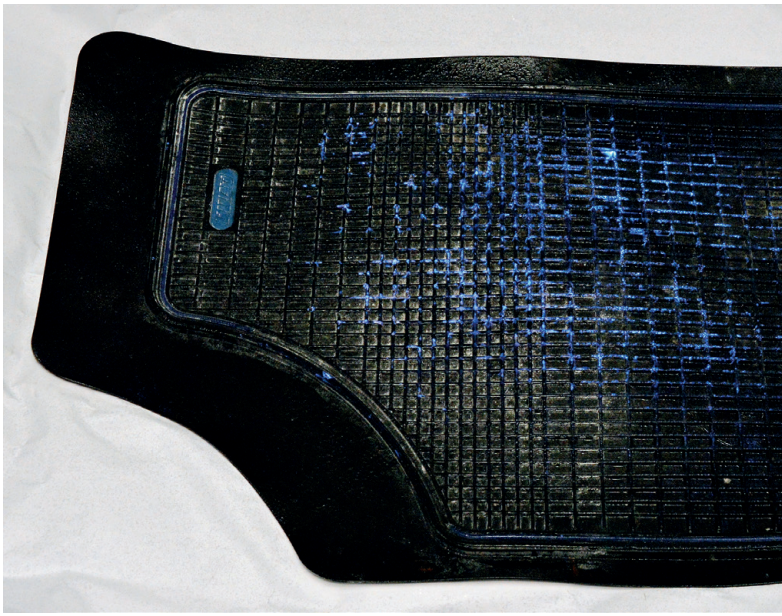
Fot. 11 Applying blood to shoes.

ryc. 12 The car interior after using the fire extinguisher.

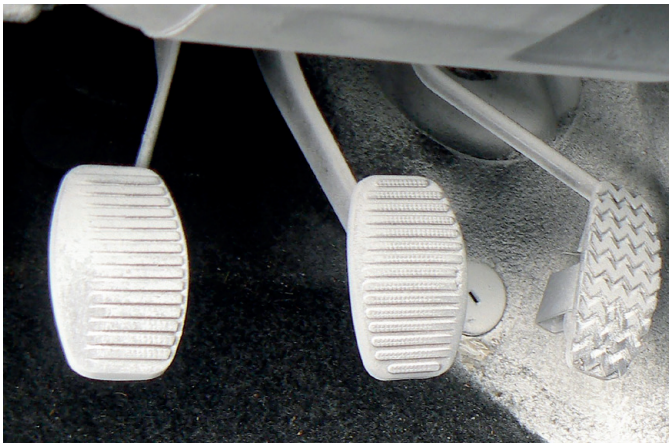
ryc. 13 The car interior 24 h from the use of the fire extinguishers



ryc. 15 The headrest after mechanical and manual removal of the fire extinguishing powder.



ryc. 14 The rubber floor mat after removal of fire extinguishing powder and application of luminol.



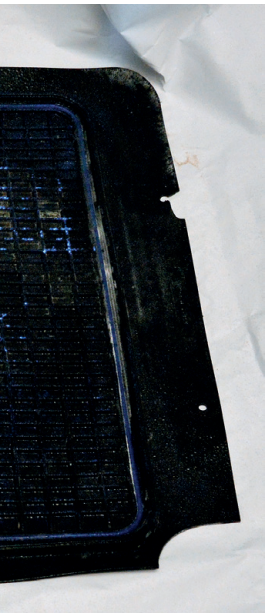
ryc. 16 The pedals after the use of a fire extinguisher.

ryc. 17 The pedals after removal of fire extinguishing powder.

The sampling sites for the genetic testing were selected on the basis of chemiluminescence after using a luminol solution. These areas were also tested with non-specific tests for the presence of blood and specific tests for the presence of human blood, with positive results for all samples in the non-specific test, and positive results for four samples in the test for the presence of human blood.

Conclusions

In conclusion, the experiment produced results clearly indicating the presence of DNA from proband II from contact traces, as well as from proband I, whose blood was used in the experiment. The fire extinguishing powder was not found to affect or significantly degrade the biological traces in a way that made them unidentifiable. In addition, both methods of removing the fire extinguishing powder from the tested items (‚gentle sweeping' and the use of a vacuum cleaner) yielded similar results. Only in the case of blood applied to floor mats in the laboratory, during the first part of the experiment, was a difference observed in the measurement of the amount of DNA, in favour of the ‚gentle sweep' method. In addition, under laboratory conditions, samples taken from a headrest soiled with blood and cleaned using the ‚gentle sweep' method yielded more alleles of the person who was the source of the trace than those cleaned with a vacuum cleaner. Contact between proband II and the substrate for 15 minutes was sufficient to determine his genetic profile from the contact traces taken with a film or swabs. After 5 minutes of contact between the blood-soiled gloves and the steering wheel, the genetic profile of proband I was obtained.



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The positive results of the tests for the presence of human blood were mainly obtained from samples taken from non-absorbent surfaces. In such a case, the conclusion is that 100 µl of blood applied to absorbent surfaces may be an insufficient amount for a positive result of this test, which does not categorically rule out its presence. On the other hand, this amount was sufficient to determine the genetic profile of proband I.

The fact that the results of the genetic test conducted in the military training ground were unidentifiable may be due to the brief contact of the proband II with elements of the car's equipment and the contact of biological material (blood) with many surfaces of the car's equipment.

It should be noted that the use of an extinguisher in an open area under windy conditions causes the extinguishing powder to disperse and settle on the substrate in smaller quantities. The environmental conditions and the quantity of the extinguishing powder can affect the quality of preliminary test results and genetic testing.

In summary, in the event of an attempt to obliterate biological traces by using fire extinguishing powder containing mainly sulphates and phosphates, it is still possible to preserve these traces and test them in order to identify the biological material and determine the genetic profile.

Very sparse literature reports support the authors' conclusions. According to a publication by French researchers, after contact with a fire extinguishing powder containing potassium bicarbonate, cells taken from the buccal mucosa do not degrade. These cells were applied to a primary slide, air-dried for 24 hours, then sprayed with a fire extinguishing powder and left for 24 hours. After 24 hours, a sample was collected on a water-moistened swab and then observed under a microscope, and DNA extracted, with positive results. A fire extinguishing powder containing potassium bicarbonate has no effect on mucosal cells or their DNA, and does not inhibit DNA amplification.

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