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Expert Witness

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I. OVERVIEW

The practice of bloodstain pattern analysis has been established by a considerable number of jurisdictions as a reliable science in criminal cases. The trend in many courts has been to allow qualification of blood spatter experts with very minimal training, namely police officers who attend a 40-hour seminar that is commonly taught by members of International Association of Bloodstain Pattern Analysis (IABPA). While this course teaches many rudimentary bloodstain pattern analysis skills, the practice of bloodstain analysis is a lengthy and complex matter *that cannot be mastered one 40-hour course* and this rudimentary course *does not teach the more advanced yet crucial skills needed for the practice*. Judges as “gatekeepers” of evidence should exercise greater vigilance than they have in the past, and *disallow* law-enforcement officers with only this rudimentary background to testify as “blood spatter” experts in court. In short, to be a blood spatter expert, requires much more education than this 40-hour course.

II. A SHORT HISTORY:

The first known study of blood spatters was done by Dr. Eduard Piotrowski at the Institute for Forensic Medicine in Poland.¹ In 1895, Dr. Piotrowski published the book *Über Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hieb- und Stichwunden des Kopfes* (retranslated as "Concerning the Origin, Shape, Direction and Distribution of the Bloodstains Following Head Wounds Caused by Blows").² His work was followed up by the forensic chemist Dr. Paul Jeserich, who investigated crime scenes in Berlin in the early 20th century, and then later, the French scientist Dr. Victor Balthazard who conducted original experiments with blood

¹ James, Stewart H., et al. *Principles of Bloodstain Pattern Analysis: Theory and Practice*. CRC Press, 2005. Pg. 3.

² *Id.* at 3-4.

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trajectories and patterns, later publishing *Etude Des Gouttes De Sang Projete* (retranslated as “Research on Blood Spatter”).³

The first legal milestone in Blood Spatter analysis occurred in *State v. Sheppard*, 128 N.E.2d 471 (Ohio Ct. App. 1955) *aff’d*, 135 N.E.2d 340 (1956). In this highly publicized case, Dr. Paul Kirk entered an affidavit concerning blood spatter evidence, purportedly showing the position of the assailant and the victim, as well as showing that the assailant struck the victim struck the victim with his left hand.⁴ This 1955 marked one of the earliest instances in the legal system recognizing blood spatter analysis in expert testimony.⁵

Then in 1971, Herbert Leon MacDowell led the movement towards further development of blood spatter analysis.⁶ Using a grant from the Law Enforcement Assistance Administration (LEAA), MacDowell performed research and experiments to recreate and duplicate blood stain patterns observed in crime scenes and published *Flight Characteristics and Stain Patterns of Human Blood*.⁷ In 1973, he established a training program for basic blood pattern interpretation and conducted his first Bloodstain Institute in Jackson, Mississippi.⁸ In 1983, participants in his advanced class for Bloodstain Pattern Analysis (BPA) formed the International Association for Bloodstain Pattern Analysis (IABPA).⁹

Since that time, MacDowell has published numerous new works and revisions, as have an assortment of other authors, including Terry L. Labor, Barton P. Epstein, William G. Eckert,

³ *Id.* at 4.

⁴ James, *supra*, at 4. Freeman, Shannon, *How Bloodstain Pattern Analysis Works*, <http://science.howstuffworks.com/bloodstain-pattern-analysis4.htm> (last visited April 15, 2014)

⁵ Freeman, *supra*.

⁶ James, *supra*, at 4.

⁷ *Id.*

⁸ *Id.*

⁹ *Id.*

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Stuart H. James, Ross Gardner, Tom Bevel, T. Paulette Sutton, and Anita Wonder, many of whom are part of the IABPA.¹⁰

Currently, most jurisdictions no longer view blood spatter to be a novel science and have taken judicial notice of the validity of blood spatter analysis in court.¹¹

III. ORGANIZATIONS

A. THE INTERNATIONAL ASSOCIATION OF BLOODSTAIN ANALYSIS (IAMPA)

The International Association of Bloodstain (IABPA) was formed in November 18, 1983 at the Hilton Hotel in Corning, NY by Herbert MacDowell and several of his students.¹² Of the 23 people present at the meeting, 22 became Charter Members.¹³

The organization was formed with the objective of promoting “education and encourage research in the discipline of bloodstain pattern analysis.”¹⁴ The organization seeks to do so by encouraging the study of bloodstain analysis, improving the practice, elevating the standards, and advancing the cause of this discipline by promoting the standardization of bloodstain pattern analysis, training, and reporting.¹⁵

¹⁰ *Id.* at 6.

¹¹ *Holmes v. State*, 135 S.W.3d 178, 195 (Tex. App. 2004); *Romano v. State*, 909 P.2d 92, 111–112 (Okla.Cr.1995); *State v. Goode*, 341 N.C. 513, 461 S.E.2d 631 (1995); *State v. Melson*, 638 S.W.2d 342, 363 (Tenn.1982); *State v. Moore*, 458 N.W.2d 90, 96 (Minn.1990); *Hampton v. State*, 588 N.E.2d 555, 557 (Ind. Ct.App. [1st Dist.] 1992); *Robinson v. State*, 574 So.2d 910, 918 (Ala.Crim.App.1990); *Smith v. Commonwealth*, 265 Va. 250, 576 S.E.2d 465 (Virginia 2003); *People v. Haywood*, 209 Mich.App. 217, 530 N.W.2d 497, 500 (1995); *State v. Roberts*, 142 Wash.2d 471, 14 P.3d 713, 740–741 (2000); *People v. Whitaker*, 289 A.D.2d 84, 734 N.Y.S.2d 149 (2001);

¹² Wikipedia, *International Association of Bloodstain Pattern Analysts*, <http://en.wikipedia.org/wiki/IABPA> (last visited April 15, 2014).

¹³ *Id.*

¹⁴ International Association Of Bloodstain Pattern Analysts, *By Laws Amended October 5, 2011*, <http://www.iabpa.org/uploads/files/Bylaws/Bylaws%20-%202010-05-11.pdf> (last visited April 15, 2014)

¹⁵ *Id.*

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In 2004, the IABPA organization consisted of well over 750 members throughout the world, including the United States, Canada, Great Britain, Denmark, Finland, Sweden, Norway, the Netherlands, Norway, New Zealand, Australia, Taiwan, Guam, and Columbia.¹⁶ The association regularly publishes the IABPA News, which details current bloodstain topics, provides a schedule of training courses, and explores the curriculum in basic instructional classes.¹⁷ The annual IABPA conference presents case presentations and research topics by members and guest lecturers.¹⁸

B. THE SCIENTIFIC WORKING GROUP ON BLOODSTAIN PATTERN ANALYSIS (SWGSTAIN)

In March 2002, the FBI created the Scientific Working Group on Bloodstain Pattern Analysis (SWGSTAIN) at a meeting held by the FBI Laboratory at the FBI Academy in Quantico, Virginia.¹⁹ SWGSTAIN generated and ratified a set of bylaws in accordance with the Scientific Working Groups published in Forensic Science Communications (July 2002). According to its website, the objectives of SWGSTAIN are to:

1. To discuss, share and compare stain pattern analysis methods, protocols, and research for the enhancement of forensic bloodstain pattern analysis (BPA) techniques, and
2. To design and encourage the implementation by practitioners of a quality assurance program in bloodstain pattern analysis and to advise the forensic bloodstain pattern analysis community of emerging quality assurance issues, and
3. To discuss and share strategies for presenting bloodstain pattern information to meet *Frye*, *Daubert*, or other jurisdictional admissibility challenges, and
4. To address the development and/or validation of forensic bloodstain pattern analysis methods, and

¹⁶ James, *supra*, at 7.

¹⁷ *Id.*

¹⁸ *Id.*

¹⁹ The Scientific Working Group On Bloodstain Pattern Analysis (SWGSTAIN), *SWGSTAIN History*, https://8927d5bd-a-377b95c6-sites.google.com/a/swgstain.org/public/documents/SWGSTAINHistory.pdf?attachauth=ANoY7cq2QbTITFT Rdl8_uXTvPgxSvCZfRrbgVjkgGavjc8mCOJ5ISgNBIDGjUbzV_IQ2NV56T6el25C8TTx3mFBZfntlgikaqLMvWNcNv3Aofmy7IYDRQRwKKtKZ8-uuwBdt-ZhzcRV9BwBDZTg2Hoqp0Ds56vL69gOz1vAmyA66_6l0yQqCzKev_MghU0BgY0ZsvXfOJdJ1Kot4IbjWMJNdk_g3K369C9rTepQvLvekg9aoxCHA8g1U%3D&attredirects=0 (last visited April 15, 2014)

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5. To design and encourage the adoption of guidelines to ensure the quality of specialized training in the field of bloodstain pattern analysis.²⁰

In accordance with its bylaws, membership is organized into six standing subcommittees that concentrate on different substantive areas of BPA. These subcommittees are: Business and Strategic Planning, Legal, Quality Assurance, Research, Taxonomy and Terminology, and Training and Education.²¹

SWGSTAIN has nationally and internationally recognized bloodstain pattern analysts, several of whom are members of the International Association of Bloodstain Pattern Analysts (IABPA).²² These experts come from various different fields, including law enforcement, federal, state and local laboratories, the private sector, and academia, as well as different countries such as the United States, Canada, England, and the Netherlands.²³ SWGSTAIN meets twice a year at the FBI Academy in Quantico.²⁴

IV. LEGAL ANALYSIS

A. Legal Theory: What is Required to Be an Expert

The federal rules of evidence provide that,

A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

- (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- (b) the testimony is based on sufficient facts or data;

²⁰ The Scientific Working Group On Bloodstain Pattern Analysis (SWGSTAIN), *SWGSTAIN Homepage*, <http://www.swgstain.org/Home> (last visited April 15, 2014)

²¹ The Scientific Working Group On Bloodstain Pattern Analysis (SWGSTAIN), *SWGSTAIN Homepage*, <http://www.swgstain.org/subcommittees> (last visited April 15, 2014).

²² Wikipedia, *SWGSTAIN*, <http://en.wikipedia.org/wiki/SWGSTAIN> (last visited April 15, 2014).

²³ *Id.*

²⁴ *Id.*

(c) the testimony is the product of reliable principles and methods; and

(d) the expert has reliably applied the principles and methods to the facts of the case.²⁵

Thus, there are five requirements that must be met: (1) the expert must be qualified, (2) the testimony will aid the trier of fact, (3) the testimony is based on sufficient facts, (4) the testimony is the product of reliable principles and methods, and (5) the expert reliably applied the principles and methods to the facts of the case. Only the first requirement, that the expert must be “*qualified*” is explored herein.

Qualification “requires that the witness possess specialized expertise, which encompasses a broad range of knowledge, skills, and training.”²⁶ If the expert testimony falls outside of the witness' expertise, it should be excluded.²⁷ An “expert” will be deemed qualified if, and only if, he possesses special skill or knowledge respecting the subject matter involved, so that his opinion will have a reliable basis in the knowledge and experience of his discipline.²⁸ The Fifth Circuit has found that a trial judge is justified in rejecting an expert's opinion who is found to not be in accord with recognized experts in his field of expertise.²⁹

Interpreting Rule 702 in *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579 (1993), the U.S. Supreme Court held that “under the [Federal] Rules [of Evidence] the trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable.”³⁰ Finding its basis in Fed. R. Evid. 104 and 702, the *Daubert* court charged trial judges with a “gatekeeping” duty.³¹ It is clear that as a “gatekeeper”, the court should assess the

²⁵ Fed. R. Evid. 702

²⁶ *Keller v. Feasterville Family Health Care Ctr.*, 557 F. Supp. 2d 671, 675 (E.D. Pa. 2008); See *Pineda v. Ford Motor Co.*, 520 F.2d 237, 244 (3d. Cir. 2008).

²⁷ *Id.*

²⁸ *Daubert*, supra, 509 U.S., at 592.

²⁹ See *Munoz v. Orr*, 200 F.3d 291, 301 (citing *Kumho Tire*, 119 S. Ct. at 1176).

³⁰ *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579, 589 (1993)

³¹ *Id.*

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reliability of an expert before a jury is asked to weight the opinion.³² The “gatekeeper” function of a trial judge under Fed. R. Evid. 702 requires that the trial judge “ensure that the expert’s testimony is both relevant and reliable before it may be admitted, regardless of whether the testimony is scientific or based on technical or other specialized knowledge.”³³

Thus, in performance of their “gate-keeping” function, trial judges have a duty to assess the reliability and relevance of an expert testimony. One of the requirements for Rule 702 is that the purported expert be qualified. In this case, any purported blood spatter expert should “possesses special skill or knowledge” in the discipline of blood spatter and his/her opinion should have “a reliable basis in the knowledge and experience” of this discipline. Should the purported expert lack this qualification, a trial court has the duty and obligation in their “gate-keeping” function to bar the purported expert from testifying on blood spatter evidence.

That is the legal theory. We examine below how this theory has been applied in practice.

B. Application of the Law: How Have Courts Been Performing their Gatekeeping Function with Respect to Blood Spatter Experts?

It has been held by many jurisdictions that experts with a general background in scientific studies, such as physics, chemistry, or forensic science, are qualified to testify as blood splatter experts for both the state³⁴ and the defense³⁵. Similarly, those with backgrounds in medical

³² *Castellow v. Chevron USA*, 97 F. Supp. 2d 780, 784 (S.D. Tex. 2000).

³³ *United States v. Lewis*, 220 F.Supp.2d 548, 551 (S.D.W.Va. 2002) (citing *Kumho Tire Co. v. Carmichael* 526 U.S. 137, 147 (1999)).

³⁴ *People v. Carter*, 48 Cal 2d 737 (1957); *State v. Rodgers*, 119 Idaho 1047 (1991); *State v. Melson*, 638 S.W.2d 342 (Tenn. 1982); *Cortijo v. State*, 739 S.W.2d 486 (Tex. App. Corpus Christi 1987); *Fox v. Ward*, 200 F.3d 1286 (10th Cir. 2000); *Broadnax v. State*, 825 So. 2d 134 (Ala. Crim. App. 2000); *Flowers v. State*, 373 Ark. 127, 282 S.W.3d 767 (2008); *People v. Hoyos*, 41 Cal. 4th 872, 63 Cal. Rptr. 3d 1, 162 P.3d 528 (2007); *People v. Bolin*, 18 Cal. 4th 297 (1998); *State v. Hartman*, 93 Ohio St. 3d 274, 754 N.E.2d 1150 (2001); *Com. v. Begley*, 780 A.2d 605 (Pa. 2001); *Com. v. Puksar*, 740 A.2d 219 (Pa. 1999).

³⁵ *State v. Myers* 301 SC 251, 391 S.E.2d 551 (1990); *Fox v State*, 506 N.E.2d 1090 (Ind. 1987);

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fields, such as coroners, medical examiners, pathologists, serologists, or the like, were held by various jurisdictions to be qualified to testify as experts on blood spatter.³⁶

Courts have also accepted testimony from crime scene investigators, evidence technicians, and detectives who do not necessarily have scientific backgrounds. There are a leading number of cases wherein criminologists were held to be qualified³⁷, as well as police officers³⁸. In fact, most analysts begin as law-enforcement officers who learn on the job, acquire certifications and take courses, workshops and seminars.³⁹

Most of the experts qualified in these cases had extensive education and experience. However, in several cases, the experts had very minimal training in blood spatter, yet the courts still allowed the purported expert to testify. In *Broadnax v. State*, a forensic scientist was held to be qualified on the mere basis that he had completed training workshops on interpretation of bloodstains held by FBI Academy and International Association of Bloodstain Pattern Analysis.⁴⁰ Similarly in *State v. Myers*, the court held it was prejudicial error to exclude the

³⁶ *Robinson v State*, 574 So 2d 910 (Ala. Crim. App. 1990); *State v Rodgers*, 119 Idaho 1047 (1991); *State v Satterfield*, 3 Kan App 2d 212, 592 P2d 135 (1979); *Whittington v State*, 523 So 2d 966 (Miss. 1988); *Wheeler v. Com.*, 121 S.W.3d 173 (Ky. 2003), *Walker v. State*, 740 So. 2d 873 (Miss. 1999). *Flaggs v. State*, 999 So. 2d 393 (Miss. Ct. App. 2008), *People v. Boozer*, 748 N.Y.S.2d 379 (App. Div. 1st Dep't 2002); *King v. State*, 531 N.E.2d 1154 (Ind. 1988); *State v Moore*, 458 N.W.2d 90 (Minn. 1990); *State v Mix*, 239 Mont 351 (1989); *State v Davolt*, 84 P.3d 456 (Ariz. 2004); *State v Bruton*, 600 S.E.2d 49 (N.C. Ct. App. 2004); *State v Cazes*, 875 S.W.2d 253 (Tenn. 1994).

³⁷ *United States v Mustafa*, 22 MJ 165 (C.M.A. 1986); *Robinson v State*, 574 So 2d 910 (Ala. Crim. App. 1990); *Droke v. State*, 252 Ga 472, 314 S.E.2d 230 (1984); *State v Hall*, 297 NW2d 80 (Iowa 1980); *State v Williams*, 445 So.2d 1171 (La. 1984); *State v Powell*, 598 So 2d 454 (La. Ct. App 2d Cir. 1992); *State v Moore*, 458 N.W.2d 90, 9 ALR5th 1058 (Minn. 1990); *State v Chiellini*, 557 A2d 1195 (R.I. 1989); *People v. Wallace*, 81 Cal. Rptr. 3d 651, 189 P.3d 911 (Cal. 2008); *People v. Farnam*, 28 Cal. 4th 107, 121 Cal. Rptr. 2d 106, 47 P.3d 988 (2002); *Everett v. State*, 54 So.3d 464 (Fla. 2010); *Jones v. State*, 287 Ga. 770, 700 S.E.2d 350 (2010); *State v Raudebaugh*, 864 P2d 596 (Idaho 1993); *People v. Evans*, 859 N.E.2d 642 (Ill. App. Ct. 4th Dist. 2006); *People v Smith*, 633 N.E.2d 69 (Ill. 4th Dist. 1994); *State v Barton*, 240 S.W.3d 693 (Mo. 2007); *State v Biros*, 78 Ohio St. 3d 426, 678 N.E.2d 891 (1997); *Com. v. Pukzar*, 740 A.2d 219 (Pa. 1999).

³⁸ *Leonard v State*, 551 So. 2d. 1143 (Ala. Crim. App. 1989); *Pedersen v State*, 420 P.2d 327 (Ala. 1966); *People v Knox*, 459 N.E.2d 1077 (Ill. 3d Dist. 1984); *Hampton v State*, 588 N.E.2d 555 (Ind. App. 1992); *State v Moore*, 122 N.J. 420 (1991); *Farris v State*, 670 P.2d 995 (Okla. Crim. App. 1983).

³⁹ Freeman, *supra*, <http://science.howstuffworks.com/bloodstain-pattern-analysis3.htm>

⁴⁰ *Broadnax v. State*, 825 So. 2d 134, 176 (Ala. Crim. App. 2000).

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testimony of a defense witness on the matter of blood spatter.⁴¹ Though she had been a forensic science investigator for eight years, had attended approximately one hundred forensic crime scenes, and assisted with one thousand or more autopsies, she had limited knowledge and experience related specifically to blood spatter, having only attended a one week seminar on the characteristics of blood stain evidence taught by Professor Herbert McDonald.⁴² The *Myers* court specifically cited *Fox v. State*, where in that case the appellate court found no abuse of discretion in allowing a police officer to testify on the topic of blood spatter analysis.⁴³ In that matter, the officer's only qualifications were that he attended a school for approximately one to two weeks for the study of bloodstains and interpretation of blood spattering and had occasion to examine blood spattering evidence in connection with one prior murder, but had never testified in a trial on blood spattering.⁴⁴ This minimal one-week training is prevalent in a lot of other cases as well. In a U.S. Court of Military appeals, the court held that a military investigator who had attended a 5-day course on blood spatter subject by Professor Herbert L. MacDonell was qualified to testify as to blood spatter.⁴⁵ In two Texas cases, police officers were held to be sufficiently qualified as to blood spatter analysis when they had completed a "level one" training program, which consisted of 40-50 hours of classes on blood spatter analysis over a one-week period.⁴⁶ Similarly in *State v. Stout*, a police officer was held to be qualified because he had completed a one week course in blood spatter evidence.⁴⁷ Perhaps the most extreme example of allowing minimal requirements as to blood spatter expertise occurred in *State v. Moore*⁴⁸. The State's witness

⁴¹ *State v. Myers*, 391 S.E.2d 551, 554 (1990).

⁴² *Id.*

⁴³ *Fox v. State*, 506 N.E.2d 1090, 1095 (Ind. 1987).

⁴⁴ *Id.*

⁴⁵ *United States v. Mustafa*, 22 MJ 165, 166-68.

⁴⁶ See, *Turner v. State*, 252 S.W.3d 571 (Tex. App. Houston 14th Dist. 2008); and, *Holmes v. State*, 135 S.W.3d 178 (Tex. App. Waco 2004).

⁴⁷ *State v. Stout*, 2010 MT 137, 356 Mont. 468, 237 P.3d 37 (2010).

⁴⁸ *State v. Moore*, 122 N.J. 420, 458 (1991)

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testified he'd been a member of the state police for 8 years and an investigator for 2 years.⁴⁹ He had investigated more than 200 crime scenes, at least 30 of them homicides, and had previously testified as an expert in crime scene analysis.⁵⁰ However, he had never before testified as a blood splatter analysis expert, and his training in blood spatter was limited to only a 1-day seminar in blood splatter analysis, which had been supplemented by another day of in-service training.⁵¹ Although the court found his "expertise may have been minimal", it held that the admission of his testimony did not constitute plain error.⁵²

Only in a few cases were purported experts disqualified. In *People v. Owens*, the court held that a police officer's testimony concerning his blood splatter analysis was improperly admitted, because the prosecution provided no evidence of the officer's training or experience in the field of blood-spatter analysis.⁵³ The court found that although the officer stated that he had studied blood spatter technique under Professor McDonald, this testimony was not sufficient in to establish his qualifications.⁵⁴ Similarly, in *State v. Philbrick*, an officer testified that he had received "special training in blood spatters (a three-week course) in New York State under Professor Herbert MacDonald."⁵⁵ The court noted that the trial court failed to determine whether blood splatter analysis was scientifically reliable enough to provide the basis for expert opinion testimony, and *further* declared that the detective's testimony regarding his training course *alone* might have called his qualifications into question.⁵⁶ The court in *People v Hogan* found that a

⁴⁹ *Id.*, at 458.

⁵⁰ *Id.*

⁵¹ *Id.*

⁵² *Id.*, at 459-460.

⁵³ *People v. Owens*, 508 N.E.2d 1088, 1094-95 (1987).

⁵⁴ *Id.*

⁵⁵ *State v. Philbrick*, 436 A.2d 844, 860 (Me. 1981).

⁵⁶ *Id.*

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criminologist was unqualified to offer testimony concerning blood spatter.⁵⁷ The purported expert never performed any laboratory analyses either in the past or in the present case, and he had admitted he never received any formal education or training.⁵⁸ *Id.* His only background on the subject consisted of “viewing some years prior an exhibit, which had since been discarded, prepared by some unknown criminalist which demonstrated patterns of human blood dropped from various heights and angles” and having read a book about flight patterns of blood. The court found this insufficient ground for qualification.⁵⁹ *Id.*

Nevertheless, considering that the cases that *refused* to qualify these witnesses as experts in blood spatter all occurred in the *1980's* (when the field of blood spatter analysis was still novel), the trend in courts today (as witnessed by the case law above) appears to be *to allow experts to testify as to blood spatter analysis if they've completed the minimal 1-week course*. If most analysts begin as law-enforcement officers who learn on the job and take these courses, it begs the question as to just what is learned at these 1- week courses that suddenly makes them “experts”?

V. EDUCATION:

Bloodstain analysts come from a wide variety of different and diverse areas of educational background.⁶⁰ As aforementioned, courts have accepted testimony from those with strong backgrounds in chemistry, physics, and biology, many of whom possess degrees in scientific or forensic medicine.⁶¹ According to *Principles of Bloodstain Pattern Analysis: Theory*

⁵⁷ *People v. Hogan*, 31 Cal. 3d 815, 852 (1982).

⁵⁸ *Id.*

⁵⁹ *Id.*

⁶⁰ James, *supra*, at 9.

⁶¹ *Id.*

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and Practice, it is suggested that taking college level courses in trigonometry, geometry, and physics are valuable assets for understanding BPA.⁶²

SWGSTAIN recommends that the minimum pre-training requirements for a bloodstain pattern analysis trainee involve a bachelor's degree in a field related to BPA at an accredited college, an associate's degree and 2 years of job-related experience, or a high school diploma and four years job-related experience.⁶³ Job related experience could include working as a crime scene technician, criminalist, or homicide/criminal investigator.⁶⁴ Other organizations, such as the International Association for Identification (IAP), offer courses which lead to certification in blood spatter analysis.⁶⁵ The Royal Canadian Mounted Police and the Ontario Police College both offer bloodstain pattern analysis understudy programs to law-enforcement officers.⁶⁶ The latter program is open to international candidates.⁶⁷

For the most part, however, many train in bloodstain pattern analysis through the IABPA. The IABPA developed criteria for the Basic Bloodstain Pattern Analysis Course, an introductory 40-hour course on the subject.⁶⁸ Provisional membership with the IABPA requires a recommendation by a 'Full' IABPA member and the completion of a forty-hour basic bloodstain pattern analysis course.⁶⁹ The IABPA details the purposes and requirements of this forty-hour course. Upon completion of the course the IABPA maintains that the student should be able to:

⁶² *Id.*

⁶³ The Scientific Working Group On Bloodstain Pattern Analysis (SWGSTAIN), *SWGSTAIN Homepage*, <http://www.swgstain.org/documents/SWGSTAINEDandTrainpublishedversion.pdf?attredirects=0&d=1> (last visited April 15, 2014).

⁶⁴ *Id.*

⁶⁵ Freeman, Shannon, *How Bloodstain Pattern Analysis Works*, <http://science.howstuffworks.com/bloodstain-pattern-analysis3.htm> (last visited April 15, 2014).

⁶⁶ *Id.*

⁶⁷ *Id.*

⁶⁸ Freeman, *supra*, <http://science.howstuffworks.com/bloodstain-pattern-analysis3.htm> (last visited April 15, 2014).

⁶⁹ IABPA, *How to Become a Member of the IABPA*, <http://www.iabpa.org/how-to-become-a-member>

- Demonstrate knowledge of the development, history and advancement of bloodstain pattern analysis.
- Demonstrate knowledge of the inherent limitations of bloodstain pattern analysis.
- Recognize key bloodstain patterns and understand the mechanism by which they are created.
- Determine impact angles for individual bloodstains.
- Determine a probable point (area) of convergence for a group of bloodstains.
- Demonstrate the ability to combine point (area) of convergence with impact angle to locate the probable point of origin for a given blood spatter event.
- Recognize proper protective measures to follow in a bloodstained scene.
- Demonstrate knowledge of the methods of documenting bloodstain scenes, both photographically and in written format.
- Demonstrate an ability to evaluate a basic bloodstain pattern scene⁷⁰

On its website, the IABPA maintains a syllabus setting out the course requirements for the 40-hour basic bloodstain pattern analysis program.⁷¹ The syllabus divides the requirements into seven major sections. The first section is titled “Introduction to Bloodstain Pattern Analysis” and includes topics such as the purpose of bloodstain pattern analysis, the history of it, the application of the scientific method, biohazards associated with the study, characteristics of blood under force and on impact, and limitations in bloodstain pattern analysis.⁷² The second section deals with the recognition and creation of basic stain patterns including passive stains (drip, flow, pools, and saturation), projected and impact spatter stains (impacts, splashes, cast-off, arterial sprout and gush, and exhaled), transfer stains (wipe, swipe, and transfer/contact), and miscellaneous stains (void, fly spot, bubble, and perimeter/skeletonized).⁷³ The third section is allotted to determining point/area of origin, including topics that evaluate and select appropriate stains for inclusion, determining the impact angle for a variety of well-formed bloodstains “to an acceptable error level of +/- five degrees,” determining directionality in a variety of bloodstain shapes, determine point/area of convergence, applying “stringing” and/or

⁷⁰ IABPA, *Bloodstain Pattern Analysis Basic Course Requirements*, <http://www.iabpa.org/uploads/files/Training%20Page%20Documents/RevEduc.pdf> (last visited April 15, 2014)

⁷¹ *Id.*

⁷² *Id.*

⁷³ *Id.*

mathematical methods for point/area of origin, recognizing when point/area of origin determinations are either impractical or impossible, and using forensic software designed for making point/area of origin determinations.⁷⁴ The fourth and fifth sections deal with the correlation of bloodstain pattern analysis with other forensic evidence and documenting forensic evidence, respectively.⁷⁵ The sixth section is allotted for the minimal necessary practical exercises the course should include.⁷⁶ The section requires that the course have nine practical exercises that consist of stain shape as a function of impact angle, diameter of individual stains as a function of distance fallen and droplet volume, creation and causation of cast-off patterns, creation of impact spatter resulting from blunt trauma force, creation of impact spatter resulting from explosive force, creation of projected blood patterns, creation of transfer patterns, creation and recognition of blood trails, and drying times of blood.⁷⁷ Finally, the last section deals with administrative requirements. These include:

1. A pretest designed to test the students understanding of the key objectives,
2. A practical based or written examination process designed to test the student's comprehension of the key objectives.
3. A course handbook or manual, which describes the practical exercises and provides space for writing notes and observations.
4. The creation of individual standards of key bloodstains patterns, by each student.
5. A certificate of completion describing the dates of training, the number of hours completed, the name of the instructor(s) and the location of training.
6. A course evaluation form, maintained by the instructor.⁷⁸

⁷⁴ *Id.*

⁷⁵ *Id.*

⁷⁶ *Id.*

⁷⁷ *Id.*

⁷⁸ *Id.*

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Aside from these basic requirements in the syllabus, there are no other requirements mentioned. Thus, while the syllabus provides guidance on a number of *practical* requirements for the course, the core of the *actual content* taught by this course is encompassed by third and fourth sections, dealing with *bloodstain pattern recognition* and *point/area of origin*.

We review the complexity of bloodstain pattern recognition and point/area of origin in detail detail below to determine the *plausibility* of a law-enforcement officer – with no other training than this forty-hour course – to be considered an “expert” in blood spatter analysis.

VI. TRADITIONAL BLOODSTAIN ANALYSIS

A. Overview

The foundations of bloodstain analysis are based upon basic and traditional hard sciences, namely biology, mathematics, and physics.⁷⁹ Bloodstain analysis relies upon classic Newtonian physics principles that incorporate viscosity, surface tension, and volume.⁸⁰ Viscosity is “defined as a fluid's internal resistance to flow”.⁸¹ Surface tension is defined as “the result of cohesive forces between molecules of a liquid”.⁸² Surface tension has also long been regarded as the explanation for blood behavior, such as its spherical shape (but, as will be explained later, this theory has been replaced by modern theory).⁸³ The volume of a single drop of blood has been widely accepted to be five hundredths of a milliliter.⁸⁴

In theory, blood spatter pattern analysis can be used to recreate elements of a crime because of how blood behaves. Blood exits the body as a liquid, following the laws of motion

⁷⁹ Gopen, Aaron D. and Inwinkelried, Edward J., *Bloodstain Pattern Revisited*, 45 No. 3 Crim. Law Bulletin ART 7.

⁸⁰ *Id.*

⁸¹ *Id.*

⁸² *Id.*

⁸³ *Id.*

⁸⁴ *Id.*

and gravity.⁸⁵ Like other liquids, it travels in spherical drops due to surface tension.⁸⁶ Due to a property known as cohesion, blood molecules are tightly attracted to each other, squeezing against each other until they form a shape with the smallest area possible.⁸⁷ These drops behave in predictable ways when they strike a surface or a force acts upon them.⁸⁸ Using physics, trigonometry, and basic knowledge on biological/chemical properties of blood, the analyst can by observing the blood spatter patterns, deduce the mechanisms that caused the formation of such patterns.⁸⁹

Traditional biology tells us that roughly fifty five percent of blood is composed of plasma.⁹⁰ Plasma consists of roughly ninety percent water and ten percent dissolved proteins.⁹¹ This assumed composition of blood affects what a bloodstain pattern analyst would assume the mass of a drop of blood to be, as well as viscosity and surface tension of that drop of blood.⁹²

Applying classical Newtonian physics principles, if an individual drop of blood falls directly downward onto a smooth surface, it will produce a round stain.⁹³ Drops that are the same volume leave the same size stain if they hit the ground at the same speed.⁹⁴ The speed of a falling drop on impact is determined by the height that it has fallen.⁹⁵ Eventually, however, a standard drop will reach terminal velocity if it falls more than seven feet vertically downward and will not

⁸⁵ Shannon, *How Bloodstain Pattern Analysis Works*, <http://science.howstuffworks.com/bloodstain-pattern-analysis1.htm> (last visited April 15, 2014)

⁸⁶ *Id.*

⁸⁷ *Id.*

⁸⁸ *Id.*

⁸⁹ Gopen, *supra*. James, *supra*, at 67-68.

⁹⁰ Gopen, *supra*.

⁹¹ *Id.*

⁹² *Id.*

⁹³ *Id.*

⁹⁴ *Id.*

⁹⁵ *Id.*

increase its speed regardless of any extra distance that it falls.⁹⁶ However, more massive blood drops can attain greater terminal velocities, leave larger stains, and require more than seven feet to reach terminal velocity.⁹⁷ Blood which is affected by forces other than just gravity — such as caused by a gunshot — is capable of achieving much higher speeds on impact with a surface.⁹⁸ The greater speed will significantly alter the size and shape of the stain.⁹⁹ By observing the size and shape of the pattern, an analyst can thus infer the kinds of causes attributed to the stain.¹⁰⁰

B. Classifying Blood Stain Patterns

A lot of blood spatter pattern analysis is devoted to classification of bloodstains. As noted earlier, section 2 of the IABPA's syllabus deals with the *recognition and creation of bloodstain pattern analysis*.¹⁰¹ Bloodstain analysts are trained to identify the appearance of the bloodstain with its classification, so that they can infer the mechanism that caused the stain.¹⁰²

Conventional classification placed bloodstains in three different categories: **low velocity** impact blood spatter, **medium velocity** impact blood spatter, and **high velocity** blood spatter.¹⁰³ These categories were based upon the size of bloodstain being inversely proportional to the force applied to the static blood.¹⁰⁴ In other words, the higher the velocity, the smaller the stain will be. There were some problems with this classification, including the overlapping between medium

⁹⁶ *Id.*

⁹⁷ *Id.*

⁹⁸ *Id.*

⁹⁹ *Id.*

¹⁰⁰ *Id.*

¹⁰¹ IABPA, *Bloodstain Pattern Analysis Basic Course Requirements*, <http://www.iabpa.org/uploads/files/Training%20Page%20Documents/RevEduc.pdf> (last visited April 15, 2014)

¹⁰² James, *supra*, at 67-68.

¹⁰³ *Id.*, at 7-8.

¹⁰⁴ *Id.*

and high velocity categories and the realization that mechanisms other than beatings, stabbings, and gun shots produced stains within the size categories.¹⁰⁵

Many bloodstain analysts have chosen to discontinue the conventional classification in favor of a more holistic approach.¹⁰⁶ According to *Principles of Bloodstain Pattern Analysis: Theory and Practice*, bloodstains are categorized in three general classifications: **passive stains**, **spatter stains**, and **altered stains**.¹⁰⁷ Placement into each of these categories depends upon physical features such as size, shape, location, concentration and distribution.¹⁰⁸ These stains are further classified in sub-categories relative to mechanisms that may produce stains with those characteristics.¹⁰⁹ Each of these main categories, along with their subcategories are described below.

The first primary category of bloodstains, **passive bloodstains**, includes patterns in whose physical features indicate that they were created without any significant force other than gravity and friction.¹¹⁰ Passive patterns include subcategories that include **transfer**, **drop**, **flow**, and **large volume patterns**.¹¹¹

A **transfer bloodstain** pattern is created “when a wet, bloody surface contacts another surface”.¹¹² The term also applies to the “physical alteration of an existing wet bloodstain caused by a nonbloody object touching or moving through it.”¹¹³ Transfer stains can be used to establish movement and activities of the victim and assailant during and after the attack. A **swipe** is a

¹⁰⁵ *Id.*

¹⁰⁶ *Id.*, at 8.

¹⁰⁷ *Id.*

¹⁰⁸ *Id.*

¹⁰⁹ *Id.*

¹¹⁰ *Id.*, at 71.

¹¹¹ *Id.*, at 72.

¹¹² *Id.*, at 88.

¹¹³ *Id.*

“transfer stain resulting from a moving object wet with blood contacting a non bloody surface that may exhibit directionality.”¹¹⁴ (A wipe is another kind of transfer pattern, but is categorized as an altered stain, not a passive stain and is described later).

Drip patterns are created when multiple free-falling drops of blood fall onto a horizontal, stationary surface and fall onto previously deposited wet bloodstains or a pool of blood.¹¹⁵ Drip patterns are “large and irregular in shape with small circular to oval satellite spatters around the periphery of the central stain.”¹¹⁶ **Satellite spatters** are “the result of smaller droplets of blood that have detached from the main blood volume at the moment of impact.”¹¹⁷ **Drip trails** are patterns that occur when drop patterns are “subjected to a horizontal force in addition to gravity”.¹¹⁸ Drip trails are used to establish directionality, such as when a bleeding person walks away.¹¹⁹

A **flow pattern** is an accumulation of a volume of blood with generally regular margins that has moved across a surface from one point to another as a result of the influence of gravity and the contour of the surface.¹²⁰ Directional changes in flow patterns may show changes in the position of the person or object, such as movement of victim during bloodshed or even postmortem.¹²¹

¹¹⁴ *Id.* at 89.

¹¹⁵ *Id.*, at 76.

¹¹⁶ *Id.*

¹¹⁷ *Id.*, at 77.

¹¹⁸ *Id.*, at 79

¹¹⁹ *Id.*

¹²⁰ *Id.*, at 84.

¹²¹ *Id.*

Large volume patterns are blood spatters resulting from large volumes of blood. Three categorizations of large volume patterns include splash, blood pools, and saturation stains.¹²² A **splash pattern** occurs “when a quantity of blood in excess of 1.0 mL is subjected to a minor impact (such as stepping into a pool of existing blood) or is allowed to free-fall at least 4 inches to a surface affected only by the force of gravity.”¹²³ Splashed bloodstain patterns are “usually characterized by a large central stain exhibiting minimal distortion with surrounding, long, narrow spatters.”¹²⁴ A **blood pool** is an “accumulation of a volume of blood on a surface whose shape is not specific but it conforms to the surface contour”.¹²⁵ A pool of blood is often associated with extensive bleeding of a victim in a position that allows the accumulation to occur.¹²⁶ A **saturation stain** is an “accumulation of a volume of blood without specific shape that has absorbed into the surface rather than pooled on top of the surface”.¹²⁷ Large saturation stains can occur on carpets, bedding, clothing, and other material when there has been extensive bleeding by a victim.¹²⁸

The second main category of blood stains, **spatter patterns**, are patterns associated with the use of an external force(s), in addition to gravity and friction. They include **impact mechanism**, **secondary mechanism**, and **projection mechanism** as subcategories.¹²⁹

Impact spatter results from an object directly striking a source of exposed blood. These patterns are further classified based on the mechanisms that caused the impact pattern: **gunshot**,

¹²² *Id.*, at 72.

¹²³ *Id.*, at 82.

¹²⁴ *Id.*

¹²⁵ *Id.*, at 87.

¹²⁶ *Id.*

¹²⁷ *Id.*

¹²⁸ *Id.*

¹²⁹ *Id.*, at 107-08.

beating, and **industrial** (power tools, etc.).¹³⁰ The size, shape, and distribution of impact spatters associated with a beating mechanism vary based off the shape, weight, and length of the weapon, the number of and force applied to the impacts, the location of wounds, the movement of the victim and assailant during the attack, and the amount of blood available for a given impact.¹³¹ Similarly, the size, shape and distribution of impact spatters associated with gunshots vary based on the caliber of the firearm, target distance, number of shots, wound characteristics and position of the victim, and blocking effect of hair, hats, clothing, or other head gear worn by victim.¹³²

A **projected bloodstain** pattern is spatter created as the result of a force other than impact.¹³³ Similar to impact patterns, they are further classified into the mechanisms that caused the projected patters patterns: **arterial spurt and gush stains**, **expired**, and **cast off swing**.¹³⁴ **Arterial bloodstain** patterns are the result of a projection mechanism resulting from arterial pressure that propels blood upward, forward, or downward from a damaged artery, often in a spray-type fashion.¹³⁵ Arterial bloodstain patterns can vary as a result of the location of artery (deep versus closer to surface), severity of injury (nick or severing), volume of blood dispersed, orientation of the surface, nature of the surface, blocking effect of skin, tissue, or clothing, position of victim, movement and activities of the victim subsequent to injury including manual, compression of the wound site, sequence of multiple injuries, overlapping of patterns created by other mechanisms, alteration of stains, and medical intervention.¹³⁶ **Expiratory bloodstain** patterns are the result of a projection mechanism that propels a volume of blood and air upward, forward, or downward from the nose, mouth, or open wound of the airway or lungs with physical

¹³⁰ *Id.*, at 120.

¹³¹ *Id.*, at 129.

¹³² *Id.* at 138-39.

¹³³ *Id.* at 149.

¹³⁴ *Id.* at 150.

¹³⁵ *Id.* at 149.

¹³⁶ *Id.*, at 152-53.

characteristics that can be observed and documented.¹³⁷ They are caused by the exhalation of blood, coughing of blood, sneezing of blood, wheezing of blood, spitting of blood, and paramedic intervention during resuscitative procedures.¹³⁸ **Cast-off bloodstain** patterns occur when blood is projected or thrown onto a surface from a bloody source or object in motion such as a hand or beating instruments (bat, crowbar, hammer, etc.) owing to a whiplike action and the generation of centrifugal force that overcomes the adhesive force that adheres the blood to the object.¹³⁹

The third main category of blood stains, **altered patterns** are patterns whose appearances indicate that the blood has undergone a physical and/or physiological change.¹⁴⁰ Bloodstain analysts are trained to spot such alterations include **clotting, dilution, diffusion, insects, sequencing, and voids.**¹⁴¹ **Clotting**, as detailed later, helps determine the time of injury. **Diluted** bloodstains may be present at scenes where excessive moisture is present, such as external environments involving rain or snow, in that the characteristics of the original stains may be altered to the point where analysis is difficult or impossible.¹⁴² **Diffusion** is defined as the movement of a substance from an area of higher concentration to an area of lower concentration.¹⁴³ A **void** pattern, a form of alteration, is the absence of bloodstaining in an otherwise continuous bloodstained area.¹⁴⁴ The void is a result of the presence of intervening

¹³⁷ *Id.*, at 160.

¹³⁸ *Id.*

¹³⁹ *Id.*, at 169.

¹⁴⁰ *Id.*, at 179.

¹⁴¹ *Id.*, at 180.

¹⁴² *Id.*, at 194.

¹⁴³ *Id.*, at 179.

¹⁴⁴ *Id.*, at 210.

objects or people. **Sequencing** is the placing of an order of events producing alterations of bloodstains.¹⁴⁵

Thus, this taxonomy has over *thirty* different kinds of bloodstain patterns that bloodstain analysts need to be able to inspect and identify. These aren't distinct categories, but rather are overlapping, so at any given crime scene, the analyst would likely need to be able to identify multiple different patterns.

C. Determining Area of Origin

In addition to the various categorizations of blood spatter patterns, analysts also use physics and trigonometry to determine the **area of origin**, or the source of the blood. This may also sometimes be referred to as the **area of convergence**, though SWGSTAIN differentiates the two terms. SWGSTAIN terminology refers to the area of origin as the three dimensional location from where the spatter originated and area of convergence as the two-dimensional area containing the intersections generated by lines drawn through the long axes of individual stains

Mathematics, particularly trigonometry, is applied to the field of bloodstain analysis in this area.¹⁴⁶ It is simple physics that a drop of blood that falls perfectly from a 90 degree angle, will be round, and have an equal length and width.¹⁴⁷ As the angle of impact increases (or decreases) the drop will be elongated, forming a more oval shape with a tail.¹⁴⁸ The tail determines the direction the drop traveled from, but it is not part of the measurement itself.¹⁴⁹ The greater the difference between the length and the width of the droper, the sharper the angle

¹⁴⁵ *Id.*

¹⁴⁶ Freeman, Shannon, *How Bloodstain Pattern Analysis Works*, <http://science.howstuffworks.com/bloodstain-pattern-analysis3.htm> (last visited April 15, 2014)

¹⁴⁷ *Id.*

¹⁴⁸ *Id.*

¹⁴⁹ *Id.*

of impact of the drop will be.¹⁵⁰ In order to determine the angle of impact, an analyst will first measure the length and the width of the spatter, divide the width by the length, and then determine the arcsin of that value.¹⁵¹ After finding the angles of each of these drops, the analyst can then determine where the area of convergence was, namely by finding the intersection point of the trajectories of the blood stains.¹⁵² Rather than making all these calculations themselves, modern analysts may use computer programs to create three dimensional models of the crime scene, after taking measurements of the area and the width and length of the spatters.¹⁵³

Another method is called the “stringing method.”¹⁵⁴ An analyst using this method will document the location of each spatter using the coordinate system.¹⁵⁵ Then, the analyst will establish a level line to show how the spatter is oriented in relation to the floor and ceiling.¹⁵⁶ An analyst will then use elastic string to draw lines from each spatter through the level line, and using a protractor, will determine the angle of flight for each spatter by measuring the level line in the area where the strings converge.¹⁵⁷

D. Determining the Time of Wounds

In addition to determining patterns and angles, analysts will also look at how wet or dry the stains are.¹⁵⁸ Over time, blood spatters dry.¹⁵⁹ The rate that this occurs will depend on the surface the blood landed on, how much blood was in the spatter, and the heat and humidity in the

¹⁵⁰ *Id.*

¹⁵¹ *Id.*

¹⁵² *Id.*

¹⁵³ *Id.*

¹⁵⁴ *Id.*

¹⁵⁵ *Id.*

¹⁵⁶ *Id.*

¹⁵⁷ *Id.*

¹⁵⁸ Freeman, Shannon, *How Bloodstain Pattern Analysis Works*, <http://science.howstuffworks.com/bloodstain-pattern-analysis1.htm> (last visited April 15, 2014)

¹⁵⁹ *Id.*

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crime scene.¹⁶⁰ Outer edges will dry first. Thus, analysts can pinpoint when a crime occurred based upon the dryness of the blood.¹⁶¹ Additionally, clotting usually occurs within 15 minutes. If some blood spatters have clotted earlier than others, it can indicate that multiple wounds occurred over a period of time.¹⁶²

E. End Note

Contrary to what case law seems to suggest, the IABPA maintains that this 40-hour program is “is not intended to create an instant expert.”¹⁶³ Nor *should* this course be regarded as creating an expert, in much the same way a college student is not treated as an expert from simply taking an introductory course. As we’ve seen, even in traditional bloodstain analysis, there are very many different kinds of patterns that overlap and have very many different mechanisms attached to their causes. Being able to know, identify, and match all of these patterns in a crime scene should take *years* to master, not days. This alone should be reason not to allow law enforcement officers with this minimal training to testify as experts. Forty hours of training is simply not enough time to not just learn and retain the knowledge of all these patterns, but also be able to identify them in the practice.

Furthermore, the traditional blood spatter analyst training has been criticized for its lack of training in modern scientific concepts that have a direct and substantial bearing on blood spatter analysis. Specifically, traditional blood spatter analysis does not incorporate differences in *red blood cell ratios* and *rheology*. These new issues are explored below.

¹⁶⁰ *Id.*

¹⁶¹ *Id.*

¹⁶² *Id.*

¹⁶³ IABPA, *Bloodstain Pattern Analysis Basic Course*, <http://www.iabpa.org/uploads/files/Training%20Page%20Documents/RevEduc.pdf> (last visited April 15, 2014)

VII. ADVANCED THEORY

The traditional assumption in bloodstain pattern analysis is that blood drop mass is fairly uniform.¹⁶⁴ This assumption relies upon the assumption that there is reasonable uniformity among individuals in their red blood cell ratios.¹⁶⁵ However, this assumption is not always true.¹⁶⁶ Health care professionals routinely analyze red blood cell counts for the purposes of transfusions, reflecting the understanding that there are meaningful differences in ratios among individuals.¹⁶⁷ Moreover, ratios can vary in a single person, from time to time, depending on a person's health.¹⁶⁸ Crime victims in particular are not known to be healthy people. Studies have shown that groups such as the malnourished homeless, alcoholics, and drug addicts are significantly overrepresented among victims of violent crimes.¹⁶⁹ These variations can affect the mass of the blood drop, which in turn can affect terminal velocity, which changes the expected results of stain size and pattern.¹⁷⁰ Basic training in bloodstain analysis does not incorporate the variations in red blood cell ratios, leading to a significant potential error in their analysis.¹⁷¹ Mark Godsey, a professor of law at the University of Cincinnati College of Law and Director for the Center for the Global Study of Wrongful Conviction, criticizes current blood spatter analysis for not factoring in the presence of the concentrations of red blood cells.¹⁷² He states that the

¹⁶⁴ Gopen, *supra*.

¹⁶⁵ *Id.*

¹⁶⁶ *Id.*

¹⁶⁷ *Id.*

¹⁶⁸ *Id.*

¹⁶⁹ *Id.*

¹⁷⁰ *Id.*

¹⁷¹ *Id.*

¹⁷² Godsey, Mark, *Blood Spatter – Evidence?* <http://wrongfulconvictionsblog.org/2012/04/30/blood-spatter-evidence/> (last visited April 15, 2014).

viscosity can vary by a factor of 2-to-1 depending on this concentration and has never seen any BPA experiments that have controlled for this factor.¹⁷³

Modern science has also revealed that blood is capable of acting as either a Newtonian or a non-Newtonian fluid.¹⁷⁴ Rheology, the study of non-Newtonian fluids is still in its infancy, and for that reason, the insight that blood chiefly behaves as a non-Newtonian fluid has been largely ignored by bloodstain pattern analysts.¹⁷⁵ But this distinction is important. While Newtonian fluids have constant linear proportion between flow rate and viscosity, this rate grows exponentially instead of linearly in non-Newtonian fluids.¹⁷⁶ Moreover, there are different equations even for calculating a fluid's flow rate, depending on whether the fluid is viscous or inviscid.¹⁷⁷ Blood, acting a Newtonian and non-Newtonian fluid, can exhibit either viscous and inviscid flow characteristics and different equations must be used for different situation.¹⁷⁸ Crime scene investigators who are unfamiliar with rheology can be misled into coming to the wrong conclusions from observing bloodstain shapes and sizes.¹⁷⁹ The lack of education and study in rheology is a significant weakness in the modern scientific foundation of bloodstain analysis and is a subject matter that is largely beyond the scope of the backgrounds of most law enforcement officers, and certainly beyond the scope of a 40-hour seminar.¹⁸⁰

VIII. FURTHER CRITICISMS

¹⁷³ *Id.*

¹⁷⁴ Gopen, *supra.*

¹⁷⁵ *Id.*

¹⁷⁶ *Id.*

¹⁷⁷ *Id.*

¹⁷⁸ *Id.*

¹⁷⁹ *Id.*

¹⁸⁰ *Id.*

As aforementioned, even the IABPA states on its syllabus its basic course is “not intended to create an instant expert.” Similarly, other commentators are also highly skeptical of the training of purported experts. According to *Principles of Bloodstain Pattern Analysis: Theory and Practice*, successful completion of the basic and even the advance courses in BPA does not imply that an individual is qualified to be a blood stain pattern analyst.¹⁸¹ The book advises that “the formal education must be coupled with years of experiences with crime scenes and evidence examinations along with regular attendance at scientific seminars or conferences.”¹⁸²

Ross Gardner, a forensic consultant, notes that purported “expert witnesses” drawn from law enforcement have attended only the minimal one forty-hour work shop and leave “reciting only three phrases (‘low’, ‘medium’ and ‘high velocity’), and fail to fully understand the nuances of the classification system with so limited training.¹⁸³ These officers believe, in Garner’s view, that they can simply look at patterns and correctly infer the events that caused the pattern.¹⁸⁴ They try to memorize the workshop patterns and then apply them to match bloodstain patterns at the crime scene, but have not mastered the more scientific insights, described earlier in *Advanced Theory*, nor have they had the experience to correctly identify the memorized patterns.¹⁸⁵ Consequently, they do not understand all the alternative, scientifically plausible explanations for the pattern observed at the crime scene.¹⁸⁶ For example, a woman with high blood pressure when wounded with a knife in a major artery can produce a fine mist-like spray, typically associated with a gun shot or other high velocity impact.¹⁸⁷ Gardner recommends a much greater emphasis on the science of bloodstain analysis and more sophisticated scientific

¹⁸¹ James, *supra*, at 9.

¹⁸² *Id.*

¹⁸³ Gopen, *supra*.

¹⁸⁴ *Id.*

¹⁸⁵ *Id.*

¹⁸⁶ *Id.*

¹⁸⁷ *Id.*

methodology in law enforcement training, not merely the skill of matching patterns as is taught in these rudimentary workshops.¹⁸⁸

Craig Cooley, a staff attorney for the Innocence Project with a master's degree in forensic science, is similarly dubious of the limited training of some law enforcement bloodstain analysts.¹⁸⁹ He states, “[f]or many forensic examiners, the only training they received before they called themselves forensic experts consisted of attending a five-day (forty-hour) workshop in their respective field of expertise (e.g., bloodstain pattern analysis ...).”¹⁹⁰ He further adds, “[a]s any legitimately trained scientist will explain, these courses do not transform a non-science investigator into a bloodstain or firearms expert.”¹⁹¹ He believes that it is “essential to have at least an undergraduate, if not a graduate degree in science, combined with a broad knowledge base of the forensic sciences, and experience using the scientific method and statistics” to be a competent expert in a forensic science discipline such as bloodstain pattern analysis.¹⁹² The forty-hour “short course” model that “qualifies” bloodstain experts is inadequate, and teaches law enforcement experts an “oversimplified understanding of a complex, physical process.”¹⁹³

The National Academy of Sciences (NAS) concurs, writing that “workshops teach the fundamentals of basic pattern formation and are not a substitute for experience and experimentation when applying knowledge to crime reconstruction.”¹⁹⁴ The NAS argues that

¹⁸⁸ *Id.*

¹⁸⁹ *Id.*

¹⁹⁰ *Id.*

¹⁹¹ *Id.*

¹⁹² *Id.*

¹⁹³ *Id.*

¹⁹⁴ National Academy of Sciences (NAS) Committee on Identifying the Needs of the Forensic Sciences Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward*, August 2009. Pg. 177.

these courses are more applicable for investigators who needs to recognize the importance of these patterns so they may enlist a qualified expert or for attorneys in preparation of their case.¹⁹⁵

Additionally, while many officers who serve as bloodstain pattern analysts have spent tens or hundreds of hours at such crime scenes, most of the time they receive their bloodstain analysis training only *after* extensive crime scene experience.¹⁹⁶ Due to this sequencing, they *lacked* the training in these prior crime scenes to know *what* to look for.¹⁹⁷ Thus, any prior investigative experience adds little depth to understanding bloodstain pattern analysis.¹⁹⁸ Moreover, the NAS writes that the emphasis on experience over education is misguided, given the importance of objective and rigorous hypothesis testing and the complex nature of fluid dynamics.¹⁹⁹

IX. CONCLUSION

It is thus apparent that the field of blood spatter analysis is a complex one. There are over thirty different blood spatter patterns that an expert would need to be able to know and identify. Moreover, it is not sufficient to merely be able to recognize patterns, the field requires knowledge of biology, physics, and trigonometry to adequately interpret the underlying mechanisms behind the spatters. Field experience seeing other crime scenes is no substitute for understanding the methodology behind the practice, and a 40-hour course is certainly implausible as outlaying a scientific foundation for law enforcement officers to come to any

¹⁹⁵ *Id.*

¹⁹⁶ Gopen, *supra*.

¹⁹⁷ *Id.*

¹⁹⁸ *Id.*

¹⁹⁹ NAS, *supra*, at 177.

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reliable and scientific conclusions. To that end, in their role as gate keepers, judges should exercise greater vigilance in the future and bar law enforcement officers with this minimal education from testifying as “experts” in this field.