APPENDIX A

Tennessee Court of Criminal Appeals Order Dismissing Smith's Motion to Reopen Post-Conviction Proceedings

IN THE COURT OF CRIMINAL APPEALS OF TENNESSEE
AT NASHVILLE

OSCAR SMITH v. STATE OF TENNESSEE

Appeal from the Criminal Court for Davidson County
No. 98-F-1773

No. M2022-00455-CCA-R3-PD

Petitioner, Oscar Smith, a death row inmate, appeals the trial court's order denying his "Motion to Reopen Post-Conviction Proceedings and/or for Review under Post-Conviction DNA Analysis Act of 2001." The trial court denied Petitioner's motion to reopen and his DNA petition in the same order. Petitioner has filed a notice of appeal (Docket No. M2022-00455-CCA-R3-PD) and an application for permission to appeal (Docket No. M2022-00460-CCA-R28-PD). The Court hereby consolidates these two appeals under Docket No. M2022-00455-CCA-R3-PD. The record has been filed and Petitioner, in addition to having filed an application for permission to appeal, has already filed his appellate brief. Upon our review, we affirm the rulings of the trial court pursuant to Court of Criminal Appeals Rule 20.

Tenn. R. App. P. 3 Appeal as of Right; Judgments of the Trial Court Affirmed Pursuant to Rule 20, Rules of the Court of Criminal Appeals

TIMOTHY L. EASTER, J. delivered the opinion of the court, in which ROBERT W. WEDEMEYER and ROBERT H. MONTGOMERY, JR., JJ. joined.

Amy D. Harwell, Assistant Chief, Capital Habeas Unit and Katherine M. Dix, Assistant Federal Public Defender, Nashville, Tennessee, for Petitioner, Oscar Franklin Smith.

Herbert H. Slatery III, Attorney General & Reporter, for Respondent, State of Tennessee.

MEMORANDUM OPINION

Over 32 years ago, Petitioner murdered his estranged wife, Judith (Judy) Lynn Smith, and her two minor children, Chad and Jason Burnett, at their home in Nashville. *State v. Smith*, 868 S.W.2d 561 (Tenn. 1993). He received death sentences for each of the three murders. *Id.* Petitioner's convictions and sentences were upheld on direct appeal.

Smith, 868 S.W.2d at 582. He was unsuccessful in his subsequent pursuit of state post-conviction and federal habeas corpus relief. *Oscar Franklin Smith v. State*, No. 01C01-9702-CR-00048, 1998 WL 345353 (Tenn. Crim. App. June 30, 1998), *perm. app. denied* (Tenn. Jan. 25, 1999); *Oscar Smith v. Ricky Bell, Warden*, No. 3:99-0731, 2005 WL 2416504 (M.D. Tenn. Sep. 30, 2005), *vacated sub nom. Smith v. Colson*, 566 U.S. 901 (2012) (Order); *Oscar Smith v. Tony May, Warden*, No. 18-5133, 2018 WL 7247244 (6th Cir. Aug. 22, 2018). This Court recently affirmed the trial court's summary dismissal of Petitioner's request for testing of evidence pursuant to the Post-Conviction Fingerprint Analysis Act of 2021. *Oscar Smith v. State*, No. M2021-01339-CCA-R3-PD, 2022 WL 854438 (Tenn. Crim. App. Mar. 23, 2022), *perm. app. denied* (Tenn. Apr. 6, 2022).

On April 4, 2022, Petitioner filed in the trial court a "Motion to Reopen Post-Conviction Proceedings and/or for Review under Post-Conviction DNA Analysis Act of 2001." Petitioner previously obtained agreed orders from the trial court for DNA testing of an alleged murder weapon and clothing collected from Ms. Smith and Chad Burnett in relation to a sample of Chad Burnett's hair and blood samples from Petitioner, Ms. Smith and Jason Burnett. Petitioner filed his motion after having obtained the results of the DNA testing. The trial court entered its order denying relief on April 11, 2022. Because the trial court's order disposed of both the request to reopen the previously-filed post-conviction petition, Tennessee Code Annotated section 40-30-117, and to obtain testing under the DNA Analysis Act, Tennessee Code Annotated sections 40-30-301 *et seq.*, Petitioner, as required, has filed both an application for permission to appeal pursuant to Section 40-30-117(c) and a notice of appeal pursuant to Tennessee Rule of Appellate Procedure 3(b).

The Court hereby consolidates the two appeals under Docket No. M2022-00455-CCA-R3-PD. A record has been prepared and transmitted on appeal and Petitioner has already filed his appellate brief in addition to an application for permission to appeal. Petitioner is scheduled to be executed on Thursday, April 21, 2022. Petitioner also filed a motion for expedited briefing and for oral argument. Pursuant to our authority under the Rules of Appellate Procedure, the Court hereby suspends the requirement of a response from the State in order to expedite our decision in this matter. Tenn. R. App. P. 2. Thus, Petitioner's requests for an expedited briefing schedule and oral argument are denied as moot.

In its order, the trial court summarized the substance of Petitioner's recent filing:

> On December 7, 2016, during the pendency of [Petitioner's] federal habeas corpus litigation, forensic fingerprint examiner Kathleen Bright-Birnbaum filed a report detailing her analysis of several fingerprints left at the crime scene. Among the prints detailed in Ms. Bright-Birnbaum's report, included as Exhibit 1 to [Petitioner's] present motion, were two fingerprints

lifted from an awl (misidentified as a "leather awe" in the report) believed to be used during the offenses. Ms. Bright-Birnbaum identified one of the prints as belonging to Johnny Hunter, the Metropolitan Nashville Police Department fingerprint examiner who testified at Petitioner's trial. *See* Bright-Birnbaum report at 2. Regarding the second print, Ms. Bright-Birnbaum explained the print was "identifiable," but she was unable to identify who left the print. *Id.* [FN: The known comparison prints referenced in Ms. Bright-Birnbaum's report - presumably, those against which the unknown print was compared - were those of [Petitioner], the three victims, three members of the Metropolitan Nashville Police Department (including Hunter), and three persons specifically identified in Ms. Bright-Birnbaum's report but whose potential connection to this case is not apparent from the current pleadings. *See id.* at 1-2.].

According to the Petitioner, the presence of the unknown fingerprint on the awl prompted Petitioner's attorneys to seek DNA testing of the awl. Based upon the agreement of the parties, this [c]ourt entered an agreed order on January 19, 2022, transferring the awl to the Petitioner's selected DNA analyst, the Serological Research Institute ("SERI"). On February 28, 2022, the [c]ourt entered another agreed order transferring samples of the Petitioner's, Jason Burnett's, and Judith Smith's blood, along with a sample of Chad Burnett's hair, to SERI. Counsel for the Petitioner explains the resubmission of these samples as follows:

> As noted in the SERI report, the technology used here [to conduct the touch DNA analysis] is so new that [the examiner] had to re-examine the "known" specimens previously analyzed in 2016 so that a scientifically valid comparison could be achieved. Ex 4, SERI Rep. at 2 (noting resubmission of items); *see also* Second DNA Order, February 28, 2022 (releasing the known samples to SERI pursuant to the parties' agreement).

Smith motion at 6 n.3 (alterations added).

On March 30, 2022, SERI forensic DNA analyst Gary Hamor (and a "technical reviewer" whose electronic signature appears only as the initials "PH") submitted SERI's report on the agency's DNA analysis to the Petitioner's lead attorney, Amy Harwell. Regarding SERI's testing of the awl handle, which consisted of comparing a "touch DNA" sample obtained from the awl handle against known DNA samples from the Petitioner and the three victims, the report stated:

a. A DNA mixture was obtained.

b. The DNA mixture was interpreted as originating from two contributors with a major male contributor. Chad Burnette [sic] could be the major contributor to this mixture. The chance that a randomly selected, unrelated person would have the same profile as the major contributor is approximately 1 in 4 octillion.

c. Oscar Smith, Jason Burnette [sic], and Judy Smith are all excluded as contributors to the DNA results obtained from this item.

d. The minor portion of the mixture is suitable for comparison.

SERI Report, at 4 (included as Exhibit 4 to Petitioner's current motion).

As stated above, the DNA profile obtained from the awl handle consists of "touch DNA." In explaining the timing of the Petitioner's current motion, Petitioner's attorneys write,

> Though it has been theoretically possible to develop "touch DNA" for several years, the Applied Biosystems™ GlobalFiler™ PCR Amplification Kit was not developed until 2012 and did not become available in most labs until after 2017. Ex.4 at 8, SERI Rep. The fully continuous probabilistic genotyping software program used for analysis on the awl, Bullet Proof Sentry, was not available until 2022. *Id.* That is, touch DNA was not available until well after [Petitioner's] trial and post-conviction proceedings, and the technology used to perform the touch DNA analysis that supports this Motion was not available until this year. Ex. 4, SERI Report at 8.

Petitioner's motion, at 5-6 (footnote omitted).

The trial court determined Petitioner did not file his "Motion to Reopen Post-Conviction Proceedings and/or for Review under Post-Conviction DNA Analysis Act of 2001" to delay execution of his sentence and thus proceeded to address the merits of the same. After discussing the established law governing motions to reopen (§ 40-30-117) and the DNA Analysis Act (§§ 40-30-301 *et seq.*), the court concluded as follows:

However, even in viewing the evidence in the light most favorable to the Petitioner - in this case the [c]ourt has no reason to doubt that SERI's testing of the touch DNA obtained from the crime scene awl revealed a profile that was, conclusively, not that of [Petitioner] - the Petitioner is not entitled to relief through a motion to reopen or under the post-conviction DNA act. As this [c]ourt set forth in its order dismissing [Petitioner's] post-conviction fingerprint petition, extensive evidence of the Petitioner's guilt was introduced at trial. The Court of Criminal Appeals summarized that evidence in its opinion affirming this [c]ourt's dismissal of the fingerprint petition:

> As the trial court observed, "the State possessed extensive circumstantial evidence against Petitioner other than the palm print, including (1) Petitioner's prior threats against and/or prior violence involving the victims; (2) a neighbor seeing Petitioner's car in the victims' driveway the night of the murders; (3) life insurance policies taken out by Petitioner on the lives of the three victims, and (4) one of the child victims yelling out 'Frank, no!' on the 911 recording." Moreover, as the trial court noted, "[t]he evidence introduced at trial suggested Petitioner (and nobody else) had motive to kill the victims." Two of Petitioner's co-workers testified Petitioner solicited them to kill his wife. Likewise, as summarized above, evidence, in addition to the neighbor's testimony, was introduced to contest Petitioner's alibi defense. The jury also learned Petitioner referred to his estranged wife in the past tense during questioning by the police and he did not "ask the officers the logical questions of where, when, how and by whom" when he was informed about the murders. *Oscar Smith*, 2005 WL 2416504, at *4. [Footnote omitted]. The post-conviction evidence also revealed Petitioner "was not contesting that the print was his; he was claiming that someone planted the print at the scene." *Oscar Franklin Smith*, 1998 WL 345353, at *15. [Footnote omitted]. Even [Ms.] Bright-Birnbaum could not conclusively state Petitioner did not leave the bloody palm print at the crime scene.

[*Smith*] fingerprint opinion, 2022 WL 854438, at *16 (footnotes added); *see also id.* at **2-7 (quoting list of facts set forth in federal district court opinion denying habeas corpus petition; this [c]ourt's November 2021 order denying

fingerprint motion also quoted that list). Additionally, this [c]ourt notes that in the DNA testing performed by Petitioner's selected laboratory, [Petitioner's] DNA "could be included as [a] contributor[] to the DNA results obtained" from the left sleeve of an "off-white long sleeve shirt with large red/brown stains." [Footnote omitted]. Presumably, this article of clothing was a bloodstained item worn by one of the victims at the time of that person's death.

To quote further from the Court of Criminal Appeals' opinion,

> In the case at hand, if we stacked the assumed most favorable [touch DNA] evidence on one side of a set of scales and the trial evidence on the other, the [touch DNA] evidence would not even begin to affect the scales or tip them in Petitioner's favor, either as to the guilty verdict or the sentences of death.

[*Smith*] fingerprint opinion, 2022 WL 854438, at *17 (alterations added).

Thus, the [c]ourt concludes there is not a reasonable probability that the recently-discovered DNA evidence would have prevented [Petitioner's] prosecution or conviction. Nor is there a reasonable probability the recently-discovered DNA evidence would have resulted in a more favorable conviction or sentence for [Petitioner] had the DNA evidence been presented at trial. Thus, [Petitioner] is not entitled to relief under either T[ennessee] C[ode] A[nnotated] section 40-30-304 or section 40-30-305. [FN: The [c]ourt observes that the touch DNA evidence at issue in this case had not been subjected previously to the type of testing conducted by SERI. While the awl still exists in a condition in which it can be tested, it is unclear whether the awl was preserved in such a manner that would have assured the DNA profiles were left at the crime scene and did not result from contamination. Had the other elements of sections 40-30-304 and -305 been met, however, this [c]ourt would have allowed the Petitioner to present evidence concerning this issue at an evidentiary hearing.]. Similarly, given the extensive evidence of [Petitioner's] guilt produced at his trial, even when considering the DNA evidence resulting from SERI's recent testing in a light most favorable to the Petitioner, the [c]ourt concludes [Petitioner] would be unable to prove by clear and convincing evidence that the DNA evidence establishes he is actually innocent of the offenses for which he was convicted. Thus, he is not entitled to reopen his post-conviction proceedings under T.C.A. section 40-30-117(a)(2). [Footnote omitted].

Analysis

A post-conviction court's denial of a motion to reopen a post-conviction petition does not afford a petitioner an appeal as of right, *see* Tennessee Rule of Appellate Procedure 3(b), rather, such denial may be challenged on appeal only by the filing of an application for permission to appeal no later than 30 days after the denial by the post-conviction court. T.C.A. § 40-30-117(c); Tenn. Sup. Ct. R. 28, § 10(B). There are four requirements for an appeal from a motion to reopen to be considered: (1) the timeliness of filing, (2) the place of filing, (3) the application to be filed, and (4) the attachments to the application. *Graham v. State*, 90 S.W.3d 687, 689 (Tenn. 2002). "In general, the contents of an application for permission to appeal must include the date and judgment from which the petitioner seeks review, the issue which the petitioner seeks to raise, and the reasons why the appellate court should grant review." *Id.* at 691. The statutory requirements are mandatory. *Timothy Roberson v. State*, No. W2007-00230-CCA-R3-PC, 2007 WL 3286681, at *9-10 (Tenn. Crim. App. Nov. 7, 2007), *perm. app. denied* (Tenn. Apr. 14, 2008).

Here, Petitioner adequately complied with the statutory requirements for seeking appellate review. However, Petitioner has not presented new scientific evidence establishing that he is actually innocent of the murders of the victims. Consequently, the trial court did not abuse its discretion when it denied Petitioner's motion to reopen the petition. As a result, we deny the application for permission to appeal the denial of the motion to reopen the post-conviction petition pursuant to Tennessee Code Annotated section 40-30-117(c).

With regard to Petitioner's motion for "Review under Post-Conviction DNA Analysis Act of 2001," we likewise conclude that the trial court did not abuse its discretion. *See Oscar Smith v. State*, 2022 WL 854438, at *17. The trial court analyzed the motion pursuant to both Tennessee Code Annotated sections 40-30-304 and -305 and determined that there was not a reasonable probability that the DNA evidence would have prevented Petitioner's prosecution or conviction or would have resulted in a more favorable conviction or sentence.

This Court's Rule 20 provides that if a judgment is rendered by the trial court without a jury, the judgment is not a determination of guilt, the evidence does not preponderate against the finding of the trial court, and no error of law requiring a reversal of the judgment is apparent on the record, then the judgment of the trial court may be affirmed by memorandum opinion when the opinion would have no precedential value. Tenn. Ct. Crim. App. R. 20. We determine that this case meets the criteria of Rule 20.

Conclusion

For the foregoing reasons, the rulings of the trial court are hereby affirmed in accordance with Court of Criminal Appeals Rule 20.

TIMOTHY L. EASTER, JUDGE

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Petitioner's motion, at 5-6 (footnote omitted).

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However, even in viewing the evidence in the light most favorable to the Petitioner - in this case the [c]ourt has no reason to doubt that SERI's testing of the touch DNA obtained from the crime scene awl revealed a profile that was, conclusively, not that of [Petitioner] - the Petitioner is not entitled to relief through a motion to reopen or under the post-conviction DNA act. As this [c]ourt set forth in its order dismissing [Petitioner's] post-conviction fingerprint petition, extensive evidence of the Petitioner's guilt was introduced at trial. The Court of Criminal Appeals summarized that evidence in its opinion affirming this [c]ourt's dismissal of the fingerprint petition:

> As the trial court observed, "the State possessed extensive circumstantial evidence against Petitioner other than the palm print, including (1) Petitioner's prior threats against and/or prior violence involving the victims; (2) a neighbor seeing Petitioner's car in the victims' driveway the night of the murders; (3) life insurance policies taken out by Petitioner on the lives of the three victims, and (4) one of the child victims yelling out 'Frank, no!' on the 911 recording." Moreover, as the trial court noted, "[t]he evidence introduced at trial suggested Petitioner (and nobody else) had motive to kill the victims." Two of Petitioner's co-workers testified Petitioner solicited them to kill his wife. Likewise, as summarized above, evidence, in addition to the neighbor's testimony, was introduced to contest Petitioner's alibi defense. The jury also learned Petitioner referred to his estranged wife in the past tense during questioning by the police and he did not "ask the officers the logical questions of where, when, how and by whom" when he was informed about the murders. *Oscar Smith*, 2005 WL 2416504, at *4. [Footnote omitted]. The post-conviction evidence also revealed Petitioner "was not contesting that the print was his; he was claiming that someone planted the print at the scene." *Oscar Franklin Smith*, 1998 WL 345353, at *15. [Footnote omitted]. Even [Ms.] Bright-Birnbaum could not conclusively state Petitioner did not leave the bloody palm print at the crime scene.

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To quote further from the Court of Criminal Appeals' opinion,

> In the case at hand, if we stacked the assumed most favorable [touch DNA] evidence on one side of a set of scales and the trial evidence on the other, the [touch DNA] evidence would not even begin to affect the scales or tip them in Petitioner's favor, either as to the guilty verdict or the sentences of death.

[*Smith*] fingerprint opinion, 2022 WL 854438, at *17 (alterations added).

Thus, the [c]ourt concludes there is not a reasonable probability that the recently-discovered DNA evidence would have prevented [Petitioner's] prosecution or conviction. Nor is there a reasonable probability the recently-discovered DNA evidence would have resulted in a more favorable conviction or sentence for [Petitioner] had the DNA evidence been presented at trial. Thus, [Petitioner] is not entitled to relief under either T[ennessee] C[ode] A[nnotated] section 40-30-304 or section 40-30-305. [FN: The [c]ourt observes that the touch DNA evidence at issue in this case had not been subjected previously to the type of testing conducted by SERI. While the awl still exists in a condition in which it can be tested, it is unclear whether the awl was preserved in such a manner that would have assured the DNA profiles were left at the crime scene and did not result from contamination. Had the other elements of sections 40-30-304 and -305 been met, however, this [c]ourt would have allowed the Petitioner to present evidence concerning this issue at an evidentiary hearing.]. Similarly, given the extensive evidence of [Petitioner's] guilt produced at his trial, even when considering the DNA evidence resulting from SERI's recent testing in a light most favorable to the Petitioner, the [c]ourt concludes [Petitioner] would be unable to prove by clear and convincing evidence that the DNA evidence establishes he is actually innocent of the offenses for which he was convicted. Thus, he is not entitled to reopen his post-conviction proceedings under T.C.A. section 40-30-117(a)(2). [Footnote omitted].

Analysis

A post-conviction court's denial of a motion to reopen a post-conviction petition does not afford a petitioner an appeal as of right, *see* Tennessee Rule of Appellate Procedure 3(b), rather, such denial may be challenged on appeal only by the filing of an application for permission to appeal no later than 30 days after the denial by the post-conviction court. T.C.A. § 40-30-117(c); Tenn. Sup. Ct. R. 28, § 10(B). There are four requirements for an appeal from a motion to reopen to be considered: (1) the timeliness of filing, (2) the place of filing, (3) the application to be filed, and (4) the attachments to the application. *Graham v. State*, 90 S.W.3d 687, 689 (Tenn. 2002). "In general, the contents of an application for permission to appeal must include the date and judgment from which the petitioner seeks review, the issue which the petitioner seeks to raise, and the reasons why the appellate court should grant review." *Id.* at 691. The statutory requirements are mandatory. *Timothy Roberson v. State*, No. W2007-00230-CCA-R3-PC, 2007 WL 3286681, at *9-10 (Tenn. Crim. App. Nov. 7, 2007), *perm. app. denied* (Tenn. Apr. 14, 2008).

Here, Petitioner adequately complied with the statutory requirements for seeking appellate review. However, Petitioner has not presented new scientific evidence establishing that he is actually innocent of the murders of the victims. Consequently, the trial court did not abuse its discretion when it denied Petitioner's motion to reopen the petition. As a result, we deny the application for permission to appeal the denial of the motion to reopen the post-conviction petition pursuant to Tennessee Code Annotated section 40-30-117(c).

With regard to Petitioner's motion for "Review under Post-Conviction DNA Analysis Act of 2001," we likewise conclude that the trial court did not abuse its discretion. *See Oscar Smith v. State*, 2022 WL 854438, at *17. The trial court analyzed the motion pursuant to both Tennessee Code Annotated sections 40-30-304 and -305 and determined that there was not a reasonable probability that the DNA evidence would have prevented Petitioner's prosecution or conviction or would have resulted in a more favorable conviction or sentence.

This Court's Rule 20 provides that if a judgment is rendered by the trial court without a jury, the judgment is not a determination of guilt, the evidence does not preponderate against the finding of the trial court, and no error of law requiring a reversal of the judgment is apparent on the record, then the judgment of the trial court may be affirmed by memorandum opinion when the opinion would have no precedential value. Tenn. Ct. Crim. App. R. 20. We determine that this case meets the criteria of Rule 20.

Conclusion

For the foregoing reasons, the rulings of the trial court are hereby affirmed in accordance with Court of Criminal Appeals Rule 20.

TIMOTHY L. EASTER, JUDGE

APPENDIX B

Tennessee Criminal Court Order Denying Smith's Motion to Reopen Post-Conviction Proceedings

IN THE CRIMINAL COURT FOR DAVIDSON COUNTY, TENNESSEE
DIVISION II

OSCAR SMITH **Petitioner**	)	
vs.	)	**Case No.: 89-F-1773** **Death Penalty Post-Conviction**
STATE OF TENNESSEE **Respondent**	)	

ORDER DENYING "MOTION TO REOPEN POST-CONVICTION PROCEEDINGS AND/OR FOR REVIEW UNDER POST-CONVICTION DNA ANALYSIS ACT OF 2001"

I. Introduction

This matter came before the Court upon the above-referenced motion, filed with the Court April 4, 2022. The Petitioner, Oscar Smith, asserts he is entitled to relief both under the statutory provision for reopening post-conviction proceedings, Tennessee Code Annotated section 40-30-117, and under the Post-Conviction DNA Analysis Act of 2001, Tennessee Code Annotated sections 40-30-301 through -313, based on what he claims is evidence of an unknown person's DNA found on a suspected murder weapon. After reviewing the parties' filings, the relevant authorities, and the record as a whole, the Court concludes the Petitioner is not entitled to have his post-conviction proceedings reopened, and he is not entitled to relief under the post-conviction DNA act. Accordingly, the motion is DENIED.

II. Procedural History[1]

[1] The Hon. J. Randall Wyatt, Jr., retired Judge of Criminal Court, Division II, presided over the Petitioner's trial and original post-conviction proceedings. The undersigned Judge has presided over all proceedings in this Court involving Mr. Smith since Judge Wyatt retired in 2017.

A. Trial and Direct Appeal

A Davidson County jury convicted the Petitioner of three counts of first degree murder for the October 1989 killings of his estranged wife, Judy Smith, and Ms. Smith's teenaged sons, Chad and Jason Burnett. The jury sentenced Mr. Smith to death on all three counts. On appeal, the Tennessee Supreme Court affirmed the Petitioner's convictions and sentences. *State v. Smith*, 868 S.W.2d 561 (Tenn. 1993).

B. Post-Conviction

The Petitioner filed a timely petition for post-conviction relief. After the appointment of counsel, the post-conviction court denied Mr. Smith's petition. The Court of Criminal Appeals affirmed the post-conviction court's decision on direct appeal. *Oscar Franklin Smith v. State*, No. 01C01-9702-CR-00048, 1998 WL 345353 (Tenn. Crim. App. June 30, 1998). The Tennessee Supreme Court denied Petitioner's application for permission to appeal on January 25, 1999.

C. Federal Habeas Corpus

After the 1999 conclusion of his post-conviction proceedings, Mr. Smith filed a timely petition for writ of habeas corpus in the United States District Court for the Middle District of Tennessee. The habeas case made its way through the federal courts over the next two decades. The most recent federal proceedings occurred in 2018-19. The District Court denied relief in January 2018, and in August 2018 the Sixth Circuit denied a certificate of appealability. *See Oscar Smith v. Tony Mays, Warden*, No. 18-5133 (6th Cir. Aug. 22, 2018) (order denying certificate of appealability). The United States Supreme

Court denied Mr. Smith's petition for certiorari on June 10, 2019.

D. Additional State Court Proceedings

Petitioner has filed two previous motions to reopen his post-conviction proceedings. These petitions were dismissed without a hearing, and the Court of Criminal Appeals denied permission to appeal. *See, e.g.*, *Oscar Smith v. State*, No. M2016-01869-CCA-R28-PD (Tenn. Crim. App. Oct. 19, 2016) (denying permission to appeal after the trial court denied motion to reopen based on U.S. Supreme Court opinions in *Obergefell v. Hodges* and *Glossip v. Gross*); *Oscar Smith v. State*, No. M2019-01662-CCA-R28-PD (Tenn. Crim. App. Oct. 28, 2019) (denying permission to appeal after this Court denied motion to reopen based on Supreme Court opinion in *McCoy v. Louisiana*).

In advance of a May 2020 execution date—which was ultimately stayed due to COVID-19 concerns—the Petitioner filed with this Court a separate "omnibus motion" seeking relief through a motion to reopen his post-conviction petition, a petition for writ of error coram nobis, and several other procedures. This Court denied the omnibus petition, and the Court of Criminal Appeals affirmed this Court on direct appeal. *See Oscar Smith v. State*, No. M2020-00485-CCA-R3-ECN, 2020 WL 5870566 (Tenn. Crim. App. Oct. 2, 2020) (not for citation), *perm. app. denied*, (Tenn. Dec. 3, 2020); *see also Oscar Smith v. State*, No. M2020-00493-CCA-R28-PD (Tenn. Crim. App. May 1, 2020) (denying permission to appeal as to the motion to reopen).

E. Post-Conviction Fingerprint Action

On July 1, 2021, the Petitioner filed a petition for relief pursuant to the Post-

Conviction Fingerprint Analysis Act of 2021, T.C.A. §§ 40-30-401 through -413, which became law the same day Mr. Smith filed his petition. The post-conviction fingerprint petition focused not on the awl (the evidence at issue in the current petition), but on a bloody palm print left at the crime scene. This Court concluded Petitioner was not entitled to relief, and on November 9, 2021, this Court dismissed the fingerprint petition without a hearing. The Court of Criminal Appeals affirmed this Court's decision on direct appeal. *Oscar Smith v. State*, No. M2021-01339-CCA-R3-PD, 2022 WL 854438 (Tenn. Crim. App. Mar. 23, 2022) ("Smith fingerprint opinion"). The Tennessee Supreme Court denied permission to appeal on April 6, 2022.

III. Summary of Petitioner's Factual Claims

On December 7, 2016, during the pendency of Mr. Smith's federal habeas corpus litigation, forensic fingerprint examiner Kathleen Bright-Birnbaum filed a report detailing her analysis of several fingerprints left at the crime scene. Among the prints detailed in Ms. Bright-Birnbaum's report, included as Exhibit 1 to Mr. Smith's present motion, were two fingerprints lifted from an awl (misidentified as a "leather *awe*" in the report) believed to be used during the offenses. Ms. Bright-Birnbaum identified one of the prints as belonging to Johnny Hunter, the Metropolitan Nashville Police Department fingerprint examiner who testified at Petitioner's trial. *See* Bright-Birnbaum report at 2. Regarding the second print, Ms. Bright-Birnbaum explained the print was "identifiable," but she was unable to identify who left the print. *Id.*[2]

[2] The known comparison prints referenced in Ms. Bright-Birnbaum's report—presumably, those against which the unknown print was compared—were those of Mr. Smith, the three victims, three members of the Metropolitan Nashville Police Department (including Hunter), and three persons specifically identified in Ms. Bright-Birnbaum's report but whose potential connection to this case is not apparent from the current pleadings. *See id.* at 1-2

According to the Petitioner, the presence of the unknown fingerprint on the awl prompted Petitioner's attorneys to seek DNA testing of the awl. Based upon the agreement of the parties, this Court entered an agreed order on January 19, 2022, transferring the awl to the Petitioner's selected DNA analyst, the Serological Research Institute ("SERI"). On February 28, 2022, the Court entered another agreed order transferring samples of the Petitioner's, Jason Burnett's, and Judith Smith's blood, along with a sample of Chad Burnett's hair, to SERI. Counsel for the Petitioner explains the resubmission of these samples as follows:

> As noted in the SERI report, the technology used here [to conduct the touch DNA anlaysis] is so new that [the examiner] had to re-examine the "known" specimens previously analyzed in 2016 so that a scientifically valid comparison could be achieved. Ex 4, SERI Rep. at 2 (noting resubmission of items); *see also* Second DNA Order, February 28, 2022 (releasing the known samples to SERI pursuant to the parties' agreement).

Smith motion at 6 n.3 (alterations added).

On March 30, 2022, SERI forensic DNA analyst Gary Hamor (and a "technical reviewer" whose electronic signature appears only as the initials "PH") submitted SERI's report on the agency's DNA analysis to the Petitioner's lead attorney, Amy Harwell. Regarding SERI's testing of the awl handle, which consisted of comparing a "touch DNA" sample obtained from the awl handle against known DNA samples from the Petitioner and the three victims, the report stated:

> a. A DNA mixture was obtained.
>
> b. The DNA mixture was interpreted as originating from two contributors with a major male contributor. Chad Burnette *[sic]* could be the major contributor to this mixture. The chance that a randomly selected, unrelated person would have the same profile as the major contributor is approximately 1 in 4 octillion.

c. Oscar Smith, Jason Burnette *[sic]*, and Judy Smith are all excluded as contributors to the DNA results obtained from this item.

d. The minor portion of the mixture is suitable for comparison.

SERI Report, at 4 (included as Exhibit 4 to Petitioner's current motion).

As stated above, the DNA profile obtained from the awl handle consists of "touch DNA." In explaining the timing of the Petitioner's current motion, Petitioner's attorneys write,

> Though it has been theoretically possible to develop "touch DNA" for several years, the Applied Biosystems™ GlobalFiler™ PCR Amplification Kit was not developed until 2012 and did not become available in most labs until after 2017. Ex.4 at 8. SERI Rep. The fully continuous probabilistic genotyping software program used for analysis on the awl, Bullet Proof Sentry, was not available until 2022. *Id.* That is, touch DNA was not available until well after Mr. Smith's trial and post-conviction proceedings, and the technology used to perform the touch DNA analysis that supports this Motion was not available until this year. Ex. 4, SERI Report at 8

Petitioner's motion, at 5-6 (footnote omitted).

IV. Applicable Legal Standards

A. Motions to Reopen Post-Conviction Proceedings

Tennessee Code Annotated section 40-30-117 states, in relevant part,

> (a) A petitioner may file a motion in the trial court to reopen the first post-conviction petition only if the following applies:
>
> [. . .]
>
> (2) The claim in the motion is based upon new scientific evidence establishing that the petitioner is actually innocent of the offense or offenses for which the petitioner was convicted; [and]
>
> [. . .]
>
> (4) It appears that the facts underlying the claim, if true, would establish by clear and convincing evidence that the petitioner is entitled to have the conviction set aside or the sentence reduced.

> (b) The motion must set out the factual basis underlying its claims and must be supported by affidavit. The factual information set out in the affidavit shall be limited to information which, if offered at an evidentiary hearing, would be admissible through the testimony of the affiant under the rules of evidence. The motion shall be denied unless the factual allegations, if true, meet the requirements of subsection (a). If the court grants the motion, the procedure, relief and appellate provisions of this part shall apply.
>
> (c) If the motion is denied, the petitioner shall have thirty (30) days to file an application in the court of criminal appeals seeking permission to appeal. The application shall be accompanied by copies of all the documents filed by both parties in the trial court and the order denying the motion. The state shall have thirty (30) days to respond. The court of criminal appeals shall not grant the application unless it appears that the trial court abused its discretion in denying the motion. If it determines that the trial court did so abuse its discretion, the court of criminal appeals shall remand the matter to the trial court for further proceedings.

Tenn. Code Ann. § 40-30-117(a)(2), (b)-(c).

"In order to satisfy the requirements of § 40-30-[1]17, a petitioner must delineate, in the motion to reopen, the new scientific evidence that has already been secured and which will establish his or her actual innocence." *Ray v. State*, 984 S.W.2d 236, 238 (Tenn. Crim. App. 1997) (alteration added, emphasis deleted).

B. Post-Conviction DNA Analysis Act

The Post-Conviction DNA Analysis Act allows, under certain circumstances, individuals convicted of certain crimes, including first degree murder, to obtain DNA testing of certain evidence at any time. *See* Tenn. Code Ann. §§ 40-30-301 through -313. Specifically, the court *shall* order DNA analysis if it finds:

> (1) A reasonable probability exists that the petitioner *would not have been prosecuted or convicted* if exculpatory results had been obtained through DNA analysis;
>
> (2) The evidence is still in existence and in such a condition that DNA analysis may be conducted;

> (3) The evidence was never previously subjected to DNA analysis or was not subjected to the analysis that is now requested which could resolve an issue not resolved by previous analysis; and
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> (4) The application for analysis is made for the purpose of demonstrating innocence and not to unreasonably delay the execution of sentence or administration of justice.

Tenn. Code Ann. § 40-30-304 (emphasis added). The Court *may* order DNA testing if a "reasonable probability exists that analysis of the evidence will produce DNA results that *would have rendered the petitioner's verdict or sentence more favorable* if the results had been available at the proceeding leading to the judgment of conviction" and elements (2) through (4) listed in subsection -304 are met. Tenn. Code Ann. § 40-30-305 (emphasis added).

A "reasonable probability" of a different result exists when potentially favorable DNA testing results "undermine the confidence in the outcome of the prosecution." *Sedley Alley v. State*, No. W2006-01179-CCA-R3-PD, 2006 WL 1703820, at *14 (Tenn. Crim. App. June 22, 2006). "Under section 40-30-304(1), therefore, prior to a mandatory order of testing, a petitioner's argument must merely establish 'a probability sufficient to undermine confidence' in the decision to prosecute or in the conviction had the State or the jury known of exculpatory DNA testing results." *State v. Powers*, 343 S.W.3d 46, 55 (Tenn. 2011). Under section 40-30-305(1), then, the petitioner must establish only "a probability to undermine confidence" in the petitioner's conviction or sentence had the jury known about exculpatory DNA evidence at trial.

"In making its decision [on the DNA petition], the post-conviction court must consider all the available evidence, including the evidence presented at trial and any stipulations of fact made by either party." *Powers*, 343 S.W.3d at 56. When reviewing a DNA petition, the court assumes the DNA testing will reveal exculpatory evidence, and

"the evidence must be viewed in light of the effect that exculpatory DNA evidence would have had on the fact-finder or the State." *Id.* at 55. However, "there is no presumption of innocence afforded to a petitioner" who files a DNA post-conviction petition. *Charles Elsea v. State*, No. E2017-01676-CCA-R3-PC, 2018 WL 2363589, at *4 (Tenn. Crim. App. May 24, 2018), *no perm. app. filed.* The petitioner bears the burden of establishing all four criteria under T.C.A. sections 40-30-304 and -305, and "[t]he court must dismiss the petition if the petitioner fails to establish each of the four criteria required" in the statute. *Powers*, 343 S.W.3d at 48.

The Tennessee Supreme Court has concluded DNA testing available to a post-conviction petitioner may include a comparison between the evidence at issue and other profiles contained in a DNA database—in other words, the comparison is not limited merely to the petitioner's DNA profile. *See id.* at 49-50.

V. Application to Present Case

The Court first addresses the timing of Petitioner's current motion. The Court observes that the post-conviction DNA analysis act allows a person to file a motion for DNA testing "at any time," Tenn. Code Ann. § 40-30-103, and no limitations period is listed in the statutory provision permitting a post-conviction petitioner to file a motion to reopen based on scientific evidence of actual innocence, *see* Tenn. Code Ann. § 40-30-117(a)(2). Although the current motion was filed seventeen days before Mr. Smith's scheduled execution date, the process which led to the motion began on January 19, 2022, when this Court entered the order transferring the awl to the Petitioner's selected DNA lab for testing. The timing of the motion is far from ideal, but this Court has no reason to

believe the timing results from an attempt to "unreasonably delay the execution of sentence or administration of justice," as contemplated in T.C.A. sections 40-30-404(4) and 40-30-405(4).

However, even in viewing the evidence in the light most favorable to the Petitioner—in this case the Court has no reason to doubt that SERI's testing of the touch DNA obtained from the crime scene awl revealed a profile that was, conclusively, not that of Mr. Smith—the Petitioner is not entitled to relief through a motion to reopen or under the post-conviction DNA act. As this Court set forth in its order dismissing Mr. Smith's post-conviction fingerprint petition, extensive evidence of the Petitioner's guilt was introduced at trial. The Court of Criminal Appeals summarized that evidence in its opinion affirming this Court's dismissal of the fingerprint petition:

> As the trial court observed, "the State possessed extensive circumstantial evidence against Petitioner other than the palm print, including (1) Petitioner's prior threats against and/or prior violence involving the victims; (2) a neighbor seeing Petitioner's car in the victims' driveway the night of the murders; (3) life insurance policies taken out by Petitioner on the lives of the three victims, and (4) one of the child victims yelling out 'Frank, no!' on the 911 recording." Moreover, as the trial court noted, "[t]he evidence introduced at trial suggested Petitioner (and nobody else) had motive to kill the victims." Two of Petitioner's co-workers testified Petitioner solicited them to kill his wife. Likewise, as summarized above, evidence, in addition to the neighbor's testimony, was introduced to contest Petitioner's alibi defense. The jury also learned Petitioner referred to his estranged wife in the past tense during questioning by the police and he did not "ask the officers the logical questions of where, when, how and by whom" when he was informed about the murders. *Oscar Smith*, 2005 WL 2416504, at *4.[3] The post-conviction evidence also revealed Petitioner "was not contesting that the print was his; he was claiming that someone planted the print at the scene." *Oscar Franklin Smith*, 1998 WL 345353, at *15.[4] Even Bright-Birnbaum could not conclusively state Petitioner did not leave the bloody palm print at the crime scene.

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[3] *Oscar Smith v. Ricky Bell, Warden*, No. 3:99-0731, 2005 WL 2416504 (M.D. Tenn. Sept. 30, 2005) (federal district court order dismissing habeas corpus petition).

[4] *Oscar Franklin Smith v. State*, No. 01C01-9702-CR-00048, 1998 WL 345353 (Tenn. Crim. App. Jun 30, 1998) (affirming denial of post-conviction relief).

Smith fingerprint opinion, 2022 WL 854438, at *16 (footnotes added); *see also id.* at **2-7 (quoting list of facts set forth in federal district court opinion denying habeas corpus petition; this Court's November 2021 order denying fingerprint motion also quoted that list). Additionally, this Court notes that in the DNA testing performed by Petitioner's selected laboratory, Mr. Smith's DNA "could be included as [a] contributor[] to the DNA results obtained" from the left sleeve of an "off-white long sleeve shirt with large red/brown stains."[5] Presumably, this article of clothing was a bloodstained item worn by one of the victims at the time of that person's death.

To quote further from the Court of Criminal Appeals' opinion,

> In the case at hand, if we stacked the assumed most favorable [touch DNA] evidence on one side of a set of scales and the trial evidence on the other, the [touch DNA] evidence would not even begin to affect the scales or tip them in Petitioner's favor, either as to the guilty verdict or the sentences of death.

Smith fingerprint opinion, 2022 WL 854438, at *17 (alterations added).

Thus, the Court concludes there is not a reasonable probability that the recently-discovered DNA evidence would have prevented Mr. Smith's prosecution or conviction. Nor is there a reasonable probability the recently-discovered DNA evidence would have resulted in a more favorable conviction or sentence for Mr. Smith had the DNA evidence been presented at trial. Thus, Mr. Smith is not entitled to relief under either T.C.A. section 40-30-304 or section 40-30-305.[6] Similarly, given the extensive evidence of Mr. Smith's guilt produced at his trial, even when considering the DNA evidence resulting from SERI's

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[5] *See* SERI testing report at 2-3 (exhibit 4 to present motion).

[6] The Court observes that the touch DNA evidence at issue in this case had not been subjected previously to the type of testing conducted by SERI. While the awl still exists in a condition in which it can be tested, it is unclear whether the awl was preserved in such a manner that would have assured the DNA profiles were left at the crime scene and did not result from contamination. Had the other elements of sections 40-30-304 and -305 been met, however, this Court would have allowed the Petitioner to present evidence concerning this issue at an evidentiary hearing.

recent testing in a light most favorable to the Petitioner, the Court concludes Mr. Smith would be unable to prove by clear and convincing evidence that the DNA evidence establishes he is actually innocent of the offenses for which he was convicted. Thus, he is not entitled to reopen his post-conviction proceedings under T.C.A. section 40-30-117(a)(2).[7]

VI. Conclusion

For the reasons stated above, Mr. Smith's motion to reopen and motion for relief under the post-conviction DNA analysis act is DENIED.

Per T.C.A. section 40-30-309, the Court ORDERS that all DNA evidence which could be subject to future testing shall be preserved to facilitate appellate review and any additional testing which may occur later.

A copy of this Order shall be provided to the Office of the Attorney General and Reporter.

IT IS SO ORDERED this the 11th day of April, 2022.

Angelita Blackshear Dalton
Criminal Court Judge, Division II

[7] The Court observes the Petitioner's allegations are not supported by affidavit, as is required by T.C.A. section 40-30-117(b). Had this Court concluded the Petitioner was entitled to have his post-conviction proceedings reopened, the Court would have permitted Petitioner's counsel to correct this oversight.

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APPENDIX C

Smith's Motion to Reopen Post-Conviction Proceedings Before The Tennessee State Courts

IN THE CRIMINAL COURT FOR DAVIDSON COUNTY, TENNESSEE AT NASHVILLE
DIVISION II

2022 APR -4 PM 12:25

OSCAR SMITH	)	
	)	
Petitioner	)	
	)	No. 89-F-1773
v.	)	**Capital Case**
	)	
STATE OF TENNESSEE	)	
	)	**EXECUTION DATE:**
Respondent	)	**APRIL 21, 2022**

MOTION TO REOPEN POST-CONVICTION PROCEEDINGS AND/OR FOR REVIEW UNDER THE POST-CONVICTION DNA ANALYSIS ACT OF 2001

After 32 years of adamantly asserting his innocence, Oscar Smith finally has proof that someone else murdered his family. Indeed, he now has the perpetrator's fingerprints and DNA. Last year Mr. Smith presented proof in this Court showing that the unknown assailant's fingerprints were on the awl that was indisputably used in the murders for which he was sentenced to death. Ex. 1, Report of Kathleen Bright--Birnbaum; *see* Ex. 2, TT Vol. 18, pp. 2566, 2600 (describing the wounds created by the awl). Mr. Smith also presented new expert palm print analysis that eviscerated the state's sole "scientific" proof at his capital trial—Sergeant Johnny Hunter's testimony that there was "no doubt" that the palm print at the murder scene belonged to Smith. Despite his proof that "the most important piece of evidence presented to the jury," was, in the end, junk science, the courts closed their doors to Mr. Smith. Ex. 3, DA Letter; *see Smith v. State*, No.

IN THE CRIMINAL COURT FOR DAVIDSON COUNTY,
TENNESSEE AT NASHVILLE
DIVISION II

OSCAR SMITH	)	
	)	
Petitioner	)	
	)	No. 89-F-1773
v.	)	**Capital Case**
	)	
STATE OF TENNESSEE	)	
	)	**EXECUTION DATE:**
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M202101339CCAR3PD, 2022 WL 854438, at *1 (Tenn. Crim. App. Mar. 23, 2022).

Now, as a result of new technological advances in DNA analysis, Mr. Smith has discovered DNA left behind by the murderer in that unknown print on the awl. Ex. 4, SERI Report. He files the instant Motion seeking review and relief, either through the reopening of his petition for postconviction relief or through a new action under the Post-Conviction DNA Analysis Act of 2001. The courts must listen now—or in 17 days, Tennessee will execute an innocent man.

I. Factual and Procedural Background

As this Court is aware, Mr. Smith attempted to present proof of his innocence in July 2021. He filed, on the day relief became available, a Petition pursuant to the newly-enacted Post-Conviction Fingerprint Analysis Act of 2021, Tenn. Code Ann. §§ 40-40-403 through 40-40-413. In support of that Petition, Mr. Smith presented the declaration of Kathleen Bright-Birnbaum, a pre-eminent fingerprint examiner who primarily testifies for law enforcement. Ms. Bright-Birnbaum revealed that the identification of Mr. Smith by then -Sgt. Hunter of the Metro Police Department was "not supported."

He also presented the Court with Ms. Bright-Birnbaum's earlier analysis, wherein she found that Hunter had made multiple other errors besides wrongly "identifying" Mr. Smith. *See* Ex. 1 Bright-Birnbaum Report. While any error in fingerprint identification is horrifying, it is hard to evaluate which of Hunter's errors was most egregious.

First, after mishandling the evidence in Mr. Smith's case, Hunter failed to identify his own fingerprint among those collected, intrinsically

demonstrating incompetence and lack of professionalism. *Id.* at 12 (identifying latent print #001-01A—which Hunter identified as having come from the awl and labeled as "N/V" (or no value)—"as having been made by the Left Ring finger of Officer Hunter beneath the lift tape"); *see* U.S. Dep't of Just., Off. of Just. Programs, *Crime Scene Investigation: A Guide for Law Enforcement* 26–28 (2000) (because "handling of physical evidence is one of the important factors of the investigation," officers "shall ensure the effective collection, preservation, packaging, and transport of evidence" and should prioritize collecting evidence in a manner that "prevent[s] loss, destruction, or contamination"); 1 Am. Jur. Trials 555, *Locating & Preserving Evidence* § 21 (2022 update) (when picking up objects at a crime scene, the investigating officer must use "proper methods of moving, marking, packaging, and transporting the article, with the least possible chance of destroying or contaminating the evidence it may disclose," as it is "inexcusable for any investigator to go to the scene of a crime and handle objects promiscuously, open or close drawers, or move papers before they have been photographed and examined for fingerprints"); *see id.* at § 107 ("In moving an article suspected of having friction-ridge prints, the investigator should realize that he cannot handle the item indiscriminately merely because he is wearing gloves or is using a handkerchief or other fabric. It is true that this will prevent him from leaving his own prints, but it may also destroy prints already on the object....Whenever an investigator moves an article while wearing gloves or using a handkerchief, he should tell the lab expert that he has done so.").

Additionally, Hunter then identified Mr. Smith as the murderer

based upon a biased and scientifically unsupported palm print analysis procedure, and he testified to that finding to an absolute certainty. Ex. 5, Trial Testimony Excerpt at 2010. Identifying the wrong man is particularly horrifying in a capital case, and the harm done to Mr. Smith cannot be overstated.

Arguably, however, Hunter's most egregious error was in failing to realize that he had an identifiable print from the perpetrator on the murder weapon itself. The perpetrator left a fingerprint on the awl. *See, Ex. 2,* TT Medical Examiner Testimony pps. 65,120(describing wounds inflicted by awl; *see also*, Ex. 6, Supp. TT of Opening and Closing Statements at 6 (arguing "[a]nd he had taken three weapons with him, a .22 pistol, a buck knife, which he carried frequently, and what's called an awl, which is like an ice pick, which is a leatherworking tool").

Hunter collected the perpetrator's print from the awl, but marked it as "N/V,"—or, "no value"— indicating that it could not be used for identification. Ex. 7, Hunter Report (dismissing 30 prints, including that on the awl, as having "no identifiable value"). As part of federal litigation, Bright-Birnbaum re-analyzed the prints lifted by Hunter and determined that Hunter had made 14 errors.[1] Among the errors was Hunter's

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[1] For procedural reasons relating to the scope of the remand from the Supreme Court of the United States, Mr. Smith's actual innocence was not before the federal courts in 2016. Instead, he was constrained to the development and presentation of claims of ineffective assistance of counsel and post-conviction counsel under *Martinez v. Ryan*, 556 U.S. 1 (2012).

determination that the print on the awl, Item 001-01B, had no value. *See id*; Ex. 1, Bright-Birnbaum Report at 1-2. In addition to determining that Mr. Smith did not leave that print on the awl, Bright-Birnbaum found that Item 001-01B *was* identifiable—that is, enough of the print from the awl was lifted and preserved to provide sufficient information such that a comparison could be made. *Id.* at 2. Despite his compelling claim, the courts closed their doors to Mr. Smith for procedural reasons. *Smith v. State*, No. M202101339CCAR3PD, 2022 WL 854438, at *1 (Tenn. Crim. App. Mar. 23, 2022).

With his entitlement to relief based on the fingerprint evidence on appeal,[2] Mr. Smith learned that new DNA technology is available. Though it has been theoretically possible to develop "touch DNA" for several years, the Applied Biosystems™ GlobalFiler™ PCR Amplification Kit was not developed until 2012 and did not become available in most labs until after 2017. Ex.4 at 8, SERI Rep. The fully continuous probabilistic genotyping software program used for analysis on the awl, Bullet Proof Sentry, was not available until 2022. *Id.* That is, touch DNA was not available until well after Mr. Smith's trial and post-conviction proceedings, and the technology used to perform the touch DNA analysis that supports this Motion was not available until

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[2] Mr. Smith filed his Application for Permission to Appeal the denial of his Fingerprint Act petition to the Tennessee Supreme Court pursuant to Tennessee Rule of Appellate Procedure 11 on March 28, 2022. His Application remains pending as of the date of this filing.

this year. Ex. 4, SERI Report at 8.[3]

Upon realizing that Bright-Birnbaum's analysis showed that the unknown murderer's print was on the murder weapon and that new scientific procedures were available to obtain profiles in such circumstances, Mr. Smith sought touch DNA analysis of the awl. On January 19, 2022, this Court, seeing the agreement of the parties, ordered the release of the awl to Mr. Smith's DNA analyst. January 19, 2022 Agreed Order. On February 28, 2022, this Court ordered release of the known samples back to SERI. , 2d Agreed Order. Re-analysis of the known samples was required because the prior analysis results were not sufficient for comparison with the new technology used to analyze the biological material left behind on the awl.

On March 30, 2022, SERI issued a report confirming the presence of the unknown assailant's DNA on the murder weapon. Ex. 4, SERI Report at 4. That is, SERI found an identifiable DNA profile on the murder weapon and *definitively excluded* Oscar Smith as the contributor of that DNA. *Id.*

The significance of this result cannot be overstated: Oscar Smith has, using new touch DNA technology, demonstrated that he is not the

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[3] As noted in the SERI report, the technology used here is so new that he had to re-examine the "known" specimens previously analyzed in 2016 so that a scientifically valid comparison could be achieved. Ex. 4, SERI Rep. at 2 (noting resubmission of items); *see also* Second DNA Order, February 28, 2022 (releasing the known samples to SERI pursuant to the parties' agreement).

person who used the awl to kill his family. Unlike other cases, there has never been any question that this crime was committed by one person. Indeed, in both opening and closing arguments, the prosecution argued that Mr. Smith, by himself, committed this crime. Ex. 6, Supp. TT of Open and Closing Statements at 4 ("Then he made the conscious decision, when he couldn't find someone else to do this dirty work for him, that he would kill."); *id.* at 4-8 (arguing that Mr. Smith committed the murders alone); *id.* at 62-64 (arguing that "there is only one man" who committed the crime). Mr. Smith did not kill his family. For 32 years, he has maintained his innocence and has attempted the nearly impossible task of proving a negative—that he did *not* murder anyone. Mr. Smith now presents this court with new scientific proof of his actual innocence: the fingerprint and the DNA of the perpetrator. He is entitled to relief.

II. Motion to Reopen Petition for Post-Conviction Relief

Pursuant to Tennessee Code Annotated § 40-30-117, a petitioner may, in certain circumstances, have his post-conviction petition reopened by the trial court. One such circumstance is where the petitioner obtains "new scientific evidence establishing that the petitioner is actually innocent of the offense or offenses for which the petitioner was convicted[.]" Tenn. Code Ann. § 40-30-117(a)(2). The petitioner must allege facts which, if true, would "establish by clear and convincing evidence that the petitioner is entitled to have the conviction set aside or the sentence reduced." Tenn. Code Ann. § 40-30-117(a)(4); Tenn. Code Ann. § 40-30-117(b) (the factual basis must be supported by affidavit and "shall be limited to information which, if offered at an evidentiary hearing, would be admissible through the testimony of the affiant under

the rules of evidence").

Based upon the new scientific evidence contained in the SERI Report, this Court must permit Mr. Smith to reopen his post-conviction proceedings, and he should be granted an evidentiary hearing. At that evidentiary hearing, Mr. Smith should be permitted to present all evidence supporting his actual innocence to meet his burden of showing that his murder convictions should be set aside or, at a minimum, that his death sentence should be vacated.

III. Post-Conviction DNA Analysis Act of 2001

The availability of STR technology and DNA testing databases have produced scores of DNA exonerations in recent years that have been nothing less than astonishing—both because of the minute traces of biological material involved and because of the grave errors revealed in a host of criminal cases where the defendants' guilt had appeared to be beyond dispute. The Tennessee legislature, through the Post-Conviction DNA Analysis Act of 2001, Tenn. Code Ann. § 40-30-301, *et seq.*, (the "DNA Act"), recognized the importance of granting access to DNA testing to individuals convicted of serious crimes and review of the integrity of those convictions in light of the results of such testing. The Act's legislative history shows it has two purposes: "to aid in the exoneration of those who are wrongfully convicted," and "to aid in identifying the true perpetrators of the crimes." *Powers v. State*, 343 S.W.3d 36, 44, 59 (Tenn. 2011). In recognition of those broad dual goals and the grave but real danger of wrongful conviction, the Tennessee Supreme Court has acknowledged that "[t]here is nothing in the Act limiting DNA testing to only those cases in which there was tenuous evidence supporting the

jury's finding of guilt." *Id.* at 57.

The DNA Act provides a procedural mechanism whereby convicted persons in Tennessee can seek exoneration through DNA testing. A petitioner, may, "at any time, file a petition requesting the forensic DNA analysis of any evidence that is in the possession or control of the prosecution, law enforcement, laboratory, or court, and that is related to the investigation or prosecution that resulted in the judgment of conviction and that may contain biological evidence." Tenn. Code Ann. § 40-30-303. The Court may order DNA analysis if it finds:

> (1) A reasonable probability exists that analysis of the evidence will produce DNA results that would have rendered the petitioner's verdict or sentence more favorable if the results had been available at the proceeding leading to the judgment of conviction;
>
> (2) The evidence is still in existence and in such a condition that DNA analysis may be conducted;
>
> (3) The evidence was never previously subjected to DNA analysis, or was not subjected to the analysis that is now requested which could resolve an issue not resolved by previous analysis; and
>
> (4) The application for analysis is made for the purpose of demonstrating innocence and not to unreasonably delay the execution of sentence or administration of justice.

Tenn. Code Ann. § 40-30-305. The testing must be performed by "a laboratory that meets the standards adopted pursuant to the DNA Identification Act of 1994 (42 U.S.C. § 14131 *et seq.*)." Tenn. Code Ann.

§ 40-30-310. "If the results of the post-conviction DNA analysis are favorable, the court shall order a hearing[.]" Tenn. Code Ann. § 40-30-312.

In this case, the parties agreed to DNA analysis, and the Court ordered release of the evidence for the purpose of the SERI examination. Feb. 22, 2022 Order. SERI meets the standards adopted pursuant to the DNA Identification Act of 1994, as required by Tennessee Code Annotated § 40-30-310. Ex. 8, SERI Accreditation Certificate. And there can be no serious doubt that the identification of a DNA profile on a murder weapon that *excludes* the condemned and the victims is "favorable" evidence. *See* Tenn. Code Ann. § 40-30-312. Thus, SERI's identification of the unknown assailant's DNA on the murder weapon entitles Mr. Smith to a hearing under the DNA Act.

As outlined above, the DNA Act does not contain a limitations period. Rather a petitioner may file a petition pursuant to the DNA Act "at any time," Tenn. Code Ann. § 40-30-303. A petitioner must nonetheless make his petition for "the purpose of demonstrating innocence and not to *unreasonably* delay the execution of sentence or administration of justice." Tenn. Code Ann. § 40-30-305(4) (emphasis added). While delay of Mr. Smith's execution could conceivably be required for this Court to be able to adjudicate Mr. Smith's entitlement to relief, Mr. Smith has been doggedly seeking this proof and has brought it to Court as soon as practicable after obtaining the results. This application is not driven by a desire to unreasonably delay the execution of Mr. Smith's sentence or the administration of justice. Rather, Mr. Smith seeks to demonstrate what he has maintained from the very

start—that he is not the perpetrator of this crime.

While there is no case law from Tennessee courts interpreting the DNA Act's unreasonable delay provision with respect to capital cases, at least one court in Texas, interpreting a similar provision of Texas law, granted a testing request submitted *the same day* a petitioner was set to be executed. In *Pruett v. State*, No. AP-77,065, 2017 WL 1245431, at *5 (Tex. Crim. App. Apr. 5, 2017), the court granted the last-minute request even though it "ha[d] no doubt the request for the proposed DNA testing was made to delay the execution of sentence" because "although such delay tactics appear to be unreasonable, it is not clear that they, in fact, are unreasonable. Although unlikely, it is not impossible to conceive that there could be exculpatory results[.]"

The same logic applies here. This is not a case where a last-minute claim has been brought based upon long-known facts or where a petitioner has slept on his rights. *See Ramirez v. Collier*, --- S. Ct. ----, 2022 WL 867311, at *13 (U.S. Mar. 24, 2022) (citing *Gomez v. U.S. Dist. Ct. for N. Dist. of Cal.*, 503 U.S. 653, 654 (1992) (*per curiam*); *Gildersleeve v. New Mexico Mining Co.*, 161 U.S. 573, 578 (1896)). Rather, Mr. Smith has steadfastly maintained his innocence and has been attempting to prove his innocence in Tennessee state court for the better part of a year. This is instead a case where the development of new law and new scientific testing and methodology have allowed Mr. Smith—who has been incarcerated for more than three decades—to obtain new and previously unavailable facts that prove his innocence. *Herrera v. Collins*, 506 U.S. 390 (1993) ("[I]n a capital case a truly persuasive demonstration of 'actual innocence' made after trial would render the execution of a

defendant unconstitutional[.]"); *see, e.g.*, *House v. Bell*, 547 U.S. 518 (2006) (new DNA evidence excluding capital petitioner as source of semen found in murder victim was "of central importance" where identity was an issue and where the previous DNA evidence pointing to petitioner was the sole forensic evidence presented to the jury); *Aguirre-Jarquin v. State*, 202 So.3d 785 (Fla. 2016) (ordering new trial and vacating death sentence for capital petitioner where new DNA evidence showed profile of alternate perpetrator, supporting petitioner's trial theory and persistent protestations of innocence). There is nothing unreasonable about seeking to use new information to save one's own life by proving one's innocence, no matter when that request is made. The Court should order a hearing.

IV. Prayer for Relief

Mr. Smith respectfully requests the following:

1. This Court should grant the Motion to Reopen and set this case for further proceedings.

2. Having shown that the results of the post-conviction DNA analysis are favorable to Mr. Smith, this Court should order a hearing pursuant to Section 40-30-312.

4. Mr. Smith requests any and all process or relief as this Court deems necessary and appropriate in the interests of justice and to effectuate the purpose of Tennessee Code Annotated § 40-30-117 and/or the DNA Act.

Respectfully submitted,

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BY: 

Counsel for Oscar Smith

CERTIFICATE OF SERVICE

I, Amy D. Harwell, certify that on April 4, 2022, a true and correct copy of the foregoing was sent to the Office of the District Attorney General, 226 2nd Avenue North, Suite 500, Washington Square, Nashville, Tennessee, 37201-1649.

BY: 

Counsel for Oscar Smith

APPENDIX D

Smith's Motion For Emergency Temporary Restraining Order Before the District Court

IN THE UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF TENNESSEE
NASHVILLE DIVISION

OSCAR SMITH Plaintiff v. BILL LEE, in his official capacity as Governor of the State of Tennessee HERBERT SLATERY, in his official capacity as the Attorney General of the State of Tennessee LISA HELTON, in her official capacity as the Interim Commissioner of the Tennessee Department of Correction, TONY MAYS, in his official capacity as Warden, Riverbend Maximum Security Institution, Defendants.	)	**CAPITAL CASE** No. _____ **EXECUTION SCHEDULED:** **APRIL 21, 2022**

EMERGENCY MOTION AND MEMORANDUM IN SUPPORT FOR TEMPORARY RESTRAINING ORDER

Plaintiff Oscar Smith respectfully moves this Court for a temporary restraining order prohibiting Defendants from executing Mr. Smith on April 21, 2022, to afford Mr. Smith time to litigate his Section 1983 lawsuit challenging the violation of his First and Fourteenth Amendment rights.

I. Background

After 32 years of adamantly asserting his innocence, Oscar Smith finally has proof that someone else murdered his family. Indeed, he now has the perpetrator's fingerprints and DNA. Ex. 1, SERI DNA Report. Last year Mr. Smith presented

proof in state court showing that the unknown assailant's fingerprints were on the awl that was indisputably used in the murders for which he was sentenced to death. Mr. Smith also presented new expert palm print analysis that eviscerated the state's sole putatively "scientific" proof at his capital trial—Sergeant Johnny Hunter's testimony that there was "no doubt" that the palm print at the murder scene belonged to Smith. Despite his proof that "the most important piece of evidence presented to the jury," was, in the end, junk science, the courts closed their doors to Mr. Smith. Ex. 10, DA Letter; *see Smith v. State*, No. M2021-01339-CCA-R3-PD, 2022 WL 854438, at *1 (Tenn. Crim. App. Mar. 23, 2022).

Now, as a result of new technological advances in DNA analysis, Mr. Smith has also discovered DNA left behind by the murderer in that unknown print on the awl. Ex. 1. Though it has been theoretically possible to develop "touch DNA" for several years, the Applied Biosystems™ GlobalFiler™ PCR Amplification Kit was not developed until 2012 and did not become available in most labs until after 2017. *Id.* at 8. The fully continuous probabilistic genotyping software program used for analysis of the DNA mixture on the awl, Bullet Proof Sentry, was not available until 2022. *Id.* That is, touch DNA was not available until well after Mr. Smith's trial and post-conviction proceedings, and the technology used to isolate the assailant's DNA from the victim's blood on the awl was not available until this year. *Id.*

On March 30, 2022, SERI issued a report confirming the presence of the unknown assailant's DNA on the murder weapon. *Id.* at 4. That is, SERI found an

identifiable DNA profile on the murder weapon and *definitively excluded* Oscar Smith as the contributor of that DNA. *Id.*

The significance of this result cannot be overstated: Oscar Smith has, using new touch DNA technology, demonstrated that he is not the person who used the awl to kill his family. Unlike other cases, there has never been any question that this crime was committed by one person. Indeed, in both opening and closing arguments, the prosecution argued that Mr. Smith, by himself, committed this crime. Mr. Smith did not kill his family. For 32 years, he has maintained his innocence and has attempted the nearly impossible task of proving a negative—that he did *not* murder anyone.

Mr. Smith immediately sought to present Tennessee's courts with his new scientific proof of his actual innocence: the fingerprint and the DNA of the perpetrator. On April 4, 2022, just days after receiving the SERI report, Mr. Smith filed his Motion to Reopen Post-Conviction Proceedings and/or for Review Under the Post-Conviction DNA Analysis Act of 2001, pursuant to Tennessee Code Annotated § 40-30-117 and § 40-30-301, *et seq*. Ex. 2, Smith DNA Motion & Petition. In less than two weeks, and without the benefit of a response from the State, let alone an evidentiary hearing, every level of Tennessee's courts rejected his attempts to have his evidence of actual innocence meaningfully considered prior to his execution. Ex. 3, Apr. 11, 2022 criminal court Order denying Smith DNA Motion & Petition; Ex. 4, Apr. 11, 2022 motion to reconsider; Ex. 5, Apr. 12, 2022 criminal court Order denying Smith Motion to reconsider; Ex. 6, April 12, 2022 Motion for Expedited Briefing; Ex.

7, Apr. 13, 2022 Application for Permission to Appeal to the CCA; Ex. 8, Apr. 14, 2022 CCA Order Denying Permission to Appeal; Ex. 9, Apr. 18, 2022 Tennessee Supreme Court Order Denying Application for Permission to Appeal.

Mr. Smith has now filed suit in this Court, seeking redress for the State's denial of his rights to due process and access to courts under the First and Fourteenth Amendments to the U.S. Constitution. He files the instant request for injunctive relief contemporaneous therewith, to prevent the State of Tennessee from executing an innocent man before such claims can be fully presented and considered on the merits. This Court should take action to prevent this case from becoming moot pursuant to the Court's authority under Article III of the United States Constitution, 42 U.S.C. § 1983, and 28 U.S.C. § 1651(a) (All Writs Act).[1]

II. Standard for Temporary Restraining Order

In determining whether to issue a temporary restraining order pursuant to Rule 65 of the Federal Rules of Civil Procedure, this Court is to consider: (1) Mr. Smith's likelihood of success on the merits; (2) whether Mr. Smith may suffer irreparable harm absent the injunction; (3) whether granting the injunction will cause substantial harm to others; and (4) the impact of the injunction on the public interest. *Abney v. Amgen, Inc.*, 443 F.3d 540, 546 (6th Cir. 2006). When determining whether to issue a temporary restraining order ("TRO"), a threat of an immediate, irreparable harm must be present. Fed. R. Civ. P. 65(b)(1)(A) (requiring a court to examine, on application for a TRO, whether "specific facts in an affidavit or a

[1] This motion is being filed under extreme exigency. Counsel for the Defendants are being served via email as of the time of this filing.

verified complaint clearly show that immediate and irreparable injury, loss, or damage will result to the movant"); *Cunningham v. First Class Vacations, Inc.*, No. 3:16-cv-2285, 2019 WL 1306214, at *1 (M.D. Tenn. Jan. 11, 2019).

Alternatively, the Sixth Circuit permits a district court, in its discretion, to grant a preliminary injunction or temporary restraining order "even where the plaintiff fails to show a strong or substantial probability of ultimate success on the merits of his claim, but where he at least shows serious questions going to the merits and irreparable harm which decidedly outweighs any potential harm to the defendant if an injunction is issued." *Friendship Materials, Inc. v. Mich. Brick, Inc.*, 679 F.2d 100, 105 (6th Cir. 1982). In other words, "[a]ll four factors are not prerequisites but are interconnected considerations that must be balanced together." *Coal. to Def. Affirmative Action v. Granholm*, 473 F.3d 237, 244 (6th Cir. 2006) (citing *Mich. Coal. of Radioactive Material Users, Inc. v. Griepentrog*, 945 F.2d 150, 153 (6th Cir. 1991)).

Because the same general analytical framework applies to both temporary restraining orders and preliminary injunctions, Mr. Smith relies on cases involving both types of relief.

III. Analysis

a. Likelihood of Success on the Merits

Mr. Smith has filed a two-count complaint containing the following claims: (1) a Fourteenth Amendment claim concerning the denial of procedural due process and (2) a First Amendment claim concerning the denial of his meaningful access to

the courts. Mr. Smith has a cause of action to assert both claims through 42 U.S.C. § 1983. For the reasons stated below, Mr. Smith is likely to succeed on the merits of both constitutional claims.

1) Mr. Smith is Likely to Show He was Denied Procedural Due Process

Mr. Smith raises a facial challenge to the constitutionality of the Tennessee DNA statute. A state's procedures for DNA testing are constitutionally inadequate when they "offend[] some principle of justice so rooted in the traditions and conscience of our people as to be ranked as fundamental, [or] transgresses any recognized principle of fundamental fairness in operation." *Dist. Atty's Off. for Third Jud. Dist. v. Osborne*, 557 U.S. 52, 69 (2009) (quoting *Medina v. Cal.*, 505 U.S. 437 (1992)).

The United States Supreme Court has recognized a constitutionally protected liberty interest in access to post-conviction relief and that a convicted state prisoner may bring a Section 1983 action on the basis that he or she was denied due process in seeking access to such post-conviction relief. See *Skinner v. Switzer*, 562 U.S. 521 (2011). A state's procedures for DNA testing are constitutionally inadequate when they "offend[] some principle of justice so rooted in the traditions and conscience of our people as to be ranked as fundamental, [or] transgresses any recognized principle of fundamental fairness in operation." *Dist. Atty's Off. for Third Jud. Dist. v. Osborne*, 557 U.S. 52, 69 (2009) (quoting *Medina v. Cal.*, 505 U.S. 437 (1992)).

Tennessee recognizes the right to present a substantive claim of actual innocence. *Dellinger v. State*, 279 S.W.3d 282, 290–91 (Tenn. 2009). The DNA Act

provides that a person with favorable DNA results has the right to a hearing to seek release from conviction. Tenn. Code Ann. § 40-30-312 ("If the results of the post-conviction DNA analysis are favorable, the court shall order a hearing . . . ."). When a state law creates a liberty interest, such as the DNA Act, the state's procedures must comport with due process. *Evitts v. Lucey*, 469 U.S. 387, 401 (1985); *see also Est. of Alley v. State*, No. W2019-02046-CCA-R3-PC, 2021 WL 1828501, at *20 (Tenn. Crim. App. May 7, 2021), *appeal denied* (Sept. 22, 2021) (noting that the DNA Act creates a liberty interest). Likewise, when a state creates a judicial remedy, access to that remedy must be fairly afforded. *See Bounds v. Smith*, 430 U.S. 817, 822 (1977). A statutory scheme providing access to post-conviction relief (such as the DNA Act) creates both a liberty interest and a judicial remedy. State procedures to access such relief must not, in their operation, offend principles of justice or fundamental fairness.

The Tennessee courts' interpretation of the DNA Act and Motion to Reopen statute have placed insurmountable roadblocks to Plaintiff, rendering those statutes essentially unavailable to him, in violation of his procedural due process rights.[2] Specifically, the court has read into Tennessee law a rule that petitioners may not access the court if "extensive evidence" of their guilt was introduced at trial, even where DNA evidence is favorable. This is an impossibly high bar.[3] Every

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[2] The criminal court's decision is the last reasoned decision and so, presumably, is also the opinion of the Tennessee Supreme Court.

[3] *See House v. Bell*, 311 F.3d 767, 777 (6th Cir. 2002) (certifying a question to the Tennessee Supreme Court as to whether "Tennessee law require[d] a new trial

capital defendant was convicted because the jury found the evidence presented was sufficient to warrant death. And every state has passed a post-conviction DNA statute precisely because they recognize the significance of DNA evidence and its ability to cause a "strong case" to "evaporate[]." *See United States v. Fasano*, 577 F.3d 572, 578 (5th Cir. 2009). The Tennessee courts' interpretation of the DNA Act ignores the reality that hundreds of people have been exonerated by DNA after having been convicted based on proof that a jury found compelling "beyond a reasonable doubt." *See* Innocence Project, *DNA Exonerations in the United States*, https://innocenceproject.org/dna-exonerations-in-the-united-states/ (last visited Apr. 18, 2022).

Tennessee courts are required to presume that DNA results are exculpatory, and it is difficult to imagine evidence more exculpatory than confirmation that another individual's DNA was found—mixed with the victim's blood—on the murder weapon. By denying Mr. Smith's request for relief under the statutes based on a finding that there was "extensive evidence" against him, the court created an unconstitutional hurdle that renders the statutes toothless and ensures that petitioners cannot vindicate their liberty interests.

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when newly discovered evidence of actual innocence, a significant part of which is in the form of DNA evidence which *could not be discovered* at the time of trial, creates a serious question or doubt that the defendant is guilty of first degree murder?"); *House v. Bell*, Case Nos. 08-5646/08-6155/08-5807, R. 403 (6th Cir. 2009) (noting the voluntary dismissal of the state's appeal of the conditional grant of habeas corpus based upon Mr. House's DNA proof).

The purpose of the DNA Act is thwarted by preclusion of access to evidentiary hearings and other post-conviction procedures and relief. Where the legislature enacted the statute to allow procedures by which an individual could prove their innocence and be released from custody and/or sentence of death, it is fundamentally unfair to petitioners, such as Plaintiff, to have impossible burdens placed upon them. Specifically, when petitioners, such as plaintiff, are denied process even with strong favorable proof, such as the DNA of an unknown person on the murder weapon, the DNA Act is applied in a manner that violates due process of law.

The Tennessee courts have similarly imposed an unconstitutional barrier upon Plaintiff by reading the Motion to Reopen statute as requiring a Plaintiff to satisfy, at the pleading stage, a standard wherein he was required to demonstrate his innocence by "clear and convincing evidence." Contrary to the construction of the Tennessee courts in this matter, the Motion to Reopen statute does not place such a tall burden upon a petitioner. The relevant section of this statute requires a petitioner to present a colorable claim of new scientific evidence of actual innocence and requires a court to assume all facts in the claim will be proven as true at a subsequent hearing. Tenn. Code Ann. § 40-30-117(a)(2), (4); Tenn. S. Ct. R. 28 § 6 (B)(2) (requiring the post-conviction court to "determine whether the petition states a colorable claim"); *Howell v. State*, 151 S.W.3d 450 (Tenn. 2004).

In the instant case, Plaintiff unquestionably identified a theory of innocence: he presented an alibi defense at trial and has always maintained that an alternate

suspect committed the murders. Plaintiff's new DNA analysis evidence is unquestionably new scientific evidence. The exclusion of Plaintiff as the source of the DNA on the murder weapon and the presence of an unknown suspect's DNA is unquestionably favorable. Such evidence strongly supports Plaintiff's theory of innocence and shows a "reasonable probability" of a more favorable verdict or sentence had the jury known about this evidence.

The impossible burden placed on Plaintiff by virtue of the construction of these two statutes by the Tennessee courts is fundamentally unfair and violates his right to due process of law.

2) Mr. Smith is Likely to Show He was Denied Access to the Courts

The Tennessee Courts have closed their doors to Mr. Smith. Because he has a liberty interest in the adjudication of his DNA Action, he is likely to prevail on the merits of his claim that he has been denied access to the courts. As this Court knows, a plaintiff with a nonfrivolous legal claim has the constitutional right to bring that claim to a court of law. *Christopher v. Harbury*, 536 U.S. 403, 415 (2002). This right of access to the courts finds support in several parts of the United States Constitution, including the First Amendment Petition Clause. *Id.* at n.12.

A prisoner may "have a liberty interest in demonstrating his innocence with new evidence under state law" and the state's procedures must afford adequate access to information to vindicate that state's right to post-conviction relief. *Osborne*, 557 U.S. at 68-69, 72. When a state law creates a liberty interest, such as the Post-Conviction DNA Act, the state's procedures must comport with due

process. *Evitts v. Lucey*, 469 U.S. 387, 401 (1985); *see also Est. of Alley v. State*, No. W2019-02046-CCA-R3-PC, 2021 WL 1828501, at *20 (Tenn. Crim. App. May 7, 2021), *perm. app. denied* (Sept. 22, 2021) (noting that the DNA Act creates a liberty interest). Likewise, when a state creates a judicial remedy, access to that remedy must be fairly afforded. *See Bounds v. Smith*, 430 U.S. 817, 822 (1977). A statutory scheme providing access to post-conviction relief is both a liberty interest and a judicial remedy. State procedures to access such relief must not, in their operation, offend principles of justice or fundamental fairness.

Tennessee recognizes the right to present a substantive claim of actual innocence. *Dellinger v. State*, 279 S.W.3d 282, 290–91 (Tenn. 2009); Tenn. Code Ann. §§ 40-30-301, *et seq*. Tennessee law provides that a person with favorable DNA results has the right to a hearing to seek release from conviction. Tenn. Code Ann. § 40-30-312 ("If the results of the post-conviction DNA analysis are favorable, the court shall order a hearing . . . ."). The Tennessee courts have recognized that the purpose of the DNA Act is to "exonerate the wrongfully convicted who are still imprisoned" and to "identify the true perpetrators of their crimes." *Powers v. State*, 343 S.W.3d 36, 51 (Tenn. 2011); *see also Est. of Alley v. State*, No. W2019-02046-CCA-R3-PC, 2021 WL 1828501, at *13 (Tenn. Crim. App. May 7, 2021), *perm. app. denied* (Sept. 22, 2021) (noting the legislative history indicates the two-fold intent of the legislature).

Mr. Smith has proof of his actual innocence in the form of the DNA of the actual perpetrator on the murder weapon. Ex. 1, SERI Report. New DNA

technology released for use earlier this year made it possible to isolate the perpetrator's DNA from the victim's blood on the awl found at the scene of the crime. This never-before-available, cutting-edge DNA technology affirmatively and definitively eliminates Mr. Smith as the source of the DNA on the murder weapon. Despite this proof—and the state courts' acceptance of its veracity—the state courts have refused to give Mr. Smith a forum for the adjudication of his claim. *See*, Ex. 3 Op. at 10 ("[I]n this case the Court has no reason to doubt that SERI's testing of the touch DNA obtained from the crime scene awl revealed a profile that was, conclusively, not that of Mr. Smith . . ."). Despite the state courts' acceptance of the new scientific evidence, the courts refused to give Mr. Smith a hearing on the merits of his claim of actual innocence. *Id.*

The Tennessee courts have denied Mr. Smith an adjudication on the merits of his claim, because the courts have read into the DNA Act a rule that petitioners may not access the courts if "extensive evidence" of their guilt was introduced at trial. This interpretation of the DNA Act flies in the fact of reality: some 375 people have been exonerated by DNA evidence to date—each of them having previously been convicted based on proof that a jury found compelling "beyond a reasonable doubt." *See* Innocence Project, *DNA Exonerations in the United States*, https://innocenceproject.org/dna-exonerations-in-the-united-states/ (last visited Apr. 18, 2022). Multiple exonerations have occurred despite evidence even more compelling that that introduced at trial against Mr. Smith.

For instance, Clemente Aguirre-Jarquin was convicted of a 2004 double-homicide of his neighbor where 64 of 67 bloody shoeprints matched Aguirre-Jarquin, his fingerprint was on the murder weapon, and the police found clothes hidden in his apartment that were covered in the victim's blood. Nevertheless, Aquirre-Jarquin was exonerated a decade later with new scientific evidence pointing to the true killer. *See Innocence Project*, Clemente Aguirre-Jarquin Released After Prosecution Dismisses Charges, https://innocenceproject.org/cases/clemente-aguirre-jarquin/ (last visited April 18, 2022). In Rochester, New York, Douglas Warney was convicted of a murder that occurred in 1996. The victim was found dead in his home, stabbed 19 times in the neck and chest. The day after the crime, Warney called the police to provide information about the murder. Warney admitted to being at the scene, and subsequently provided a detailed confession to the crime which contained key non-public facts that only the killer would know: including what the victim was wearing, that the victim was cooking chicken, and that the killer cut himself with a knife and wiped the blood with a tissue in the bathroom. See *Warney v. State*, 947 N.E.2d 639,641 (N.Y. 2011). Warney requested testing for the purpose of comparing his DNA to the crime scene evidence and a search any unknown profile obtained in the DNA database to determine if it matched a known individual. Prosecutors opposed testing arguing the strength of the State's trial proof, and that the testing request was speculative, based on "a drawn-out kind of sequence of if, if, if." Yet that is exactly what happened. STR DNA testing on the victim's fingernails and blood from

the crime scene (on a towel and tissues) excluded Warney. The profile was entered into CODIS and matched an inmate who was serving a life sentence for a series of burglary and stabbing offenses involving a very similar modus operandi, who had no connection to Warney, and when questioned admitted that he alone had committed the crime. Warney's conviction was vacated upon a joint motion by the State and his lawyers at the Innocence Project. *Warney,* 947 N.E.2d at 645–46; *see also Innocence Project*, Douglas Warney Released After Post-Conviction DNA Testing Excluded Him from the Crime Scene, https://innocenceproject.org/cases/douglas-warney/ (last visited April 18, 2022).

Indeed, every capital defendant was convicted because the jury found the evidence presented was sufficient to warrant death. And every state has passed a post-conviction DNA statute precisely because they recognize the significance of DNA evidence and its ability to cause a "strong case" to "evaporate[]." *See United States v. Fasano,* 577 F.3d 572, 578 (5th Cir. 2009). Tennessee courts are required to presume that DNA results are exculpatory, and it is difficult to imagine evidence more exculpatory than confirmation that another individual's blood was found on the murder weapon. By denying Mr. Smith's request for relief under the statutes based on a finding that there was "extensive evidence" against him, the court created an unconstitutional hurdle that renders the statutes toothless and ensures that petitioners cannot vindicate their liberty interests.

b. Irreparable Harm

"Perhaps the single most important prerequisite for the issuance of a preliminary injunction is a demonstration that if it is not granted the applicant is likely to suffer irreparable harm before a decision on the merits can be rendered." Wright & Miller, *Federal Practice and Procedure* § 2948.1. Moreover, when the party seeking the injunction has a full and adequate remedy at law, the harm is not irreparable. *See Fort v. Dixie Oil Co.*, 95 S.W.2d 931, 932 (Tenn. 1936). Defendants will execute Mr. Smith if the Court does not grant a TRO. Execution is the ultimate irreparable harm, and Mr. Smith has no adequate remedy at law for a wrongful execution. This requirement is satisfied.

c. Substantial Harm to Others

The only hardship a TRO would work against Defendants would be a delay in Mr. Smith's scheduled execution. Mr. Smith took immediate steps to challenge the DNA evidence in his case, and he has now sought relief well in advance of his execution. *See* Ex. 3 at 9–10 ("[T]his Court has no reason to believe the timing results from an attempt to 'unreasonably delay the execution of sentence or administration of justice,' as contemplated in T.C.A. sections 40-30-404(4) and 40-30-405(4)."). Without a TRO, Mr. Smith—who has a legitimate claim of his actual innocence—stands to be executed. The equities favor a TRO in this case.

d. Public Interest

"[I]t is always in the public interest to prevent violation of a party's constitutional rights." *G & V Lounge, Inc. v. Mich. Liquor Control Comm'n*, 23 F.3d

1071, 1079 (6th Cir. 1994). Here, it is in the public interest to ensure that Mr. Smith receives a full review of the DNA evidence in his case. Defendants would likely respond that the public interest favors timely execution of criminal judgments. While that may be true in general, the public interest does not favor the execution of an innocent man.

IV. Conclusion

For the reasons set forth above, and those stated in the complaint, plaintiff, Oscar Smith prays the court will:

1) conduct an emergency hearing on this motion;
2) issue a temporary restraining order and/or preliminary injunction restraining defendants from executing plaintiff pending further proceedings on his complaint.

Respectfully submitted,

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BY: /s/ Amy D. Harwell
Counsel for Oscar Smith

APPENDIX E

Smith's Trial Transcript

Q Okay. Did they have any children by that marriage?

A They had twin boys.

Q What are their names?

A Christopher and Casey.

Q Okay. How old are they?

A They just turned three, and that was in December, I guess. They're three and a half.

Q What name did everyone in your family call Mr. Smith by?

A Frank.

Q Okay. Did you ever know him by any other first name than Frank?

A No.

Q Is that what Judy Smith and Chad and Jason Burnett called him?

A Yes, sir.

Q Did you personally ever hear Mr. Smith make any threats against your daughter or Chad and Jason Burnett?

A On -- just a couple of weeks before, it was two or three weeks, I can't recall the exact time frame there, about two or three weeks before that, he came to the house. He was supposed to pick up the twins and Judy was not there. And he said, "You tell

Judy that I've been playing with her with kid gloves, but now the gloves are coming off.

One other occasion at their house, he had said if she ever left him that she -- that he would kill her.

Q Prior to her death, during the period that she was separated from Mr. Smith, did she ever express fear for herself and her children from anybody?

A Yes, she did.

Q Who was that, please, sir?

A From Frank.

Q After your daughter moved to Lutie Street, who provided all the furnishings for the house there?

A When she left, she didn't have anything, so my wife and I and her brothers -- her brother and sister-in-law and several members of the family and friends provided whatever she had. She did buy a couple of small things, a couple of beds and it seemed like another item or two, but most of it was all provided by family and friends.

Q Was Mr. Smith allowed visitation with the twins after the separation, pending the divorce?

A Yes, it was on weekends.

Q And --

A And I'm not --

A Yes, sir.

Q Was that the tape you listened to?

A Yes, sir.

Q How can you tell that's the tape you listened to?

A I put my initials on it.

Q Were you able to identify any of the voices on that particular tape?

A Yes, I was.

Q Okay. Were you able to identify whose voice was making the call?

A It was the younger son, younger grandson, Jason, was making the call.

Q Okay. Were you able to determine whose voice was in the background?

A Yes, that was the older one, Chad.

GEN. THURMAN: If the Court, please, I'm going to ask for identification purposes only it be made an exhibit to his testimony.

THE COURT: Okay.

GEN. THURMAN: That it be Exhibit No. 1.

THE COURT: It will be No. 1 for identification to Mr. Robirds' testimony.

A Yes, I did.

Q How long had they lived at that particular address?

A They moved there around mid-July.

Q Did you know the defendant, Oscar Franklin Smith?

A Yes, I did.

Q How long had you known Mr. Smith?

A Since just prior to their marriage. I think 1985.

Q Okay. So they were married in 1985; is that correct?

A (No response.)

Q What name did Judy and her sons call Mr. Smith?

A Frank.

Q Everybody in the family called him that?

A Yes.

Q What was the status of the marriage between the Smiths at the time of your sister's death?

A They were separated, going through divorce proceedings.

Q Do you know the date of the separation?

A In June. I'm not sure of the exact day.

Q On the day that they did, in fact, separate did you receive a call from any person?

A Yes, my nephew Chad called to my mother's house and needed someone to come out there right away to pick them up.

Q Did you respond to that particular call?

A I did.

Q Okay. How long did it take you to get to where they requested you to come?

A About 30 minutes.

Q And did you, in fact, find Judy Smith and her sons, Chad and Jason Burnett?

A Yes, I did.

Q And how far were they from the trailer where they had been living?

A They were one -- about one mile from the trailer, walking down the road.

Q Okay. How were they acting when you stopped to talk to them?

A They were all very nervous to the point of hysterical, all of them talking at once. It was hard to get them to calm down enough to tell what had happened and what was going on.

Q Were you able to get them calmed down enough where they could tell you what had happened?

A Yes, they did.

Q Okay. And what did they tell you happened?

A My sister was saying that they had been in an argument, and it had escalated. Frank and Jason had gotten into a fight. He had been trying -- he had -- Frank was kicking Jason's legs and was trying to kick him in the groin, then ended up biting him on the back. It escalated from there. He told them to get out, had got a gun out, had put it to Jason's head. They had gone outside. He shot the gun out in the air. He told them to just get out. And they all left. She was trying to get -- she did get her purse, but that was all their belongings that they -- she was able to get. He told her not to get the car or try to get the kids or he would kill 'em. And if she took out a warrant or brought the police up there, that he would kill them.

Q Where did you take them when you got them back to Nashville?

A When we got back to Nashville?

Q Yes, ma'am.

A We didn't actually come back to Nashville. First, we went to a phone up in the Springfield area.

Q I understand that, but after you left the Springfield area where did you take them later that day?

A We first went to the phone, trying to call the Crisis Center to find a shelter for battered women that she could go to. We were unsuccessful. All the shelters were full, so I did take her over to my sister-in-law's house and my brother's house.

Q And how long did they stay there?

A They stayed there only one night. Then they came over to my parents' house and stayed. They stayed approximately three weeks.

Q Okay. Did they have anything other than the clothes on their back at that time?

A No, they did not.

Q Where did they move when they left your parents'?

A To Lutie Street.

Q Okay. And during this period of time of separation, did your sister ever express fear from any one person for her life and her childrens' lives?

A Only from Frank.

Q Did you personally ever hear any threats made by Mr. Smith to your sister or her sons?

A No, not direct threats.

Q Did you ever know Oscar Frank Smith to carry any type of weapons?

A Yes, he always had a knife on his belt, a case knife.

Q You're saying a case knife. What kind of a knife are you talking about?

A Folding knife with a blade about that long (indicating with hands), about two to three inches long, the wide blade.

Q And then in August of 1989, did your sister have an occasion to go back to recover some clothes and other items?

A Yes, she did.

Q Did you see her after she had done that?

A Yes, I did.

Q Where was that, please?

A At my mother's house.

Q Did you observe her condition at that time?

A Yes, she was very confused, in shock, very -- almost down -- downgraded or feeling really bad, mostly in shock. She really didn't -- wasn't hysterical, but she was so flat it was just hard to -- hard to explain how she was.

Q Okay. Were you able to identify the voice of the person who was actually on the phone asking for assistance?

A Yes, I was. It was Jason Burnett, my oldest nephew, I mean my youngest nephew.

Q Were you able to identify the voice in the background?

A Yes, I was. It was --

Q And who was that, please?

A It was Chad Burnett.

Q Okay. Were you familiar with your sister's handwriting?

A Yes.

(Pause in the proceedings while Gen. Thurman shows documents to defense counsel.)

Q (By Gen. Thurman) Okay. Let me hand you these sheets of paper.

(Document handed to the witness.)

Q (By Gen. Thurman) Can you identify the writing on that piece of paper?

A This is just a photograph of the front door as we saw it when we walked on the steps. I assume that would be called the porch, the front porch.

Q And that is where located on the diagram?

A That is this location here (indicating on diagram).

Q And you entered through the front door?

A We entered through the front door. We checked. There was no forcible entry at the front door.

Q When you say "no forcible entry," what does that term mean?

A That means that it didn't appear that anyone had broken in the house, the door was open, and the lock was unlocked.

This next photograph is what we saw when we walked in the front door, looking back down the hallway in a north direction. You can see the debris, some of the debris, a belt, which is indicated in the diagram. And you can see the bathroom at the very back of the house. You can also see some bags of clothing, which was not indicated on the diagram, because we didn't feel like that was significant just to put on a diagram.

arm had been at one time. The blood had transferred from her arm to her blouse.

There was also something on the bed that we noticed immediately. And it was an impression made by a palm print, made by a person's hand. And it was at this location right here (indicating on photograph).

Q You have noted that location over here (indicating on diagram)?

A That's correct.

Q All right.

A We apparently --

Q What were you --

A We assumed that palm print was made in blood at that time.

Q Okay. Now, what --

A Okay.

Q If you would, just point out what other observations did you have in that room?

A After examining that particular body, without touching her or moving anything around, we decided -- I looked to the left and saw the victim's youngest son laying on the floor at the end of that bed. He was lying in approximately the same position that you see him in the diagram.

Something unusual or something brought

(Gen. Blackburn holds up photograph for the jury to see.)

(Gen. Blackburn hands the witness another photograph.)

THE WITNESS: This is also sitting somewhere right behind Jason and like right close to the heater. And it's a disposable diaper box. And the reason that this was photographed, one reason was that it did have blood splatter on it, indicating it was a forcible splatter, which we would explain later. And also, if you look down into the box, you'll see a yellow -- I mean a brown cotton glove that was found. It was a lefthand glove.

Q (By Gen. Blackburn) Where on -- where in this photograph was the blood?

A The blood splatter itself was on the box.

Q Where's the glove?

A The glove is inside the box.

Q Right -- is that --

A The dark area is the blood itself. It's very difficult to see from that angle.

Q And that was found --

A That was found right behind Jason, between Jason and the heater that you saw the blood on.

(Gen. Blackburn holds up photograph for the jury to see.)

(Gen. Blackburn hands the witness another photograph.)

THE WITNESS: Okay. This is the bedroom -- this is going to be the den across the hall. I've indicated it as a den. After leaving this particular room, I went out into the hall, along with Sergeant Robert Moore, went in this room.

And this is photographs of that room. This is photographed back in the direction that I came in. This photograph was to depict, first of all, the location. And secondly, it was to depict the location of a live round, a live cartridge, a .22 caliber cartridge that was found. The cartridge is, of course,

THE WITNESS: This is another angle showing the table leg, also showing the awl that's lying on a paper sack, which I didn't show in that photograph. An awl is similar to an ice pick, sometimes used in leather work, I believe, a tennis racquet laying here, pizza boxes (holding up photograph). There is also something we noticed that may be -- might be of some significance, was a -- someone had prepared some food. It was on the counter. There was only one bite that had been out of it. That food was a piece of pizza and also a bologna sandwich.

(Gen. Blackburn holds up photograph for the jury to see.)

(Gen. Blackburn hands the witness another photograph.)

THE WITNESS: This is just another angle, showing just a table as it was turned over, showing the blood splatter on it. Large spots of blood splatter like that is usually very low velocity coming from a wound that's bleeding quite a bit.

There was also a pen beside it. There was a pair of blue jeans lying on the floor beside the bed. And if I remember correctly, there was I.D. belonging to Chad inside the pockets.

(Gen. Blackburn holds up photograph for the jury to see.)

(Gen. Blackburn hands the witness another photograph.)

THE WITNESS: Okay. This is another photograph in Chad's room. This is the back door of the house. There's only two doors to the house, the front door that we come in, and this is the back door. Again, we examined the back door for forced entry, and we didn't find any. In other words, the door hadn't been pried that we could tell or kicked in.

Q (By Gen. Blackburn) Okay. And that is at this location right here (indicating on diagram)?

A That's correct.

Q So the only doors to the house would be one through Chad's room and the other through the front door?

consistent with arterial bleeding here, which is a large quantity of blood. The small blood splatters here on this was cast-off splatters. And there was also a small splatter of blood here.

A bullet hole -- the last bullet hole was found right here. Only a partial, a very small fragment of that bullet was found. It was torn apart when it was retrieved from the wall.

(Gen. Blackburn holds up photograph for the jury to see.)

(Gen. Blackburn hands the witness another photograph.)

THE WITNESS: There was an awl that was found in the kitchen. This is a photograph of my hands. I was trying to process it for fingerprints. There was no fingerprints found on that particular item that was identifiable.

(Gen. Blackburn holds up photograph for the jury

individual processing the items in the bedroom, such as the walls near the victims, anything that was smooth and non-porous that we could process for prints that particular night.

Q Sergeant Hunter, what -- were you able to do anything at all with the footprint that was there in the kitchen, that was the bloody footprint?

A No, that footprint was photographed and took back to our lab to be able to try to match it, but there wasn't enough detail to find out whose footprint that belonged to.

(Pause in the proceedings while Gen. Blackburn shows photograph to defense counsel.)

Q (By Gen. Blackburn) Sergeant Hunter, I would have --

THE COURT: Gen. Blackburn, are you to a kind of a next stage in the questioning?

GEN. BLACKBURN: Yes.

THE COURT: Okay. I think I might want to give the jury about a little ten-minute break here to let them kind of loosen up and so forth. So let's -- we're going to -- this is going to go on a little

Q The one that has two fingers missing, which hand is that?

A That's the left hand.

This is a photograph taken of abrasions on the defendant's back (holding up photograph) and the defendant's elbow.

Q And you were taking these at the request of the detectives that were there?

A That's correct.

Q Thank you, Sergeant Hunter.

(WHEREUPON, the witness returns to the witness stand.)

GEN. BLACKBURN: Your Honor, I would just request that these photos be Exhibit No. 11, a collective exhibit.

(State's Exhibit No. 11, eleven (11) photographs, marked and filed.)

Q (By Gen. Blackburn) Sergeant Hunter, while you were in Robertson County, were various other identication officers going to other places?

MR. DEAN: Your Honor, I'd request any Jencks material.

THE COURT: Go ahead. All right. General Blackburn.

(Pause in the proceedings while Gen. Blackburn hands Jencks material to Mr. Dean.)

MR. DEAN: It's fairly lengthy.

THE COURT: All right. Take your time.

GEN. BLACKBURN: While he's reviewing that, could I ask Sergeant Hunter a couple more questions on something I forgot?

THE COURT: Yes, go ahead and finish.

Q (By Gen. Blackburn) Sergeant Hunter, when you were comparing the latents found at the crime scene, were you able to identify the latents you found at the crime scene?

A Yes, I was.

Q And what, specifically, were the results of that comparison?

A The results of that comparison was one latent fingerprint, No. 1 finger, which is the right thumb was identified to Judith Smith, recovered from

Q (By Gen. Thurman) Okay. And what vehicle did you see in front of the house when you passed it, please, sir?

A It looked like a white LTD. It looked like an old police car, is what it looks like.

Q Okay.

A And a station wagon.

Q How was it parked?

A It was parked straight in. I mean you could see the back end of the car.

Q Let me hand you a photograph that's been marked State's Exhibit No. 11-A, and ask you if that appears to be consistent with the car you saw that night?

A Yes, this is the car.

Q And that's the car you saw parked that particular night?

A Yes, sir.

Q Sometime between 11:00 and 11:15?

A Right.

GEN. THURMAN: If the Court, please, that's all the questions I have, but I am going to ask that that photograph be made an exhibit, the one that he marked on.

THE COURT: Okay. Mark that. The car was already an exhibit, was that correct?

Q And was that warrant still pending on October the 1st of 1989?

A It was.

Q When was the court date scheduled on that warrant?

A October 30th, 1989.

Q Okay. And do you have a warrant dated in August?

A Yes, I do. It was issued on August 1st, 1989.

Q What is the warrant number on that?

A 185-1027.

Q Okay. And what is the charge on that case?

A Aggravated assault.

Q Okay. And when was the court date on that particular case?

A It had been continued to October the 30th, 1989.

Q Okay. And who was the alleged victim in that case?

A Judy Smith.

Q Can I see those warrants, please?

(Warrants handed to Gen. Thurman.)

GEN. BLACKBURN: Mr. O'Mara.

THE COURT: Mr. O'Mara, Les.

MR. ROD O'MARA was called, and being duly sworn, was examined and testified, as follows, to-wit:

DIRECT EXAMINATION

BY GEN. BLACKBURN:

Q Please state your name.

A Rod O'Mara.

Q If you would, spell your last name for the court reporter.

A O-'-M-a-r-a.

Q Where are you employed, sir?

A American General Life and Accident Insurance Company.

Q And what is your position there?

A I'm the Associate Director of Claims and Manager of the Life Claims area.

Q And at my request, did you bring with you the policy that Oscar Franklin Smith had obtained that includes coverage on Judy Smith, Chad Burnett, and Jason Burnett.

A Yes, I did.

Q If you would, please, look at that policy, and first of all, would you tell us what type of a policy it is?

A This is a -- it's a joint whole life policy. It insured both Oscar F. Smith and Judy Smith and the children, under a children's term coverage writer. Each -- each of the adults were covered for $20,000 and each child for -- for $10,000.

Q Okay. And how many children are included in that policy?

A There's six children named on the application.

Q All right. Now, with regard to Judy Smith, the amount of coverage on her life would be $20,000?

A Right.

Q Okay. And as to Chad Burnett, $10,000?

A Right.

Q And as to Jason Burnett, $10,000?

A Right.

Q And when was this policy taken out?

A The application for the policy was March the 6th, I believe, yeah, March the 6th of 1989.

Q And what type of renewal did that policy have?

MR. KEN HAMBRICK was called, and being duly sworn, was examined and testified, as follows, to-wit:

DIRECT EXAMINATION

BY GEN. BLACKBURN:

Q Please state your name.

A Ken Hambrick.

Q If you would, spell your last name for the court reporter.

A H-a-m-b-r-i-c-k.

Q And what do you do for a living, sir?

A I'm District Manager for Liberty National Insurance.

Q All right. And did you bring with you at my request records on the policies obtained on the life of Judy Smith, Chad Burnett and Jason Burnett, obtained by Oscar Franklin Smith?

A Yes, I did.

Q If you would, what type of a policy was that?

A This was a family type policy, where it insured the applicant, Oscar Smith, his wife, Judy Smith, and the children.

Q Okay. How many children were included in that policy?

A I don't have that -- excuse me -- I do, too. They -- all the children, stepchildren and children of the marriage.

Q And what was the value of the life of Judy Smith?

A $20,000.

Q And as to Chad Burnett?

A $5,000.

Q And as to Jason Burnett?

A $5,000.

Q Okay. So a total of $30,000?

A That's correct.

Q When was this policy obtained?

A This policy was applied for on February the 2nd of '89.

Q And who was the beneficiary of -- on the lives of Judy Smith, Chad Burnett and Jason Burnett?

A Oscar Smith.

Q And when was -- what type of renewal did that policy have?

A It was a monthly premium policy, where he paid the premium each month.

THE COURT: Mr. Watts.

MR. JERRY WATTS was called, and being duly sworn, was examined and testified, as follows, to-wit:

DIRECT EXAMINATION

BY GEN. THURMAN:

Q State your name for the Court, please.

A Jerry Watts.

Q And how are you employed, Mr. Watts?

A I work for an electrical distributor here in town.

Q And were you at one time employed at Maintenance Service Corporation?

A Yes, sir.

Q And did you know the defendant, Oscar Franklin Smith?

A Yes, sir.

Q How long have you known Mr. Smith?

A At that time, approximately 12 months.

Q And did you and Mr. Smith become somewhat friends while you were working at Service Maintenance Corporation?

A Yes, sir. He was a work associate with me. We would talk during lunch hour, basically, daily or every other day during the week..

Q And did you have an occasion to see Mr. Smith use a knife at work?

A Yes, sir. Mr. Smith would come into my office occasionally and have lunch. And he would make sandwiches and put his mayonnaise on his sandwiches with a -- with a knife. And also, one instance, he came in, and Mr. Smith has two fingers missing on his left hand. And he asked me to cut two fingers off with a knife, off of his gloves, so he wouldn't get it stuck in some machinery.

Q And could you just describe that knife?

A It appeared to be a long buck knife, brass tips, wooden style handle, maybe three and a half, four inches long.

Q And did you also have an occasion to see some guns that belonged to Mr. Smith?

A Yes, sir. Mr. Smith, we were talking one day. And I had spoke about buying the pistol. And he said he had one for sale, that it was a little -- in bad shape, but he still was thinking about selling it, and that he was going to a local gun range to fire, and for me to meet him there, and we would fire at some targets. And I did meet Mr. Smith there. And he was

already there when I arrived. I went downstairs, and he was already shooting. And I used his weapons to fire at the targets.

Q And what -- what weapons were there that you can testify about?

A He had four -- four weapons. He brought four with him. One was a .22 caliber rifle with a scope, lever action. One was a 9 millimeter handgun, a Smith and Wesson, I believe. One was a 9 millimeter Intertact 9, which is an assault pistol, and one was a .22 style revolver, a western style revolver, in a leather holster.

Q Okay. Can you just describe that holster for us?

A It was detailed; it looked like someone had made it, you know, a leatherworker of some sort, had -- also had a little string that went around the trigger, I believe, to keep it from falling out of the holster.

Q Did you discuss this holster with Mr. Smith?

A No, sir; other than when we was getting ready to leave, he had -- he had put his weapons up. And he said this was his -- his baby, and that he had tooled the holster himself.

wife and children?

A Yes, I did.

Q And if you would, what was the amount of insurance on his wife, Judy Smith?

A The amount on Judy Smith and himself was $10,000.

Q Okay. On her it would be $10,000.

A $10,000. Normal death, $20,000, accidental.

Q And Chad and Jason Burnett, what was the value -- the amount on the life of Chad Burnett?

A $4,000.

Q And Jason Burnett?

A $4,000.

Q And when was this policy obtained?

A It was obtained August 28th, 1985.

Q Okay. And how was it paid?

A Paid by monthly.

Q Monthly?

A Yes, ma'am.

Q Okay. And do your records reflect when the last payment was made?

A I believe it was September of -- of last year.

Q September, 1989?

Q Okay. Did he ever talk about his hobby that he had, about anything that he could do as far as a craft or a hobby?

A Yes, he mentioned he was into leather crafts. He had showed me a belt that he had made.

Q Okay. What did you notice that was unusual to you about the belt?

A The belt had said "Frank" on it and--

Q And what name did you know Mr. Smith by?

A Oscar.

Q Did you question him about why he had a belt with the name "Frank" on it?

A Yes, I did.

Q What did he tell you?

A He said his real name was Frank.

Q And that was the first time that you had known that?

A Yes.

Q Back in September of 1989 what type of car was he driving?

A It was a white Ford, an old squad car.

Q And do you recall when his wife and two stepchildren were killed on October the 1st?

A Excuse me?

Q Do you recall when his wife and stepchildren were killed on October the 1st, 1989?

A Yes, I do.

Q Prior to their death, did you and Mr. Smith have any unusual conversations?

A Yes.

Q Okay. When was the first one?

MS. PARSONS: Your Honor, I'd object to this and ask for an out of jury hearing. Hearsay.

THE COURT: Okay. Let the jury -- instead of us going out -- well, let's just --

GEN. THURMAN: We can have a bench conference, Your Honor.

THE COURT: Let's let the jury step out here for a minute. Why don't you all go this way where you don't have to go up the steps, and I'll see you in just a couple of minutes.

(WHEREUPON, the jury retired from open court at 9:38 a.m., and the further following proceedings were had, to-wit:)

THE COURT: Okay. Ms. Parsons, what is the basis of your objection?

MR. NEWMAN: Your Honor, we --

(WHEREUPON, the jury returned to open court at 9:46 a.m., and the further following proceedings were had, to-wit:)

THE COURT: Okay. Go ahead, Mr. Thurman, please.

Q (By Gen. Thurman) Mr. Merritt, approximately a month before the death of Judith Lynn Smith and her two sons, did you and Mr. Oscar Frank Smith have a conversation?

A Yes.

Q About this?

A Yes.

Q And what was the nature of that conversation?

A He had asked me at that time if I had knew anyone that would kill his family.

Q Where did you live prior to coming to work?

A Chicago.

Q How long did you live there?

A Eight years.

Q Okay. What was your response at that time?

A I didn't really take him serious at the time.

Q What did you say?

A What did I say to Mr. Smith?

Q Yes.

A I just told him that I didn't know of anyone.

Q Did he then approach you again?

A Yes, two weeks later.

Q And what was the nature of that conversation?

A He had told me he would offer $20,000 to have someone kill his family.

Q Did he specify who that time in the family?

A Judy Smith and the two stepchildren.

Q And did he specify anyone that was not supposed to be killed?

A Yes, his two twins.

Q What was your response at that time?

A At that time I told him I think he has serious problems, and I thought he should get professional help.

GEN. THURMAN: That's all the questions I have.

THE COURT: Okay. Mr. Newman.

Q Okay. And where did he request you to go with him when he approached you?

A Well, he was wanting me to go for a ride with him at break time.

Q And did you do that?

A Yes, I did.

Q Did you just get out and ride around the countryside there?

A Yes, sir; we just rode around.

Q Okay. And what did Mr. Smith say to you while you were riding around at break time?

A Well, he said that we could take care of each other's problem, that he'd kill my wife and I'd kill his wife.

Q Okay. What was your response?

A I told him it was a joke. I didn't really mean it.

Q Okay. Did he later come by your house?

A Yes, sir.

Q And how long was that after this first conversation?

A I think it was about two weeks; I don't really remember, but it's --

Q Were you living in Lebanon at that time?

A Yes, sir.

Q So he came all the way to Lebanon?

A Yes, sir; he did.

Q Okay. And did you have a certain conversation at that time?

A Yes, sir; he brought this thing up again, said he was real serious about this and wanted to do it. And he told me that we could set the thing up where I -- I could be gone, and he'd do mine first, and then I could be out of town, somewhere where I wouldn't be suspected of it. And I -- I could do his, and he'd do the same way.

Q He would go out of town while you killed his --

A Yes, sir.

Q Did he talk about whether he could pay anybody?

A Well, I -- I told him that, you know, this is a joke with me. I told him this is a joke, totally. And he said, well, I could make it worth your while. He said, I'd get some money up. And I just told him I -- I didn't want to talk about it anymore. I refused to have anymore to talk about it at all.

Q So you terminated all that conversation?

A Yes, sir.

GEN. THURMAN: That's all the questions I have.

Q Did you have conversations with Mr. Smith?

A Yes, sir.

Q And were you all working together after Judy and Frank Smith were separated in June of 1989?

A Yes, sir.

Q And during that period of time, prior to her death, did you have an occasion to listen to certain phone conversations between Judy Smith and Oscar Frank Smith?

A Yes, sir. I did.

Q And how did you know it was Oscar Frank Smith on the other line?

A Because he called Judy, and when he called, she would get real upset, and she would ask me to listen in.

Q Okay. Did you recognize his voice?

A Yes, sir.

Q And why were you listening in?

A Because he had threatened to kill her, and she asked me to be a witness to this.

MR. DEAN: Your Honor, if we could aprroach the bench, please.

THE COURT: Let's just step in the office for a second. Hang in there with me just for a

it was about six weeks prior to that.

THE COURT: All right.

THE WITNESS: Four to six weeks. I'm not sure of the dates.

THE COURT: Okay. Sometime in the Summer of 1989?

THE WITNESS: Yes, sir.

THE COURT: Go ahead, Mr. Thurman.

Q (By Gen. Thurman) So is that the first time you started listening to the calls?

A Yes, sir.

Q In the Summer of 1989?

A Yes, sir.

Q And how many different calls did you actually listen in on?

A Around 12 to 15 different calls.

Q And was there anything said in a threatening nature at all during any of these calls?

A Pardon me now?

Q Were there any threats made during these calls?

A Yes, sir; there was.

Q Okay. Can you just describe what was said?

A For instance, one night Frank called on a Friday night. And we were always busy on Fridays. Judy called me to the phone, and I went there. And I listened to him, and he said that she would never know, her and I neither, when he was sitting across the road at Shoney's ready to blow her brains out.

Q How many times over the period of this -- these calls was Judy Smith's life threatened?

A Oh, at least 12 of those calls he threatened her life.

Q Okay. How would he threaten to kill her?

A Everytime but one he threatened to shoot her. Once he threatened to stab her.

Q During these calls were any references made to her sons, Chad and Jason Burnett?

A One time, he threatened to kill Chad and Jason, because he said that she was better to them than he was -- she was his twins.

Q Was that towards the end of these calls or back at the first of the calls?

A Probably about the third to fourth week.

Q So these calls were continuing, ongoing?

A Yes, sir.

Q And when was the last conversation you heard?

Q Okay. Did you do that?

A Yes, sir.

Q Okay. And who was present when you arrived?

A When I arrived at the residence of Oscar Smith, two young twin boys that was described to me, and Mr. and Mrs. Smith, Oscar's parents, and I don't recall who else. Sergeant on patrol, he was with me when I arrived.

Q Okay. And did you request Mr. Smith to do anything at that time?

A Yes, sir; I stopped in the drive of the house and called him over to my car and told him that Metro officers had contacted me, and that they wanted to talk to him, and that I asked him to get in the car with me and ride to the interstate to meet with the Metro officers.

Q Did he do that?

A Yes, sir.

Q At any time did he ask you why they wanted to question him or anything about that?

A No, sir.

Q Did you at any time tell him why they wanted to question him?

A I told him that I did not know what the reason was that they'd called and wanted to talk to

A Originally, I was dispatched on the call, the original call.

Q But once you got to the scene, where were you then sent?

A To the City of Springfield.

Q And what was your purpose in going to the City of Springfield?

A Myself and Detective Mike Smith went to the City of Springfield or Rutherford County or Robertson County to interview Mr. Oscar Frank Smith.

Q Okay. And had you previously requested ahead for assistance by Detective Bennett?

A Yes, sir.

Q And where did you observe Mr. Smith? Where did you find Mr. Smith?

A When we got off the interstate, Detective Bennett was there with Mr. Smith. We then went from that location prior to talking to him to the Robertson County Sheriff's Department.

Q And at that time did you advise Mr. Smith why you wanted to talk to him?

A No, sir.

Q Did he ask you at that time why you wanted to talk to him?

A No, sir; he did not.

to come back on in and just have a seat.

(WHEREUPON, the jury returned to open court at 12:33 p.m., and the further following proceedings were had, to-wit:)

(The witness retakes the stand.)

THE COURT: Okay. Go ahead, Mr. Thurman.

GEN. THURMAN: Thank you, Your Honor.

Q (By Gen. Thurman) Detective Bernard, I think we were to the juncture where you were at the police department in Springfield; is that correct?

A Yes, sir.

Q And at that time, had you advised Mr. Smith why you were interviewing him, what the circumstances were?

A No, sir; I had not.

Q Had he asked you at any time why you were interviewing him?

A No, sir; he did not.

Q Did he tell you how long it took him to get there?

A Approximately seven hours.

Q Okay. Did he tell you why it took that length of time?

A He stated that he ran into some fog on the way.

Q How long did your interview last with him?

A I believe it was 35 minutes.

Q And during this initial interview, did you notice anything unusual about the interview?

A During the interview itself, I noticed that Mr. Smith was shaking, he was smoking quite a bit. During the interview, the words -- he referred to the victim as well as any incidents concerning her in the past tense. He stated that we were getting back together, things were going well. At one point he mentioned a marriage counselor, that they were seeing a marriage counselor. And he stated that we were seeing a marriage counselor. When I asked him when did they stop seeing the counselor, he stopped for a few minutes and stated we're still seeing the counselor.

Q He used the word "were" repeatedly?

A Yes, sir; he did.

Q And did you observe any other unusual behavior after he was -- when did you advised him of why you were asking him the questions?

A Approximately 35 minutes after we originally walked in and I identified myself.

Q Okay. What was his reaction when you advised him of his wife's death and the childrens' deaths?

A He didn't ask any questions about the -- about the children; he didn't ask any questions about the victim, as such as what happened or where it occurred or anything such as this.

At one point Detective Smith, Detective Bennett had gone to separate rooms, and I'd stepped outside. And we asked Mr. Smith to sit in the little waiting room area, which is right in the front door of the Sheriff's Department. I was standing outside, in the parking lot, approximately 35, 40 feet away. There were some other deputies down a ways from the front of the door. Mr. Smith was sitting in a straight chair by the front door, with the door open. I'd walked into the shadows and was watching him, to make sure that either he didn't try to leave or run away or whatever, due to the fact that we'd just told him about this death. I observed him smoking a cigarette with his left hand. He would smoke the cigarette, would take a

draw or two off the cigarette and hold it in these two fingers here. Then he would take these two fingers and blow smoke onto these fingers here and then rub them in each eye, like this (indicating). And then he called me over, called -- said, Detective Bernard, and asked me, said, "tell me it's not true," assuming -- meaning to the -- referring to the deaths. At that time he did have a tear on each eye.

Q And did you observe any injuries on him that particular night?

A Yes, sir; I did.

Q And what were those, please?

A There was some abrasions on his right hand, his right elbow, and his left back and left shoulderblade.

Q I'd hand you these photographs that have been previously marked 11-K, 11-I, and 11-J, and see if you can identify those.

(Three (3) photographs handed to the witness.)

THE WITNESS: Yes, sir; these were the photographs that I requested to be taken of Mr. Smith, of the injuries that I noted.

Q (By Gen. Thurman) If you could, Detective, could you step down before the jury and just point out the injuries that you've just testified to?

(WHEREUPON, the witness steps down from the witness stand and stands at the jury box.)

THE WITNESS: The injury here is an abrasion to the outside right arm (indicating on photograph), in the area of the elbow (holding up photograph).

These are two --

Q (By Gen. Thurman) You might want to come on down in front where everyone can see you.

THE COURT: Come right in the middle, maybe, if you would.

THE WITNESS: These are three scratches to Mr. Smith's right hand, three abrasions. There's a half moon-shaped abrasion to the right little finger. There's an abrasion on the top knuckles of the right hand, and another abrasion or scratch between the -- the thumb and the first finger (holding up photograph).

This is Mr. Smith's back, on the left side. This would be the left side of his back, what

appears to be an abrasion or a scrape. At the top here, the left shoulderblade is the beginning of what appears to be a bruise (holding up photograph).

In case anyone didn't see it at the beginning, this is his right arm, his right elbow, and the outside (holding up photograph).

Q (By Gen. Thurman) Go back.

(WHEREUPON, the witness returns to the witness stand.)

Q (By Gen. Thurman) Did you ask Mr. Smith about a knife, about whether he carried a knife?

A Yes, sir; I did.

Q And what was his response?

A Never.

GEN. THURMAN: That's all the questions I have.

THE COURT: Give him the pictures over there.

MR. DEAN: Your Honor, I'd request any Jencks material of this witness.

THE COURT: Mr. Thurman.

(Jencks material handed to Mr. Dean.)

CROSS-EXAMINATION

BY MR. DEAN:

Q Detective Bernard, you asked Mr. Smith about what he did on Monday, I guess the day that you were interviewing him; is that correct?

A Yes, sir.

Q And I think your report would reflect that he told you that he had slept for approximately two and a half hours?

A I believe it was a little bit longer than that. I think it was somewhere between 3:00 and 5:30 or 6:00.

Q 5:30 to 6:00?

A I believe it was about 6:00, yes, sir.

Q If I could show you the report, and ask you if you could identify this copy of the report you prepared?

A Yes, sir; it is.

Q Would you look at approximately -- I think it's the second or the third paragraph from the bottom?

October.

Q Detective Flair, I'd have -- hand you this item, which has been identified as Exhibit 21 for identification only, and ask you if you can identify that?

A That's correct, ma'am. This is the holster that I found inside Mr. Smith's trailer.

Q Where exactly was that located?

A This was hanging in the -- I would call it the main or master bedroom, if you will, of the trailer, hanging in -- in the wall -- or I'm sorry -- on the wall.

Q And why was it that you collected that particular item?

A Well, there was -- at the original crime scene, it was learned that there was a weapon, a pistol used. And we were trying to ascertain, possibly, if this -- this holster could have, you know, be involved or if we recovered the pistol at a later date.

Q Did you ever -- did you recover a pistol with that?

A No, ma'am; I did not.

GEN. BLACKBURN: Your Honor, I'd request at this time that that be made an exhibit to his testimony.

THE COURT: Okay.

(State's Exhibit No. 21, holster, marked and filed.)

(Pause in the proceedings while Gen. Blackburn shows two (2) belts and a leather item to defense counsel.)

Q (By Gen. Blackburn) Detective Flair, I'll hand you three other items, and ask you if you can identify those?

A Yes, ma'am; these are the three other items that I recovered from the -- inside the trailer. They were as well, if you will, in the main bedroom of the trailer.

Q And this is the defendant's trailer?

A That's correct; yes, ma'am.

Q If you would, what -- describe what each of those items are.

A Well, this is just a leather work, and it has, if you will, imprinted on it, "Home Sweet Home." The other two are -- appears to be trousers, a belt for trousers, and it's got the word "Frank" imprinted on the back of both of them.

Q Okay. If you would, hold them up to the Ladies and Gentlemen of the Jury.

A (Holding up items).

Q And both of the names "Frank" are imbedded in there --

A Printed -- that's correct. "Frank" here, F-r-a-n-k on the back on that one and this one as well.

Q And where exactly did you find those in the trailer?

A These were in the bedroom, hanging on the wall.

GEN. BLACKBURN: Your Honor, if that could be made Collective Exhibit next in order.

THE COURT: Okay.

(State's Exhibit No. 23, two (2) belts and leather-worked item, marked and filed.)

Q (By Gen. Blackburn) The court officer is going to hand you this item and ask you if you would look at that and see if you could identify that?

A Yes, ma'am; this is a .22 caliber live round and has a slip of paper on the inside of it with my initials, and it was behind -- this was found behind

the gun case of the main living area. It's got it marked here, and that is my writing, and that's how I tagged it when I located it.

Q And it's a live .22 round?

A Yes, ma'am. That's correct.

GEN. BLACKBURN: Your Honor, if that could be State's Exhibit next in order.

THE COURT: Okay.

(State's Exhibit No. 24, live .22 round, marked and filed.)

Q (By Gen. Blackburn) Now, there is a box that I need to have handed to you. It's sort of heavy, and ask you if you can look in that and see if you can identify the items that are in that box.

A Yes, ma'am; these are, if you will, leather-working tools. There are several leather-working tools that are used in leather work. They've also got -- they're several pieces of metal work that you use as a stamp to spell out a word. Like here's an "E", and there's several -- an alphabet, if you will. And there's numerous other -- I don't know the correct pronunciation or the correct term for them, but I would call it something like a stamp. If you took this and

put it on leather, hit it so it would have an impression of whatever design was here. And this happens to be a bird. And there's --

Q Where did you locate those items?

A These were found in -- in an outbuilding about 15 to 20 feet from Mr. Smith's trailer.

GEN. BLACKBURN: If you would -- Your Honor, that would be the State's next exhibit.

(State's Exhibit No. 25, box containing assorted leather-working tools, marked and filed.)

Q (By Gen. Blackburn) Detective, let me hand you some photographs.

(Pause in the proceedings while Gen. Blackburn shows five (5) photographs to defense counsel.)

Q (By Gen. Blackburn) And see if you can identify them.

(Five (5) photographs handed to the witness.)

Q (By Gen. Blackburn) A series of five photographs and see if you can look at those photographs and see if you can identify them.

A The first three photographs are photographs of tennis shoes that I extracted from the trailer there at Mr. Smith's residence. The other two photographs is a partial piece of a tennis shoe that was found in what I would call a small firepit, located just behind the trailer, another 15 to 20 feet away from Mr. Smith's trailer.

Q Okay. And what was your purpose for collecting those particular items?

A To see possibly if there was any type of link back to the original crime scene.

Q And you were collecting all the tennis shoes that you found at the trailer?

A Well, first of all, it was rather odd that there was a tennis shoe that was -- that was partially burned, as it -- maybe it might have been thrown in the fire and could have been to be destroyed or whatever. We didn't collect any and all shoes, but the tennis shoes we were interested to see if, again,

DIRECT EXAMINATION

BY GEN. BLACKBURN:

Q Please state your name.

A My name is Mona Gretel Case Harlan.

Q You might have to speak up, both of us have a tendency to talk a little low. What is your occupation?

A I am a licensed physician in the State of Tennessee, currently serving as an Assistant Davidson County Medical Examiner.

Q And what is your educational background?

A My educational background is that of high school, college, medical school, finishing in 1974. I did a pathology residency at the University of Tennessee in Memphis. I finished that in 1978, became anatomic and clinical board certified, worked as an Assistant Shelby County Medical Examiner while there, and worked as an Assistant Davidson County Medical Examiner part time beginning in the Fall of 1983 and full time beginning in May of 1986.

Q And as part of your duties as an Assistant Medical Examiner, are you required to do autopsies?

A I do autopsies, quite a few of them.

Q About how many?

A This year it's going to be about 200.

Q Okay. And during the course of that, are you required to determine the cause of death?

A Yes, this is our primary reason for doing the autopsy, is to determine the cause and manner of death.

Q And as your job as an Assistant Medical Examiner, are you also required to testify with regard to the results?

A Yes, I am.

Q Okay. And have you been so qualified as an expert in your field of forensic pathology?

A I have been qualified in courts in Davidson County, additional counties in Tennessee and in Kentucky, as an expert in forensic pathology.

GEN. BLACKBURN: Your Honor --

THE COURT: Excuse me just a minute. I'm not sure -- my clerk has reminded me whether or not Dr. Harlan was sworn in the presence of the jury?

THE WITNESS: I was not.

THE COURT: I think she wasn't. So let me ask her now just for the purpose of the record and for the jury's benefit if you would be sworn, Dr. Harlan.

(The witness is sworn by the Clerk.)

GEN. BLACKBURN: Your Honor, at this time I'd offer Dr. Harlan as an expert in her field.

THE COURT: All right. Mr. Dean, do you have any questions?

MR. DEAN: No problem.

THE COURT: Okay. Dr. Harlan has testified as an expert in this Court a number of times. And she will be allowed to testify today in her field.

GEN. BLACKBURN: Okay.

THE COURT: Okay. Go ahead.

Q (By Gen. Blackburn) Dr. Harlan, in performing autopsies, would you just explain to the Ladies and Gentlemen of the Jury exactly what -- what's required or what you do during the course of that.

A Yes. An autopsy consists of several phases. First, we try to view the body as soon as possible after its discovery, take into account surroundings, clothing, etc. We document our findings with photographs. We then remove the clothing, weigh and get a height of the body, examine externally for any injuries present externally, and then do a complete autopsy, in which we examine the contents of the head, the neck, the chest and the abdomen.

With examination of the organs, we also retain small pieces of the tissue, which we have made into microscopic slides that we examine beneath the microscope. In addition to that, we also take pertinent samples for such things as cultures to see if there are bacteria growing in cases in which we suspect an infection and toxicology samples to determine what drugs or alcohol or anything such as that are present and to determine the blood type.

Q And during the course of all this, first of all, are you required to do autopsies where the cause of death is suspected to be a homicide?

A Yes, I am.

Q Okay. And that would be in all cases?

A In almost all cases.

Q In almost all cases. Let me direct your attention to October the 2nd of 1989, and ask you if you had an occasion to do -- to perform an autopsy on the bodies of Judith Smith, Jason Burnett and Chad Burnett?

A I performed autopsies on Judith Lynn Warden Smith and -- beginning on October the 3rd at 5 p.m. I did an autopsy on Chad Altman Burnett beginning October the 3rd at 11 a.m., and on Jason Don Burnett, I did an autopsy beginning at 1:30 a.m., on

October the 4th.

Q Had you, though, been made aware of their being deceased, though, on October the 2nd? Had your office been notified of the discovery of their bodies on October the 2nd?

A Yes, we had.

Q And had you or any individual of the Medical Examiner's staff gone to the scene at 324 Lutie Street?

A Yes, my husband Charles did.

Q And did you go to the scene at that time?

A Not at that time.

Q Did you later go to the scene?

A I did go to the scene.

Q Okay. If you would, you indicated that you did the autopsy on Judith Smith first; is that correct?

A I believe I did the one on Chad Altman Barnett or Burnett first. Yes.

Q Why don't we just take them in the order that you did them.

A All right.

Q If you would, you indicated that the first thing you do is you make a visual observation analysis?

A Yes. I examine the body clothed, unclothed, and photograph the body, make diagrams and pertinent notes concerning my findings at that point.

Q All right. Describe when you first viewed the body of Chad Burnett what you observed.

A On Chad Burnett, as I first examined him, the body was still clothed, had quite a bit of blood on the clothing. I charted what injuries I could see easily with the body in that shape, weighed and measured him, then removed the clothing, still charting the body and then cleaned off the skin so that I could get a better look at the wounds to the skin.

Q And what were the wounds that you observed?

A He had several different types of wounds. He had multiple gunshot wounds, one of which that I called Gunshot Wound A, which was to the inner edge of the left eyebrow. And it was a contact type of gunshot wound, which shows a small bruising of the orbit or orbital contusion beneath it.

Q Dr. Harlan, let me interrupt you. What is a contact gunshot wound?

A A contact gunshot wound is a wound in which the muzzle of the gun is against the skin's surface.

Q Okay. So that the actual muzzle of it would be pressed against the skin's surface.

A In Chad's case, it was against the skin's surface but was not in tight contact.

Q Okay. And you can tell the difference?

A Yes, I can.

Q What was the next observation that you noticed?

A I then examined the remainder of the body and found another gunshot wound, which I called Gunshot Wound B, which was to the right upper chest. And it was also a contact gunshot wound. In addition to this wound, which had no exit wound, nor did the Gunshot Wound A, I discovered another gunshot wound to the top of the right shoulder, which I called Gunshot Wound C, which had an exit wound to the back of the right shoulder, actually base of the neck area, which I called Gunshot Wound D.

Gunshot Wound C was somewhat different from the other two gunshot wounds, in that it was not straight in, went at a -- a marked angle and did not show obvious gross powder present.

Q Okay. So you've got the contact wound to the -- to the face.

A Correct.

Q One to the chest area, and then the other is not a contact wound?

A The other has to have been fired from more than two feet away or had to have gone through some other target first. And I did not find a defect in his shirt to explain that.

Q So he had three separate gunshot wounds to the body of Chad Burnett?

A We do.

Q What were the other -- the injuries that you could observe?

A In addition to those wounds, he had multiple stab wounds which were in three different types. Some of these were stab wounds that appeared to have been caused by something that was very sharp and needle-like and elongated and had no side edge to it, something such as an ice pick or an awl or a -- something sharp and pointed. He had one such wound at the chest, beneath the area where the clavicles come toward the midline here (indicating on self), and had a small trail-off from that, a little abrasion down towards the right side.

He had multiple additional -- additional small abrasions but none that were definitively made by a puncture type instrument. In addition to these, he

had several stab wounds that were made by something with a blade shape to it. One of these was in the -- what we call the lumbar area of the back, in the small of the back, above the pelvis, in the midline, and was orientated across or transverse in comparison to the body.

Two others were just above and on either side of the umbilicus or belly button, made with a smiliar type of instrument, and a third type of injury from a sharp object such as that was also present, but this was a laceration type injury or series of laceration type injuries to the neck. And in these there were a small abrasion, superior, then a bigger laceration or incision that had some frayed edges to it. Then along its left edge it had another small, what we call abrasion or scrape, and then beneath and about mid-neck or high mid-neck an even larger area of slashing type injury with edges on it that suggested more than one cut.

Q Dr. Harlan, let me ask you this. After you are making these visual observations, are you documenting these on a chart in some manner?

A Yes, I did, at the -- at the autopsy, document these on Special Chart 11, which is a form that we use, and Special Chart 8, which is the second form.

(Chart is brought to the front of the jury box.)

Q (By Gen. Blackburn) Dr. Harlan, can you look at this chart--

MR. NEWMAN: Your Honor, if I could interrupt, with the Court's permission, could I move around so that I could see?

THE COURT: Sure, move right over here in this chair, if you want to.

Q (By Gen. Blackburn) And ask you if this appears to be an enlargement of that chart that you have prepared with regard to Chad Burnett?

A Yes, it is.

Q If you would, step down in front of the chart and point out to the Ladies and Gentlemen of the Jury the wounds that you've just been describing.

(WHEREUPON, the witness steps down from the witness stand and stands at the board.)

THE WITNESS: This is a separate chart that I used that simply indicates the relative shapes of the wounds, the size of the injuries. I try to

tabulate their inches above the heel. And Chad was a total of 170 pounds, that is, 170.6 pounds, and 71 inches tall, which would be 5'11".

Q (By Gen. Blackburn) So both of these charts are with regard to Chad Burnett, this being just a documentation of the larger chart of the type of wounds?

A Yes.

Q You use this in conjuction with that? If we could scoot it over, to this side. Now, Dr. Harlan, if you would, go through each one of the wounds that you observed on Chad Burnett and just tell the Ladies and Gentlemen of the Jury about each of them.

A The gunshot wounds are --

THE COURT: Dr. Harlan, would you like a pointer?

THE WITNESS: -- not on this chart; they're on this chart.

GEN. BLACKBURN: Do you need a pointer?

(The witness handed a pointer.)

THE WITNESS: The gunshot wound to the inside of the left eyebrow is here (indicating on diagram) and the small contusion is there (indicating on diagram).

The gunshot wound at the end of the shoulder went in here at an angle, is diagrammed here (indicating on diagram), and exited in the back here (indicating on diagram), making a small, irregular slit. That's through the right shoulder. It did not go across the midline. The gunshot wound that went into the right chest, from front to back, basically, and it had no corresponding exit wounds.

The sizes of the wounds are similar but not exact. The minimal size, which is fairly important, is .28 inches of Gunshot Wound B to the chest.

Q (By Gen. Blackburn) And why is that significant?

A Generally, a high speed projectile, like a bullet, will make a hole similar in size to the diameter of the bullet, unless it's going at an unusual angle.

Q Okay. And what does this one tell you about this particular kind of bullet?

A This -- this dimension here being a .28 inches tells me that it's a fairly small bullet.

Q And did you recover the bullet from Gunshot Wound B?

A Yes, I did. I also recovered one from Gunshot Wound A. After the gunshot wounds, I described the puncture type wounds just below the base of the throat here, which was designated Gunshot Wound HB -- or Stab Wound HH, which has a central hole or a little bit eccentric hole and then kind of a tadpole type tail going across. So it's made by a small puncture type instrument.

The wounds to the neck are diagrammed here (indicating on diagram). They were in more detail and an abrasion which I didn't designate differently, a small superficial laceration, which I designated II, and then Laceration EE and SS, being a large laceration. This one is .9 centimeter or .9 inches by 3.7 inches. This one is .85 inches, as the head is turned slightly away, with length unaffected by that motion of 4.1 inches and shows the regular edges suggesting that there are multiple strokes involved, as it does here (indicating on diagram).

Q Okay. Now, the irregular edged multiple strokes of the cutting instrument?

A That's correct.

Q And this would have to be a sharp instrument, such as a knife?

A This would have to be something with a decent edge to it.

Q Can you tell whether or not it would have a serrated edge or is it smooth or can you tell--

A I could not demonstrate any serrations to it. Sometimes there can be serrations shown, not always. I did not see any serrations in this. They're usually found at the point type edges of the wound. I did not find any abnormality to suggest that in any of his wounds.

The stab wounds to the abdomen just above and on either side of the belly button are indicated on this chart as well.

And BB, which is to the right side, and CC, which is to the left side, I've measured across the midline here (indicating on diagram). Their dimensions, they are open slightly. They do tend to have kind of a flat edge on each at opposite sides. This can occur with a knife that has a single edge. It is not specific for that, because the side could be duller on this side than on the other side. But the length on this one is a .72 inches. The length on this one is a .70 inches, which should, within a reasonable tolerance, given that the skin is somewhat elastic, be close to the measurement of the width of the blade that inflicted.

Q Okay. And again, did you notice any serrations on this?

A No, no serrations.

Q Okay.

A The stab wound to the back, the small of the back, is here (indicating on diagram). That one I designated JJ, and it is oriented across and again, shows its blunter end here and the edge here (indicating on diagram). These also have a bit of a tail. Those kind of curve with an inward motion that's slightly at a different angle from the outward motion, that actually slices the edge of the wound in two pieces.

Q Okay. So you can tell it goes in one place and comes out another?

A Well, slightly different. It makes a second small laceration as it comes out here (indicating on diagram), because this is a wound that goes basically inward on the body.

Stab Wound AA is back over here just at the edge of the left nipple (indicating on diagram) and has a small abrasion down from it.

Stab Wound AA is further over on the left side of the body, shows maximum dimensions of 1.38 by 0.85 inches this direction (indicating on diagram), which, again, is similar to our dimension here

(indicating on diagram) and is a bit wider. I think that this knife actually did a bigger turn on being pulled out, and may not have been placed directly in and out, but instead may have moved slightly in the skin.

Q Could that be either the object moving or the -- Chad, himself, moving?

A Yes, and its location made it a little more amenable to movement, because there are ribs underneath there. So you're talking about glancing on ribs, which are tougher tissues to get through than the two on the abdomen.

Stab Wound DD here is way around on the right side of the chest here (indicating on diagram). And it's labelled here (indicating on diagram). And it also shows a tadpole-type shape. It is vertical in relationship to the body as opposed to these others, which are oblique.

There is one other knife-type injury, and that is Laceration GG. And the reason this is not a stab wound is because of where it is. It's on the left thumb here (indicating on diagram), and has sort of a triangular tear in the skin. By its slice, it has caused an action such as this (indicating) on the skin, so that this is a loose flap of skin that's been raised

from where it was introduced. And as it slid across got moved, okay?

This injury is suggestive of a defensive type of wound, because it is at an area where if one grabs for the blade, this would be pulled or pushed through that area of laceration.

Q So that would indicate that Chad Burnett was either, what, grabbing for the knife and trying to keep it from doing that? Is that what you're terming a defensive wound?

A Yes, a defensive wound means that he had his thumb in the way of the sharp edge of the blade, either trying to push, grab or some other motion. And so this -- this wound was inflicted with the edge of the blade.

Q How many different types of weapons can -- just from looking at the wounds, can you say inflicted the injuries to Chad Burnett?

A There would have to be a minimum of three, the gun, which could be similar caliber in all three wounds, a knife that had an edge to it, to cause all of these and this as well, and then something elongated and sharp without an edge to cause that.

Q Okay. So three different types of weapons?

A Yes.

Q If you would, with regard to Gunshot Wound A, when you were doing the autopsy, what sort of organs did that gunshot wound penetrate?

A Gunshot Wound A is -- went through the edge of the orbit at that point, broke the bone ahead of it, went through the frontal -- what we call the front part of the skull, the skull, and the temporal skull, which is around the temporal lobe. It went from front to back and really didn't go up or down as far as his head was concerned. It may have gone up or down as far as a floor was concerned, if the head had been tilted. And it really did not go to the right or the left, but, again, that may have been in relationship to his body, because the head may have been turned somewhat. I don't know. But at that wound, it caused injury by the bullet going through the area and by bone fragments being shoved away from the area by the broken bone from the impact of the bullet that cause injuries to the left bottom of the brain, the thinking part of the brain, the middle of the right frontal lobe, in other words, the whole left side of the thinking portion of the brain or cerebrum, the inside of the right lobe, and also caused bone fragment disruption of the left internal carotid artery as it was coming up through the skull. The left internal carotid artery in

Chad above and below the area of laceration and disruption was a fairly good sized vessel. And he would not have lived long after this artery was destroyed.

The bone fragments also went into the temporal lobe of the brain. The bullet itself and bone fragments damaged the olfactory, which is the smelling portion of the brain, left frontal lobe as well. And as a consequence of these injuries to the brain and its blood vessels, with hemorrhage, etc., the lungs started to develop the edema, became filled up with fluid, which occurs with penetrating injuries to the brain.

Q So, as a result of that, I mean this one was a fatal wound?

A This wound was a fatal wound. You could not even have a heart survive this from -- for very long. The internal carotid artery is a major vessel that is necessary, his thought processes, his control of his bodily functions would have been ended with the penetration of that -- of that artery.

Q The -- that's Gunshot Wound A?

A That's Gunshot Wound A.

Q What about Gunshot Wound B?

A Gunshot Wound B is the one to the right chest. Again, it's the contact gunshot wound.

Q Again, the barrel of the gun and muzzle being next to the skin?

A Correct. It went through the right second rib and right intercostal space, second intercostal, went through the right lung, went through the back of the chest wall between the fifth and sixth ribs and then became lodged beneath the skin, in the back, 57 inches above the heel.

Gunshot Wound D is 56 inches above the heel, so you can see it rose one inch in his body. It was also very slightly, from right to left, meaning that it went at some point at an angle, such as that (indicating). But basically it went from front to back.

Because of this wound, he not only bled into the right side of the chest, approximately two units worth, he also had the disruption of the lung and the bleeding from that and with continuing to breathe, so I do know that he was alive at this point. He developed air around the lungs and into the skin, which requires the pressure of continue to breathe or be resuscitated. There -- the area around the gunshot wound then felt like air-filled type fluid in the skin.

That's about it for Gunshot Wound B.

Q Could Gunshot Wound B, was that also a fatal gunshot wound?

A Gunshot Wound B, if given long enough, could have killed him by itself. He at -- you know, initially, might have survived it had he had prompt medical care at a trauma center, first class trauma center with transfusions, chest tubes, etc., but he did live for a while with that wound, which was bleeding in the chest and causing air build up in the chest, was actually shoving the heart to the left and trying to fill up the left side of the space with everything being moved to the left, because the lung is deflating and air is being lost into the chest and out into the chest wall.

Q Gunshot Wound C, did it strike -- it's an in-out motion?

A Gunshot Wound C, in an old western terminology, would be considered a flesh wound. It did bleed into the tissues. It was there while he was alive. It was placed there while he was alive, but it went in the front, came out the back and did not strike a vital structure in passage. Okay? It did get muscle, it did get skin, and it did get fat, but no great big muscles and nothing major.

Q And a person could survive a Gunshot Wound C?

A It would take major medical problems to--

THE COURT: Hold on just a minute.

THE WITNESS: -- to die of Gunshot Wound C.

THE COURT: Excuse me a minute. I think one of the jurors needs to be excused just a moment, to be excused a moment. So why we just let whoever that juror is be excused, and we'll just wait here. I don't want to embarrass whoever it is, go right ahead, Ms. Montgomery. And you can go in my office. Mr. Himmelberg will show you, and then we'll be back whenever you get here.

(Juror No. 2 is excused and then returns.)

THE COURT: Okay. Go ahead.

Q (By Gen. Blackburn) Okay. Dr. Harlan, the --

A Gunshot Wound C, the only way he would have died of Gunshot Wound C is if he had had long-term complications like an infection that wasn't controlled. So it would have taken almost no medical care for him to have died.

Q And the damage done by the stab wound, if you would, just describe each of the stab wounds.

A If we go in order on that chart, Stab Wound AA, labelled that simply because I'd already used A, B, C and D for the gunshot wounds. So we went for double letters.

AA is just on the outside, anterior to left nipple. It's 5.35 inches to the left side of the midline. What it did was to go to maximal depth of 2.8 inches. And I measured this through the tissue and into the left lung, which it did go into. And it went basically from front to back and left to right, meaning on him, approximately that angle (indicating). And it's oriented vertically, vertically (indicating).

Q When you say a depth of 2.8 inches, what does that tell you about the knife?

A The maximal depth of 2.8 inches tells me that it requires a blade about 2 and a half inches long to make it. If I have a blade with a hilt on it at 2 and a half inches, I can actually indent the skin slightly if it's sharp enough and push it in slightly further than that. So it would have required a minimum blade of around two and a half inches.

Q So a minimum blade?

A Correct.

Stab Wound BB here is here on him (indicating on diagram). This went into the abdomen, went through the skin into the peritoneum, which is the cavity around the gut, etc., and went into the right anterior liver. Its maximal depth was 2.35 inches, so it's slightly less deep than the first stab wound that I showed you. It's going from front to back and slightly from inferior to superior, which is angled upwards.

The third stab wound is here (indicating on diagram) and is also obliquely oriented; in other words, it goes across like this (indicating on diagram). And it's going through the abdominal wall; it went through the front edge of the stomach. It did not go out the back side of the stomach. And I don't know how full his stomach was or how deep in the stomach it went, but it did go into his stomach. So its miminal depth is 1.8 inches. I can track it that far in, but because it's going into a stomach bubble and whatever else, I can't tell you how deep it went after that hollow edge of the stomach there. It was going from front to back, inferior to superior, and from left to right. So it's all three things at the same time. That's that one.

Stab Wound DD is to the right lateral chest. That's the point up here, almost in the armpit here. And that's got a maximal depth of 1.8 inches and went from right to left, slightly from up to down, and went from posterior to anterior. It came in from the side like. At the point where this went into the chest wall, it did not strike lung, and it's at an odd angle. So I don't know if it didn't strike lung because the lung was already being shoved over by the fact that it had a gunshot wound and was, therefore, deflated, or if it just missed the lung.

Stab Wound EE at the top of the two bigger lacerations or slice wounds to the neck. And it is not abundantly deep. It's 64 inches above the heel. It's mostly to the midline and left and did cause bleeding, but it did not get major life structures. It did get small vessels, so it did bleed. So I know that it was put there while he was alive.

This wound is the next big wound. It's beneath the one I just described. It also had acute hemorrhage to it.

Q When you're saying "acute hemorrhage", that would be --

A Bleeding. So I do know that he was alive on that one. He also was alive when the wound to the left thumb was made. That also bled.

He -- the next wound was also a stab wound, but it's a very small little hole. And that one went only .3 inches deep, so we're dealing with a very shallow wound, but then it's placed directly over the sternum. The sternum is a very sturdy bone. It also bled. It did show vital reaction. Stab Wound II, I went back and charted this one, because it was a little deeper than at first I had noted, but it's still superficial, and it's between the other two major slice wounds to the neck.

Stab Wound JJ is through skin and skeletal muscle. That's diagrammed here and it's on the back side here and it went to a depth of 2.9 inches through skin, muscle, and in between the vertebral processes. It's directed from front -- excuse me -- from back to front, slightly from his left to his right and slightly from top to bottom. So it's approximately at that angle (indicating). And that one also did bleed. That was while he was alive.

Q Dr. Harlan, while you're down in front of the jury, I'm going to hand you a series of photographs and ask you to see if you can look at those photographs and identify them?

A Yes, I can. These are all of Chad Burnett.

Q If you would, take those photographs--

MR. NEWMAN: Your Honor, excuse me. For purpose of the record, now that Your Honor has had a chance to see the chart, we renew our objections concerning the photographs.

THE COURT: Okay. The Court will overrule your objection. Go ahead.

Q (By Gen. Blackburn) Dr. Harlan, if you would, take those photographs and turn around and explain to the Ladies and Gentlemen of the Jury what each one represents and what does that tell you about those injuries.

A This is a photograph of Chad's face (holding up photograph), which shows me several things, the contact gunshot wound to the eyebrow is here (indicating). There is bruising beneath it. It did not take this long to kill him or this would have been a much bigger bruise. There is some hemorrhage in the neck involving these, not a marked amount. I might have expected more bleeding had they been early in his dying episode rather than late. So I think these are probably late injuries.

Q What about the gunshot wound, can you tell whether the gunshot wound came before, during or after death?

A The gunshot wound came before death.

Q Okay. And that is by -- what is it that--

A The bruise to the left eyelid here (indicating on photograph).

The next photograph (holding up photograph) is of Chad's neck and it shows several things. These are the abrasions which are not very deep. That's an abrasion and lacerations or slice type wounds to the neck. And this photograph has been taken with the head to show the wounds the best. In other words, instead of the front or side, this has been taken obliquely from wounds that are directly across the neck here (indicating on photograph). Also, the head has been turned to the right to allow me to show their maximal depth, etc.

Q And can you tell from that whether or not those wounds were before, during or after death?

A These are -- these do show some vital reaction but not a marked amount. There is some bleeding here, and it did slice blood vessels in the neck, but not the major bleeding I'd expect if he were a healthy individual at this point.

Q And how many different lacerations or how many different cuts can you actually see in that

photograph?

A I can see a minimum of four, but this one shows several edges on it. And instead of at -- well, with a knife that's being put into a tissue, you can put it in and pull it out and have two different edges on the sharper edge of the knife. In a wound like this, pulling it across one time does not make two tails on the wound. Instead, that's -- that's two separate wounds. These did not line up in the skin folds as one wound.

Q Okay. So that would mean that the knife is going across the skin how many times?

A A minimum of two with this one, a minimum of two at this one, one with that one, and one with that one. So there were probably actually six times across the neck.

Q Six times across the neck. And that's what's demonstrated by this picture?

A Yes.

Q And this is while he is dying?

A This is while he is dying.

This photograph is of Chad's left thumb. (Holding up photograph). And it shows how the injury was inflicted by the -- by the drawing of the knife across the finger there.

Q Okay. This is a defensive wound --

A That's the defensive wound.

This injury I did not yet talk about. (Holding up photograph). This is an injury to the upper left thigh. And again, this one did not cause major injury. And I'd call it a superficial laceration. I did not designate it with AA, BB, etc. Basically, I was very tired of writing by that time. And I'd come to the bottom of that page. So I, instead, designated this as a superficial laceration, meaning that it did no major damage and charted it as being 29 and a half inches above the heel. That also shows vital reaction and is transversely oriented. So his leg would be like this (indicating), with the number upside down.

Q When you say "vital reaction," meaning it was --

A It was while he was alive. This may or may not be a defensive wound. If he's trying to get something in the way of a sharp object, that could have occurred during the struggle. I don't know.

This is the wound to the back. (Holding up photograph). If you're looking at it from his back, it would be this way (indicating). And that is a stab inward type wound to the small of the back. Again, it shows vital reaction. It does show bleeding, etc.

There is a little reddening around the skin, around the edges.

These are the two stab wounds to the belly button area. (Holding up photograph). If I put it like this, and you realize that I am taking a photograph from his right, here is his belly button, here is the taller or the higher of the stab wounds, which is BB, here and here is CC, here (indicating on diagram). We just use this thing here to show us relative size. This is a centimeter ruler. And these again are basically directed towards the inside of the body. And they show the reddening of the edges of the wounds as well.

Q Again, that -- he's alive?

A He was alive.

This is a photograph (holding up photograph) of his chest. And I've taken it from the left side, basically, to show stab wounds just to the outside of his nipple, but it also shows a little abrasion here that I did not separately chart as a stab wound. It's just an abrasion. I don't know how it occurred, but it's about the same age as all the other injuries, but it didn't do any major damage. He also has an abrasion here (indicating on photograph). I think he had those -- no, he does have punctate abrasions here, and I believe that's all.

He does have abrasions here, here, and here (indicating) on the right shoulder area. I'll show you those in a minute. This one does show, it's from the right side, if he's lying down, which is how I viewed him, it would be like, this is little abrasion here (indicating). This is the puncture wound, it's a closer puncture wound shot than the one I'm going to show you in a minute, show a little tail off it, the fact that it is a very round little hole rather than being a slit-like hole here (indicating). This is a relatively close-up shot of the Gunshot Wound B, but I've taken it from across the body, it's over here on the right side of the chest. And it shows a relatively dense black color around the wound indicating the deposition of powder because it's a contact nature.

Q All right. So this would show three different types of weapons.

A Three different types of weapons --

Q And --

A -- in one photograph.

Q -- all of which were the injuries inflicted prior to death?

A Prior to death.

Q All right. This is the last photograph. This, again, if you imagine Chad -- it's difficult to

do it that way. Let's do it this way. These are some abrasions, but the important things are the gunshot wounds to the right chest. That's B.

Q The contact wound?

A The puncture wound. Yes. That would be. The puncture wound here (indicating) with a little tail on it, some scrapes there. And this is the wound that went through muscle type tissue, in and out. And here is the stab wound to the right side of the chest (indicating).

Q So, again, that shows three different types of weapons, the number of weapons, and also before death?

A Before death.

Q All before death?

A (No response.)

Q What, Dr. Harlan, was the cause of death of Chad Burnett?

A Because several of his stab wounds, if given long enough, could have resulted in his death, I listed his cause of death as being multiple gunshot wounds and stab wounds. Several of the stab wounds were deep enough that if given long enough they could have led to his death. The gunshot wounds to the right chest certainly could have caused his death. He was probably in a weakened state by the time he received

the final gunshot wound, which was the gunshot wound to the edge of the left eyebrow, which killed him rather quickly.

Q So that he -- all of his injuries occurred before death?

A All of his injuries occurred before death.

Q Can you tell anything about from your viewing of the body the time of death of Chad Burnett?

A Chad, when initially viewed, by and others was in rigor mortis, had fixed posterior livor mortis, and had begun to show drying around the edges of the wounds, etc. So he had been dead for more than 12 hours. If I tried to go back and -- and categorize that further on him, I would say that it was probably right around 12 hours at that time.

Q From when he was first viewed or longer?

A Uh --

Q Would it be consistent --

A From when I started the autopsy.

Q When the --

A No, excuse me, from when first viewed.

Q When -- would it be consistent with being dead around 11:30 on October the 1st?

A Yes, it would.

Q So that's his time of death. During the course of your autopsy, do you also look at the stomach contents?

A Yes, I do.

Q And what were you able to determine about the stomach contents of Chad Burnett?

A We actually weigh and measure our stomach contents. And what we found was that he had in his stomach 180 cc.'s dark green-black mush which you couldn't see through. And it contained bits of onion, cheese, green pepper, black olives, mushrooms and pepperoni.

Q Would that be some of the ingredients of a pizza?

A That sounds like a pizza supreme.

Q And based on what you could see, can you tell anything about the time of death with regard to looking at the stomach contents?

A I can tell that Chad ate within one hour of the time that he died.

Q I think that's all I had with regard to Chad.

GEN. BLACKBURN: Your Honor, at this point I'm going to request that the photographs be made an exhibit to our hearing and that the two charts be a

collective exhibit as to Chad Burnett.

THE COURT: Okay. The pictures will be one collective exhibit and the diagrams will be another collective exhibit as the next number as to Chad Burnett.

(State's Exhibit No. 33, photographs, marked and filed.)

(State's Exhibit No. 34, two (2) charts, marked and filed.)

Q (By Gen. Blackburn) Dr. Harlan, after you did the autopsy with Chad Burnett, did you then do an autopsy of Judith Smith?

A Yes, I did.

Q And what, if you would, in doing this, do you recognize these two charts?

A Yes, I do.

Q And are these the charts that you made with regard to the autopsy of Judith Lynn Smith?

A They are enlargements of those charts.

Q Would you just, either using the charts, or explain your view of the body of Judith Smith.

A Okay. Let me make one note here. All of the information, I believe, is on that one. There is one -- a Special Chart 11 here. And the edges of the abrasion here got cut off by our xerox machine's copy.

All right. The wounds on Judith were a gunshot wound, which was not contact, which did not show near stippling, but instead showed that the muzzle had to have been more than two feet from the left arm, which entered the back side of the left arm and came out the front side of the left arm. Those are designated as Gunshot Wound B and Exit Wound C. This did show vital reaction. She was alive when this occurred. It did not lead to her death.

Q Let me stop you at this point. When you're saying the back side of the arm, it would have to be facing the --

A Anatomic -- anatomic position would place that at the back side of the arm. That doesn't mean that she was shot from the back. She could have easily have been shot through the back side of the arm, with her arms back side toward the gun, facing the gun.

Q Okay. So she could have had her -- like her arm between the gun and the other parts of her body?

A That's correct.

Q Okay. Gunshot Wound A.

A Gunshot Wound A is at the top of the neck. It does not show well on any of these diagrams because this is a front and back shot. And this is a side area, but it's approximately here (indicating on self).

Gunshot Wound A, when -- especially when compared to Gunshot Wound which is .24 by .24 inches is somewhat bigger and shows a large amount of black color around it, which is the powder burn. This is a gunshot would which would be described as being a near gunshot wound, but I can qualify that a little bit further by telling you that anything within two feet is considered a near gunshot wound, because it will leave a spray of black powder. This is considerably closer than that. And while not immediately adjacent to the skin, has to be very close to it, because this did not have the stipple pattern around it that a further back gunshot wound would show.

Q So on Chad we had contact wounds, we've got the near gunshot wound and then the other --

A What we would classify as a distant gunshot wound being more than two feet from the skin to the muzzle.

Q This one was within two feet or closer?

A Definitely.

All right. Those were the gunshot wounds. She also had a slice wound to the neck. Hers is a bit different because instead of being over here with the gunshot wound it's more on the right side of the neck coming around to the midline. And this one on her does not show even a degree of bleeding that those on Chad showed. Now, I qualify that by saying "mild hemorrhage." The amount of bleeding that was present from this slice was about that that would be drained if you slice something that's already dead or dying. So circulation to the neck was not good at this point. Her heart may have actually already stopped.

Q So these lacerations to her neck could have been after death?

A At or after death.

The Stab Wound BB, again, is superficial and it's here (indicating on diagram), and it's a small, narrow wound, very similar to Chad's wound that was here (indicating on diagram), but it was a little further down and right here (indicating on diagram).

Stab Wound CC is, again, small and round, superficial, and right there (indicating on diagram). Stab Wounds DD and EE are, again, round. This one (indicating on diagram) is only .08 inches by .015 inches, but it is at a little bit of an

oblique angle causing that kind of ovoid or a tadpole-type shaped wound there.

This one, again, is a puncture type wound. The injuries that these cause internally were a little interesting, too. The near gunshot wound to the neck went through the skin, through the soft tissues in the neck, through the C-3 vertebral discs, through the cerebral -- through the cervical spinal cord, slicing it into. And the bullet was recovered in the cervical spinal canal. The bullet was at 59 inches above the heel. The entry wound is at 60 inches above the hell. The direction of the bullet went was from left to right and from anterior to posterior. So we're talking at an angle left to right and anterior to posterior, but not downward or upward.

Q What would be the effect of this gunshot wound?

A This gunshot wound, because of the injury, which is a transection, a total separation of the cervical spinal cord would have rendered her incapable of moving her arms or legs at that point.

Q In other words, she would have been paralyzed from the neck down?

A That would have been instant paralysis. She also had subdural hemorrhage in the area and

bleeding. She also had subarachnoid hemorrage from it. I doubt seriously if she would have been capable of breathing at this point. If she did, it was not for very long. There was some bleeding into the upper airway, and it did not really get down far into the lungs. So I think she may have had a few deep breaths, and that's about it.

In -- in going through the neck and being lodged in the canal, it went through the basilar artery and left vertebral artery or actually lacerated those arteries from the motion as it went past. That caused bleeding inside the brain itself, caused a hematoma of the left internal jugular vein in the neck. That quickly ended her life.

Q What -- the -- how many different types of weapons were used on Judith Smith?

A I doubt seriously if the puncture wounds that were superficial here (indicating on diagram) were made by a really, really sharp instrument capable of giving the slice that we have here (indicating on diagram). So I really believe that there are a gun and two different types of instruments to make the stab and slice shapes.

Q So, again, three different types of weapons?

A Correct.

Q Can you state anything at all about the -- the instrument that was capable of doing that slicing -- slicing motion?

A Not very much. Again, I did not see evidence for serration. And its depth of the slice was .8 of an inch.

Q So no serration and -- but with regard to the depth, it did not go very deep.

A It did not go very deep, but it should have made more bleeding than it did, because .8 of an inch is approximately that far (indicating with hands) beneath the skin. And in the area that it went in, there are plenty of smaller blood vessels that should have been redder had the heart still been functioning.

Q And the puncture wounds were caused by what kind of an instrument?

A Again, it's something with a sharp point, like an ice pick, something similar to that.

Q Similar to ones that you observed on Chad's body?

A Yes.

Q Was there any way to tell from your observations whether or not the same instrument was used on both Chad and Judith?

A Not precisely, but it appears likely. I can find no dissimilarities.

Q The puncture wounds, were they made before or after the death of Judith Smith?

A The puncture wounds charted here (indicating on diagram), there was very, very little bleeding. And particularly, on the one here, which I diagrammed here (indicating on diagram). Stab Wound -- let's see, it's not BB. It's EE, here (indicating on diagram). That wound went in a maximal depth of 2.20 inches. And it was going from front to back and a little bit from bottom to top. And it went into the right lobe of the liver, and yet, it caused no major bleeding. A liver, when stuck, bleeds, remarkably. This was capable of producing with these sized holes, but at the same time it didn't bleed, so I believe that Judith's heart had already stopped by the time that this wound was administered.

Q Okay. So the puncture wounds are after death?

A I do believe they are.

Q Dr. Harlan, let me hand you a series of five photographs and ask you if you'd look at those and see if you can recognize those.

A Yes, I do. I took these, and they are all of Judith Smith. The first one is a photograph

showing the Gunshot Wound A, which is back here, in the side of the neck just past the angle of the mandible. And you can see the black coloration around it. You can also see some red around it. That is vital reaction.

Q Okay. Vital reaction, meaning she was alive when this -- the gunshot wound --

A Yes.

The second photograph is of the right side of her neck, taken from the right. (Holding up photograph). This is her chin (indicating on photograph). That's her left shoulder. She's in that position, and it's obliquely orientated, and it is a slice type wound. And there's very little bleeding.

Q Which would lead you to believe this is after death?

A Yes.

Q And --

A At or after.

Q At or after death. Can you tell whether or not there's one or two?

A On that particular one, I could not see a good tail type edge at either end. That may have been one. If it was not one, then the deeper cut had to have been centrally placed and not involving the

skin.

Q So one, maybe more?

A One, maybe more.

This photograph is of Judith's left elbow. (Holding up photograph). This shows the distant of entry gunshot wound to the back side of her arm and a little bruise above it.

This photograph I made before I took her shirt off. This is her left arm coming down this way (indicating on photograph), almost off the photograph. This is Stab Wound BB. And you can see a very small hole in the shirt. It shows that the shirt was also penetrated by whatever caused the puncture wounds. And that's all the bleeding that there was at a time between injury and when she was finally brought in to us.

Q Which would indicate, again, that it was--

A There is no indication there that her heart was beating.

Q So that --

A So that's about what would be soaked out by a blotter-type effect from the shirt from a puncture on someone that's dead.

This (holding up photograph) is the same wound as it looked after we took the shirt off. And

there's -- I mean it's very easy to overlook it. It's a small, little hole there and no reddening around the edge.

Q And what was the cause of death of Judith Smith?

A I listed Judith's cause of death as multiple gunshot wounds and stab wounds. Basically, the gunshot wound that -- that ended her life was the one to the angle of the jaw, upper neck here (indicating on diagram).

Q So the main cause of death would be this gunshot wound (indicating on diagram).

A That's correct.

Q Which caused the paralysis. And would the time of her death be consistent with 11:20 or before on October the 1st of 1989?

A Yes, it would.

Q And again, did you look at the contents of -- of her stomach?

A Yes, I did. Hers was somewhat different from that of Chad. Her stomach contained 570 cc.'s or grams of orange-tan mush with green leafy vegetables, sliced peaches, noodles, yellow cheese, orange grease, bread, brown -- brown meat that was ground up, onion, and tomato.

Q And what would that tell you about the time of death with regard to when she had eaten?

A She had definitely eaten within the hour of her death.

GEN. BLACKBURN: Your Honor, at this point, I'd request that these photographs be made the next exhibit and the two charts, be a collective exhibit.

THE COURT: Again, the same way, be collective, the pictures, and then the charts another exhibit.

(State's Exhibit No. 35, five (5) photographs, marked and filed.)

(State's Exhibit No. 36, two (2) charts, marked and filed.)

Q (By Gen. Blackburn) Dr. Harlan, after you performed the autopsy on Chad and Judith Smith, Chad Burnett, did you then perform an autopsy on Jason Burnett?

A Yes, I did.

Q Okay. If you would, just describe his injuries.

A If you'll look, we do have a chart that's different from the other two. Basically, these are the same two types of charts for him. Jason had no gunshot wounds. Instead, he has all stab type wounds and lacerating type stab wounds.

He had a few abrasions on the back of the neck, some scars and other things, a yellow and purple contusion of the left eye, which is something that occurred prior to the episode leading to his death. This would have required a day or more to have shown that yellow-purple change. The contusion here with the central abrasion, however, was -- the other abrasion that's listed on here are also fresh.

What he had was a series of stab wounds. Let me begin with A, which is the one to the left side of his neck. And again, this stab wound is looked at uneven and shows some change around it that just suggests more than one motion back and forth. This one is from the left, clear across the midline slightly on the right, but more on the left than the right.

That one was directed inwards. It had a maximal depth of half an inch and showed dimension of 6.2 inches by .65 inches. So it's over 6 inches long. This one did bleed. He was still alive and still -- heart activity was going on when this occurred.

Stab Wound B is to the upper abdomen. This is its shape, .8 by .4 inches, and places it in the same range as the stab wounds that we've described on his brother. Stab Wound B is here (indicating on diagram). This stab wound went through the abdomen, went through the entire anterior abdomenal wall, went through the entire thickness of the left lobe of the liver, went through the inferior vena cava, which is the big vein that takes blood all the way from the -- everything below the diaphragm back into the heart and also got the right edge of the first lumbar vertebrae disc. We're talking backbone disc, and then ended in the right perispinous muscles and deep fat beneath the skin in the back. Its minimal depth is 5.1 inches.

Q So what does that tell you about the injuries that cause that?

A The blade almost had to have exceeded more than about 4.8 inches in order to have indented the skin that far and would depend somewhat on how much he was able to give, how much force was used and how sharp the instrument was as to what its actual length would have been.

Q And it has to be at least 4.8 inches long?

A Correct. This was directed from the front to the back but from the inferior to superior,

meaning it was angled upwards. And it was angled from left to right. And it actually went across the midline and into the back there (indicating on diagram). And there was quite a bit of bleeding from it. He had two shared wounds that could have caused all of the bleeding that we saw.

And the next one is the one that could also have been a fatal wound. That would could have been fatal, and it would have taken him a matter of minutes to die. The other wound, also, could have been fatal and, again, would have taken a matter of minutes, possibly half an hour to die.

Stab Wound C is a very long stab wound, but even though it looks like a slice-type wound, it has to have been done with major amount of depth to it. So I believe it was from a raking motion, not of a slice but instead of a knife put in and pulled.

Q And why is it that you think that?

A I think this because of its depth.

Q And what's that?

A Its minimal depth is 3.8 inches.

Q Minimal depth?

A Minimal depth.

Q And maximum depth?

A About that.

Q What was actually --

A You can actually trace it that far.

Q What was the result of that particular raking motion?

A The result there is that it went into the abdomen, raked across and lacerated the left common iliac vein, which is the big vein coming up from the leg. It carries everything from the leg and part of the pelvis up into the inferior vena cava and also got the muscle that's attached to the backbone and had quite a bit of depth within that muscle. And the result of it not only was the bleeding that occurred, but the majority of the small bowel was exposed to that wound and made its way out of that wound.

Q That was as a result of the raking motion?

A No, it's a result of the big wound.

Q So it cut the muscle to the extent that the lower bowel came out?

A The upper bowel.

Q The upper bowel.

A The small bowel came out, yes.

The other wounds that he had were to the trunk. They're not as impressive. He had a Stab Wound D, here, (indicating on diagram), to the lower abdomen. And its minimal depth because it was between loops of

bowel, and we couldn't trace exactly how deep it went, but was 1.2 inches. It did go into the peritoneum cavity and did bleed in the issue around it.

Stab Wound E was to the right anterior chest, here, (indicating on diagram), and its maximal depth was 1.2 inches. Stab Wound E, again, is .44 by .25 inches. This is not a puncture. This on him was some drying of the wounds prior to the fact of me charting it, giving it a more ovoid appearance.

Q When you say "not a puncture", how many types of instruments were used on Jason Burnett?

A Jason may have had all of his injuries from one instrument. They were certainly all in the classification that we would consider that of a knife.

Q Can you tell us anything about the knife?

A It would had to have been fairly sharp. It would had to have been fairly long. It could have been something such as a barber's type razor. It could have also been a sharpened cutting knife or a kitchen knife that was very sharp.

Q A cutlery type knife?

A If it were sufficiently sharp.

Q Was there any evidence from your observations of the wounds a serrated blade?

A No, there was no observations to suggest serration. There is an unusual pattern to Stab Wound D. And there is a little bit of a V-shape to it. And I don't know whether this represents a second small slice here and a bigger slice here and an instrument that may have had a single edge for most of its blade or not. But that does suggest that. And there was some suggestion of that sort of thing with his brother's wounds as well.

Q So from the suggestion of this wound and some on Chad, you're saying that the same knife was used?

A May well have been. And I really can't tell whether it was a double-edged knife, a single-edged knife with a partial double edge or just an awful lot of activity with a single-edge knife.

Q When you say "a lot of activity," that is movement?

A Yeah.

Q Either --

A Twisting.

Q That would be caused by either the movement of the knife or the body on the knife?

A The movement of the boy or the movement of the knife in relation to the movement.

In addition to those, we have another chart here to show the injuries to Jason's hands. He has on the back of his right hand a little laceration here, but he also has a big laceration to the angle of the thumb that shows it slightly here (indicating on diagram). This is the right thumb on these two. This is the left hand (indicating on diagram). And there is a slice here that extends around onto the back side of the hand slightly, and a slice here (indicating on diagram). But the majority of the injuries are where he can have gotten them by grabbing at the knife, at the blade. And these three could have conceivably been made by one stroke, if he had hold of it with his right hand, left hand, excuse me, if he had hold of it pulling, and there was force against those fingertips.

This represents the second one and this a third one (indicating on diagram), or possibly more than one. This could have been multiple times through the thumb area there. I can't really tell.

The right hand -- I'm sorry, I don't know whether he was right or lefthanded, but the right hand sustained more injuries to the palm side. And again, these were slices across the palm to the thumb, little scrapes on the fingers, and bigger scrapes, and a large scrape across the base of the knuckles. This

one -- these two did line up. This one didn't line up quite as well, but could conceivably have been from that. I tried to calculate how many times he would have had to have grabbed the knife and had it removed from his hand and grabbed the knife as it was coming toward him in order to do those injuries. And you really can't get a -- a really good number on it. There -- it could range from about 10 to certainly more than 13.

Q So 10 to 13 times that the knife would have had to have enter the hand --

A Yes. If there is -- the reason my estimate is a little lower than I think, because there may have been a double-edged blade. And some of these injuries may have occurred because the skin's being folded up around something with two blades, edges.

Q What -- how do you classify these type of wounds on Jason's hands?

A These injuries on Jason are quite characteristic of what we see with defensive type wounds. I'm assuming that he did not deliberately try to grab something that sharp unless he needed to. So I do think that these are -- are defensive type wounds. They're not the sort of thing that one does to one's self unless one's trying to protect one's self from a sharp instrument.

Q The injuries to Jason in all of these, were they before or after death?

A They are all before death.

Q And the hands and all. What was the cause of his death?

A I classified his death as being due to multiple stab wounds. To be a little more exact, he died from quite a bit of bleeding. Two wounds, in particular, could have led to his death much more quickly. And those were the two that I showed you, here and Stab Wound B (indicating on diagram), because those did get major blood vessels. They did get veins rather than arteries. And it takes a while longer because they are not under pressure that an artery is, in order to die.

Q All right. I'd hand you a series of six photographs, and ask you to look at those and see if you can identify them.

A Yes, I can.

Q If you would, please explain what each one of them represents to the jury.

A Yes. This is (holding up photograph) Jason's neck injury. This is the extent of the left side of the neck. There's also -- you can see the bruising of the eye that's beginning to fade. The

other important thing in this photograph is this purple color. And the purple color here (indicating on photograph) is not bruising, this big one. The purple color here is because he was lying on his left side for more than 12 hours before he was removed from his left side.

Q So if he were found on that left side--

A Yes.

Q -- or first observed by someone, he would have had to have been on that left side --

A For more than 12 hours prior to being moved. The reason for that is that livor mortis, which is what this represents is pooling of the blood by gravity. As it pools, it can be, if you roll the person, then it will start pooling in the other direction. It only begins to fix in the tissues at approximately 12 hours. His, I think, had been more than 12 hours because it did not move during the entire time of the autopsy. Some of these photographs were made more than a day later. He had been lying on his back in our facility during that time and still has this anterior left side pooling of the blood.

Q So that would tell you or would it tell you that he had been laying on that left side prior to being found at least -- or prior to being moved at least if not more than 12 hours?

A Correct.

The second photograph shows that same finding, but it also shows the extent of the wounds, which comes from behind the left ear, clear across the right midline. It also shows his shirt that he had on with quite a bit of blood soaked into the shirt.

Q And what does that -- what does that wound show you about whether or not that was before death and can you tell --

A That -- that shows me that there is an accentuation of the blood up here around the neck. There is some pooling back here on the back of that. And this shows me that he was alive and did bleed after the injury to his neck.

Q And can you tell how many strokes that that laceration made?

A That laceration has got some unusual directional changes to it. And the right side of it, in particular, has two little tails over there. So it suggests at least three changes of direction across.

Q Would that be three different slices that--

A It could be three different slices or it may be going across it while moving.

Q It could be moving across it three times without removing the blade?

A Yeah. Either three slices, probably in this direction (indicating) or three times like that (indicating).

Q But three separate movements?

A Correct.

Q On his neck.

A Correct.

The other photographs that I have are of his hands to show what the diagram also attempts to show, and that is, the injuries mostly to the palm side of his hands. This is the back of his right hand. You can see the injury to his right thumb and the small injury to the back of the right thumb (holding up photograph).

This one is of the palm side of the left hand. The thumb is over here off the photograph (holding up photograph). But it shows the slice marks to the fingertips.

The next one (holding up photograph) is the palm side of the right hand and shows the numerous different slice marks across, basically, the right hand. There's a little variation in angle. Some of these are a little deeper. And some of them may have been like this (indicating), others trying to grab

something aimed at or being pulled away from him.

Q Is this the hand that has a minimum of ten to thirteen different --

A Right. And as I said, there could be more than thirteen. I really can't tell, for instance, how many times it may have gone through that same slice.

The back of the left hand is shown in that photograph (holding up photograph). To show that two-tailed laceration there and the ones here (indicating).

Q And what does the two-tailed lacerations tell you?

A That tells me two different changes in direction, being pulled through them twice, two strokes.

GEN. BLACKBURN: Your Honor, again, I would request that those pictures be made a collective exhibit and the charts be a collective exhibit.

THE COURT: Okay.

(State's Collective Exhibit No. 37, six (6) photographs, marked and filed.)

(State's Collective Exhibit No. 38, three (3) charts, marked and filed.)

Q (By Gen. Blackburn) Take your seat, Doctor.

A All right.

(WHEREUPON, the witness returns to the witness stand.)

Q (By Gen. Blackburn) Dr. Harlan, can you tell how long it had been since Jason Burnett had eaten at the time of his death?

A Yes, I can, within limits. Within his stomach, he, as his brother, had a -- a fairly full stomach. He had 430 cc.'s of tan, thick mush with yellow grease, sliced black olives, onions, mushrooms, a small piece of paper that I'm still wondering about, flat noodles, tomato and green pepper.

Q Would that also be ingredients of a pizza?

A Part of them could well be the ingredients of a pizza. I really don't know where he got the flat noodles and I don't know if he just was very hungry or how he got the piece of paper.

GEN. BLACKBURN: If I can have just a minute.

(Pause in the proceedings while Gen. Blackburn confers with Gen. Thurman.)

Q (By Gen. Blackburn) Dr. Harlan, did you have an occasion to, one, go to the -- 324 Lutie Street?

A Yes, I did.

Q And in addition to that, did you also look at some knives that were collected from 324 Lutie Street?

A Yes, I did.

Q And when you looked at those knives, were there any of those that could have been used to cause any of the injuries that you saw?

A The knives themselves did not appear to be very sharp. Several of them didn't have handles. And it would have taken quite a bit of force to inflict the majority of the injuries that I saw here. The one thing that I have not seen is the implement that -- well, I haven't seen the implement that produced the puncture injuries either, if one was collected.

Q Okay. Well, Dr. Harlan, I'll hand you Exhibit No. -- have the court officer hand you Exhibit No. 8, and ask you if you can look at that.

A All right. This could easily be the instrument. It would certainly take something about the size and sharpness of this. And that could be the ones that produced the puncture wounds, particularly the ones to the chest there.

Q So that awl that's been previously identified could, in fact, have produced the puncture wounds that you observed on both Judith Smith and --

A Chad.

Q -- Chad?

A Yes.

Q Dr. Harlan, I'll have -- I'll hand you what's previously been identified as Exhibit 30 for identification only, and ask you if you would look at that and see if you can identify that?

A Yes, I can.

Q And what is that?

A These are three bullet pouches that I prepared of the three bullets that I removed from the victims.

Q And they were removed from which victims?

A From Judith and from Chad, two from Chad.

GEN. BLACKBURN: Your Honor, I'd just request that the Exhibit No. 30 be made an exhibit to her testimony.

THE COURT: Let it be done. Hand those over.

THE WITNESS: All right.

THE COURT: And those will be Exhibit No. 30.

(State's Exhibit No. 30, bullets, marked and filed.)

Q (By Gen. Blackburn) And Dr. Harlan, I'd hand you Exhibit -- actually, it's a picture from Exhibit 6, and ask you if you would look at that knife and see if that's the type of instrument that could have done the injuries that were to both the -- all the victims?

A It does not appear to have been.

Q Okay.

A No.

Q That's more like a kitchen type knife?

A I would -- I would have to take that home and sharpen it first.

GEN. BLACKBURN: If I can have just a moment, Your Honor.

(Pause in the proceedings while Gen. Blackburn confers with Gen. Thurman.)

GEN. BLACKBURN: Your Honor, I don't have any further questions of Dr. Harlan.

THE COURT: Mr. Newman.

MR. NEWMAN: Your Honor, if I could have just a second, please.

(Pause in the proceedings while Mr. Newman confers with Mr. Dean.)

MR. DEAN: That's all.

THE COURT: Mr. Thurman.

CROSS-EXAMINATION

BY GEN. THURMAN:

Q Detective Smith, you and Detective Bernard travelled to Springfield together, did you not?

A That's correct.

Q And you both participated in the questioning?

A Correct.

Q But from time to time you would leave the room; is that correct?

A Yes, I did.

Q To do certain things. So you weren't present the entire time?

A No.

Q He was questioned. Okay. During the time you were there, when Mr. Smith would discuss his wife, what tense would he use?

A He was using her name "Judy" in past tense. Everything he said about her was in past tense.

Q When you started questioning him about where he was and what he was doing, did he ask you why?

A No, he didn't.

Q Even after he was informed -- well, let's talk about this emotion. You say there was watering in his eyes?

A Yes, it was.

Q How long did that emotion last?

A Not very long.

Q Okay. And after that, did he ever ask you how they were killed?

A Not that I recall, no.

Q Did he ever ask you if you'd caught anybody that had killed them?

A No, he didn't.

Q Did he ask you when they were killed?

A No.

Q And what time did he tell you he arrived in Springfield at his residence with the twins on October the 1st, 1989?

A He said he got back at his home at 10 o'clock p.m.

Q Okay. What did he tell you he did once he got back?

A He said he took his twin boys to his mother's trailer or house and packed some clothes, got a drink of water and then left to go to Kentucky at 10:30, around 10:30.

of work on that Monday.

Q And did he say why he told her that when he had to go to Kentucky?

A He said he -- he -- he forgot that he was having to go to Kentucky.

Q So he forgot --

A But he had --

Q -- he had to drive to Morehead --

A -- prearranged it --

Q Excuse me. I didn't mean to interrupt you.

A He said he prearranged with Judy to have them on Monday. Normally -- than the week -- longer than the weekend, he has them on the weekend, and he made arrangements to have them on Monday because he was going to be off work, that he forgot that he had to go to Morehead, Kentucky, for that job.

Q And did you see his car that night?

A Yes, I did.

Q What kind of a car was he driving?

A It's a four door white Ford, Crown Victoria. It's an old police car.

Q Okay. Did you have any discussions about that car with him?

A Yes, I did.

CROSS-EXAMINATION

BY GEN. THURMAN:

Q Mr. Smith, I think you go by the name of Frank, is that right?

A Yes, sir. In Ohio, that was my nickname.

Q And people you work with basically know you as Oscar, but the family calls you Frank; is that right?

A No. When I started working for what is now MSC, originally, my uniform said Frank on them.

Q But you switched it to Oscar?

A The company switched it.

Q But you go by the name of Frank; is that--

A I go by Frank or Oscar.

Q And let's see, your first marriage -- the wife you talked about, Wanda O'Shea; is that right?

A That is her present name, yes.

Q In what year did you marry her?

A 1971.

Q I believe she was 13, is that correct?

A Possibly.

Q Possible?

A (No response.)

Q Well, how do you get that, if you're the beneficiary --

A Because --

Q -- and you've already filed claims for $88,000? How do you not benefit?

A Because every penny of that money goes to the children.

Q That's not by law, that's --

A That was mutual agreement between Judy and I, the same as the way her funeral was supposed to be arranged, and she knew how I was to be put away if that was me.

Q But Judy's not around to enforce that mutual agreement, is it? So it will be your decision about what to do with the $88,000, if, in fact, you get it; isn't that correct?

A It's not a decision, really, to be made.

Q. I understand that. Right now it's not. The car that you were driving, the one that was identified here in the photograph, that was the car you were driving, is that right?

A I drove it that day, yes.

Q Describe that car?

A It's a '87 Ford LTD. It's an ex-police patrol car, has a trailer hitch, a piece of molding off the back left corner of it, dome light out of it, holes

in each of the door panels where -- where a shield had been up in there, to divide the front from the back, and no door hinges on the back.

Q Would it go 140 miles an hour?

A It may.

Q Do you remember talking to the police and telling them it would go 140 miles an hour and the only speed you knew was faster and faster and faster?

A I don't remember that exact conversation.

Q What was the conversation about your driving?

A He asked me -- the conversation came up about the car. He asked me if it was a patrol car. I told him, yes, it was a Murfreesboro police car, and it 140 on the speedometer.

Q Did you comment about your driving or your speeding?

A I told him that I had tried it one time.

Q So you'd driven that car 140 miles an hour?

A Not at 140, no.

Q How fast would it go?

A Probably 115, 120.

APPENDIX F

Randolph, Brianna Wyema-Rochelle (2019). An Analysis of Bulletproof As Probabalistic Genotyping Software For Forensic DNA Analysis Casework [Thesis and Dissertation]. Boston University School of Medicine

2019

An analysis of bulletproof as probabilistic genotyping software for forensic DNA analysis casework

BOSTON UNIVERSITY

SCHOOL OF MEDICINE

Thesis

AN ANALYSIS OF BULLETPROOF AS PROBABILISTIC GENOTYPING SOFTWARE FOR FORENSIC DNA ANALYSIS CASEWORK

by

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B.A., Boston University, 2017

Submitted in partial fulfillment of the

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2019

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ACKNOWLEDGMENTS

I would like to thank Dr. Robin Cotton for her guidance, advice, and aid throughout this project. I would also like to thank her, Rebecca Boissaye, and Crystal Oechsle for their reading and reviewing of this thesis.

I thank the eDNA consortium for the use of their Bulletproof Software, as well as Dr. Kent Harman for the Bulletproof training, primer, and troubleshooting. I would like to thank Drs. Robin Cotton and Catherine Grgicak et al for the use of the single source and mixture profiles that were utilized in the genotyping software.

I would also like to thank my dear friends and family, especially my mother, for getting me through this laborious process. Lastly, I would like to dedicate this work to God, and to my late grandmother, Willie Mae Randolph (October 28, 1939 – October 1, 2018), whose no-nonsense spirit guided me through to this accomplishment.

AN ANALYSIS OF BULLETPROOF AS PROBABILISTIC GENOTYPING SOFTWARE FOR FORENSIC DNA ANALYSIS CASEWORK

BRIANNA WYNEMA-ROCHELLE RANDOLPH

ABSTRACT

Using computer systems for probabilistic genotyping on DNA evidence in forensic casework is beneficial as it allows a complete analysis of the data available for a wide range of profiles, a range that is limited when analyzed manually. One such software, *Bulletproof,* uses the exact method as the statistical foundation of its web-based interface to estimate the likelihood ratio of two hypotheses that explain the given evidence. In this investigation, the capability of *Bulletproof* was examined by analyzing the effects of evidence and reference sample template amount, injection time, and stutter filter utilization on likelihood ratio. In terms of likelihood ratio, deconvolution by the software is more efficient in cases in which evidence samples of high contrast ratios (such as 1:9 vs. 1:1) and low contributor count have high template, and when sample injection times are low. Reference sample template amount and injection time are less impactful than that of evidentiary samples. As with unknown samples, reference samples should be analyzed beforehand and artifacts removed for better deconvolution.

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LIST OF ABBREVIATIONS

Bp .....Base Pairs

BU.....Boston University

CE .....Capillary Electrophoresis

CPI..... Combined Probability of Inclusion

DNA.....Deoxyribonucleic Acid

Hd .....Hypothesis of the Defense

Hp ..... Hypothesis of the Prosecution

IPC.....Internal Positive Control

LR .....Likelihood Ratio

NIST. .....National Institute of Standards and Technology

PCR..... Polymerase Chain Reaction

PH.....Peak Height

qPCR..... Quantitative Polymerase Chain Reaction

RFU .....Relative Fluorescence Unit(s)

RMP.....Random Match Probability

STR..... Short Tandem Repeat

SWGDAM .....Scientific Working Group on DNA Analysis Methods

1. INTRODUCTION

1.1 Overview

Current human deoxyribonucleic acid (DNA) processing exploits specific components in our DNA in order to produce and analyze a profile for comparison in forensic casework. The generation of a DNA profile occurs in five steps: extraction, quantification, amplification, typing, and interpretation of the DNA present in a sample. During extraction, using heat and chemicals, the DNA is separated from the substrate, debris, and other cellular components present in the sample. The type of extraction method selected is dependent mostly on the type of sample, as well as the amount and quality of DNA estimated to be in the sample. Quantification serves to calculate how much human DNA, and also male DNA, is available in the sample. The quantification process is a real-time polymerase chain reaction, or qPCR, in which the concentration of DNA in a sample is estimated by the amount of cycles it takes to reach fluorescence threshold in the instrument[1]. This step is vital because the subsequent phase, amplification, is optimized at a target template value. If a sample is found to have too little or too much human DNA after qPCR, more of the sample can be extracted, or re-extracted using a different technique or parameters, or the sample can be concentrated or diluted. QPCR also serves to determine if there is a component in the sample that could inhibit amplification, as there is an internal positive control (IPC) in the primer mix that is introduced to each sample. Quantification results include a concentration threshold value (C_T) for this IPC, and if this value is higher than expected, then there is an

indication that the reaction maybe inhibited, and the sample can be re-extracted, diluted, or further purified to limit or remove the inhibition. [1],[2].

During amplification, specific regions of the genome, called loci, that are found in every human being are targeted and amplified into millions of copies via PCR. These sequences have characteristics, called alleles, that vary from person to person due to their hereditary nature. (Due to this nature, identical twins have the same characteristics and thus the same DNA profile, though there are recent methods to distinguish twin DNA in other ways[3].) In common current practice, the loci used for forensic testing are composed of short tandem repeats (STR), which gives the entire five-step process the name STR analysis. STR are hypervariable areas of DNA that have sequences of repeating bases (typically four bases in length for forensic casework), and the number of repeating blocks of bases (repeats) dictate the allele[4]. For example, if Parent 1 donates a strand containing 15 repeats of the sequence AGAT to their offspring at a specific location on the genome, i.e. at a specific locus, and Parent 2 donates a strand containing 16 repeats of the sequence AGAT, then the offspring will have a "15,16" genotype at that locus. The offspring would have two different alleles at a single locus, and would therefore considered to be heterozygous at this location. The kit used for PCR determines which loci are targeted for amplification in the samples. The amplified fragments are tagged with a fluorescent dye during PCR so that they can be isolated and identified in the next process.

The amplicons are then "typed", or separated from each other and detected, through a method that is most commonly capillary electrophoresis, or CE. During CE, the

specific sequence fragments are separated by size, i.e. number of base pairs (bp), and their fluorescent dye tag is excited by a laser. The resulting fluorescent emission information is compiled and uploaded to a computer program that organizes the information to form a DNA profile, in which the dye tagged-fragments are separated by color[5]. The alleles present in the fragments are organized by size, thus in increasing order of number of repeats. The alleles are represented as peaks on a spectrum, with the horizontal axis depicting base size and vertical axis depicting the relative fluorescent units (RFU) of the peak. The RFU of the peak corresponds to the relative intensity of the fluorescent emission of the fragments, and thus is proportionate to the amount of the tagged DNA sequence present in the sample[6].

After a DNA profile is generated, it must be interpreted. During interpretation, the analyst will assess the quality of the profile by looking at each sample's size standard and look for any artifacts in the profile that are not believed to be a part of the contributor's actual genome. For example, a common artifact seen in profiles is stutter. Stutter occurs during amplification when the DNA polymerases that create the fragment copies "slip" during the process and create a new fragment that is either one repeat longer or shorter (the latter being the most common) than the target fragment. This results in small peaks in a profile that are a repeat longer or shorter than the peaks that actually represent the alleles of the contributor, the most frequent being the latter, namely "backwards stutter"[7]. Generally, stutter peaks have a lower RFU than "true allele" peaks, and so an analysis level can be set in the software so that some stutter peaks can be excluded. This analytical threshold is also used to exclude most of the "noise", or uninformative peaks that result

from operating the machinery itself[8,9]. Although typically analytical threshold falls between 30-100 RFU, the threshold ideally should be calculated after careful analysis of the baseline level of noise at each detected color[9]. A way to analyze stutter that is above this analytical threshold is to look at each locus individually, as the percentage level of the true allele's RFU that stutter peaks are found is relatively conserved. In many cases, this percentage is around 10-15%, therefore peaks in stutter position, that have a ratio of around 0.10-0.15 to the proximal true alleles, are typically considered stutter. Stutter ratio is generally conserved from laboratory to laboratory as long as the amplification kit and CE instrument are conserved[10]. Other common artifacts include dye blobs, pull-up, spikes, and minus-A peaks.

Another thing that affects profile interpretation is allelic dropout. Allelic dropout is the occurrence that an individual's allele(s) at a location is below analytical threshold and is therefore not shown on the profile even though it exists in the individual's genotype. It occurs when the sample is of relatively low quality (i.e. Low template, degradation, etc.) and/or one or both of the individual's DNA strands are not amplified efficiently during PCR[11]. If low quality DNA is unavoidable, one way to account for allelic dropout is by validating a stochastic threshold. The stochastic threshold is the RFU level at which an analyst can safely assume that if an allele is above this threshold at a particular locus, then it's sister allele would be at least above the analytical threshold[7]. Stochastic threshold is typically set after amplifying a series of samples of known genotypes of various concentrations and determining at what threshold sister alleles of heterozygous loci are detectable. However, there has been research conducted in order to

determine stochastic threshold more easily, such as using a logistic model incorporating PCR and CE parameters[12].

Profile interpretation is further complicated in the presence of two or more contributors to a sample, creating a mixed profile, also known as a mixture. In a mixture, there could be potentially more than two alleles at a single locus. Generally, the peak heights of the alleles belonging to each contributor is proportional to the amount of each contributor's DNA that was amplified. For example, if two contributors donated DNA to a sample equally, typically there will be a 1:1 ratio of the total peak heights belonging to each contributor at a single locus. If contributor genotypes can be determined, possible major and minor contributors can be isolated from each other and treated as individual profiles. As stated before, this can become challenging in the presence of degradation, low template, allelic dropout, and artifacts[13]. Contributors can also share alleles (ex. One contributor is a 15,15 at a given locus and another contributor is a 15,16). Allele sharing can impede the process of estimating the number of contributors to the profile, a process that is recommended by the Scientific Working Group on DNA Analysis Methods[14] and is necessary for certain statistical computations. The estimation of the number of contributors can be calculated by maximum allele count at each locus, a probabilistic approach incorporating allele frequencies[15] or computer software[16].

1.2 Statistical Analysis

Once an evidentiary profile is interpreted, the analyst can compare the profile to a reference, or known sample. In this way, individuals can be included or excluded as a

possible contributor to the DNA in the sample. An exclusion, according to John Butler in his textbook on DNA interpretation, occurs when "the genotype comparison shows profile differences that can only be explained by the two samples originating from different sources."[17] An inclusion means that the evidentiary sample contains all of the alleles possessed by the reference and all differences between the samples can be explained. However, evidentiary profiles can have vastly different components- amounts of artifacts, overall amount of DNA, peak height ratios, number of loci with alleles above stochastic threshold, etc.- and thus every inclusion does not hold the same weight. For instance, an inclusion to an evidentiary profile with only two loci with peaks above stochastic threshold will not have the same weight as one to a profile with sixteen loci with peaks above stochastic threshold.

There are various methods utilized in current practice to determine the weight of evidence. One method is combined probability of inclusion (CPI), requires an inclusion of the reference to the evidence, and then determines what portion of the population is also included as a possible contributor to the evidence[18]. The benefit of CPI is that it does not require an assumption of the number of contributors for the calculation, and is relatively simple to calculate:

> *CPI = (sum of allele frequencies at locus 1)^2*(sum of allele frequencies at locus 2)^2....*(sum of allele frequencies at locus N)^2,* with N being the number of detectable loci[14]

CPI is limited, however, in that it cannot be used when allelic drop out is reasonable based on the data, and it also does not take advantage of peak heights, peak height ratios,

or genotypes of known persons[19,20] Thus, CPI takes into account all permutations in a mixture and is very conservative, but it is not an accurate statistic as it adds genotypes that are not truly in the profile.

Another method random match probability (RMP), which is defined by the Scientific Working Group on DNA Analysis Methods (SWGDAM) as "the probability that the DNA of a randomly chosen person has the same profile as the DNA of an evidentiary sample[14]." RMP takes into account an estimated number of contributors and Hardy-Weinberg Equilibrium. The analyst determines all the possible genotypes that can be made with the alleles present at a single locus, calculates and combines the genotype frequencies according to heterozygosity or homozygosity:

RMP: Heterozygous genotype = $2pq$ (with 'p' as the frequency of allele 1 and 'q' as the frequency of allele 2)

Homozygous genotype = $p^2 + p(1-p)\theta$ (with 'θ' as the correctional value for any relatedness; θ = 0.01 for the United States, 0.03 for some isolated populations)[14]

All the RMP of the possible genotypes for that locus can be added together, and then the RMP of each locus can be *multiplied* together using the product rule to get the RMP of the profile. Both CPI and RMP can be presented either as a decimal, or more commonly, as "1 in 1/(decimal result) individuals." For RMP, peak heights can be considered (using the restricted RMP method) in order to eliminate genotypes that are not probable with the data. Allelic dropout can also be considered with RMP, according to SWGDAM guidelines[14].

A method that includes more of the data presented in a profile than RMP is the estimation of likelihood ratios. The likelihood ratio (LR) is a comparison of the probabilities of two hypotheses given a certain set of data[21]. In the context of forensic analysis, the ratio is typically the hypothesis of the prosecution (Hp) over the hypothesis of the defense (Hd). The individual probabilities of the hypotheses themselves is less important in reporting than the ratio showing the probabilities *relative* to each other, like so:

$$LR_{Hp,Hd}(E): \frac{P(E \mid Hp)}{P(E \mid Hd)}$$, with 'E' being the evidentiary data[21]

If LR < 1 and there are no other possible hypotheses than Hp and Hd, then the evidence supports Hd rather than Hp, meaning Hd is more likely to have occurred given the evidence[21]. The two hypotheses must be mutually exclusive, meaning one of them must be true and they cannot be true at the same time. Typically, Hp includes the hypothesis that the suspect is a contributor to the evidence, but can include unknown individuals as well.

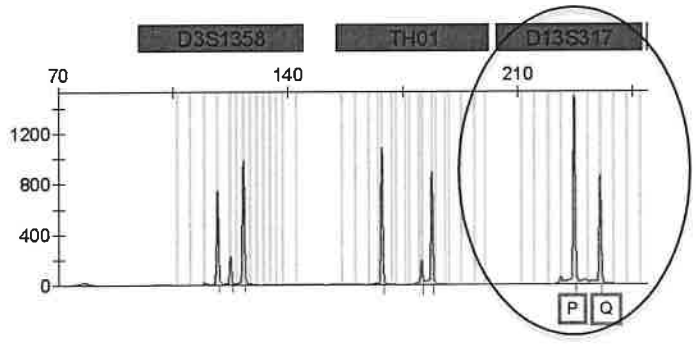

Figure 1. Example Loci of Two-Person Mixture Profile. At D13S317 locus, two peaks are shown for the alleles P and Q, with P having a larger peak height than Q.

Unlike CPI and RMP, LR can consider peak heights, peak heights relative to each other (the peak height ratio, PHR), an estimation of the number of contributors, the genotypes of those that can be assumed to be in the evidence, as well the genotypes of those *debated* to be a part of the evidence[18]. The analyst can choose to calculate an unrestricted or restricted LR. Unrestricted LR means that peak height ratios (PHR) are not considered when determining possibly genotype combinations, and thus combinations of alleles present at a locus are possible. Restricted LR means that PHR *is* taken into account, and combinations of alleles that are not probable given the PHR are not given as much weight[14]. The probabilities of Hp and Hd are calculations of the frequencies of the genotypes that support each hypothesis. For example, a two-person mixture has alleles *P* and *Q* at a locus (with frequencies of *p* and *q*, respectively) and the suspect has *P,Q* at this locus (Figure 1). Upon analysis of the entire profile, the ratio of contributors is determined to be 4:1. Hp is the hypothesis that the suspect is included as a contributor to the evidence as well as one other individual. In this case, the restricted LR numerator would be:

$$LR\ numerator:\ 1*p^2$$

The probability of the suspect is 1 because the Hp is that the suspect is 100% included, and the probability of the other unknown is the possible genotype combination that can be made with the suspect eliminated which is *P,P*. Hd is the hypothesis that the mixture is composed of two unknown individuals. In this case, the restricted LR denominator would be:

$$LR\ denominator:\ [p^2 + p(1-p)\theta]*\ [q^2 + q(1-q)\theta]+[2pq]*\ [p^2 + p(1-p)\theta]$$

The denominator is the sum of all the probabilities of the possible genotype combinations[14]. In an unrestricted LR, the hypotheses would include all the possible genotypes, disregarding the 4:1 PHR.

In the example given, there was an estimation of only two contributors, there was a notable difference in peak heights, and only two alleles for one locus was analyzed. Calculating LR becomes increasingly more difficult to compute manually with an increase in contributors, a smaller difference in peak heights, inclusion of artifacts such as stutter, degradation, low template, and any other frequent but complicating components.

1.3 Probabilistic Genotyping

SWGDAM guidelines define probabilistic genotyping as "the use of biological modeling, statistical theory, computer algorithms, and probability distributions to calculate likelihood ratios (LR) and/or infer genotypes for the DNA typing results of forensic samples"[22]. Probabilistic genotyping computer systems are beneficial to DNA analysis because they allow a complete analysis of all the data available for a wide range of profiles, including low template and high contributor profiles. Also, according to Perlin, computer systems give a more accurate statistic, as human analysis tends to be more conservative by ignoring data under a certain threshold or ignoring loci that exhibit drop out characteristics[23]. Software can also analyze and predict the genotype of minor contributors that are less than 10% of the evidence sample[23]. Furthermore, using computer software for statistical analysis eliminates any subjectivity (as in human

analysis, the analyst needs to analyze the suspect's DNA as well as the evidence) and considers more possible genotypes for unknown contributors in mixtures than a human analyst is capable of[24].

In recent years, many companies have developed probabilistic genotyping software in order to make DNA processing more efficient and thorough. Software generally uses of one of two models: semi-continuous (which does not consider peak heights or stutter when making calculations) or continuous (which makes assumptions based on peak height ratios)[25]. Software can also be based on various statistical methods, which can produce slightly different likelihood ratios for the same data set. For example, popular continuous method software STRmix™ and TrueAllele® both use the Markov chain Monte Carlo (MCMC) technique in order to estimate the most probable set of parameters- contributor genotype, degradation, amplification efficiency, etc.- for the data[25,26]. MCMC uses a "chain" to link the most probable parameters together using posterior probability distribution. On the other hand, another continuous software called *EuroForMix* uses an exact method that utilizes all possible contributor genotypes and parameters. The parameters are measured against their probability of occurrence given drop out, and only the parameters with extremely low probability are excluded[27]. This is different from MCMC as the MCMC "chain" assures that only the most probable out of the random parameters chosen are included.

Bulletproof is another continuous method software with underlying algorithms based on EuroForMix. Instead of an external or downloadable software, *Bulletproof*'s interface is browser-based, and can be accessed from various operating systems[28]. There

is no need for a software or statistical calibration, and parameters can be set for the laboratory (accompanying every new data set) and adjusted for each run (i.e. changed for each new data set).

In this study, the capability of *Bulletproof* was examined by observing the output it produced given various sets of data. The likelihood ratios given low template reference samples and low template evidence mixture samples, as well as a range of CE injection times for both reference samples and evidence mixtures samples were studied. Knowing that Hp was in fact the correct hypothesis, it was assumed that there would be a lower limit of template amounts and injections times for both reference and evidence samples to observe extremely high likelihood ratios. The study also compared the parameter estimates given by *Bulletproof* for what was believed to be in the mixtures compared to the actual contributor proportion.

2. METHODS

2.1 Preparation of Profiles

In order to look at the effect of various evidence and reference characteristics on LR, DNA profiles were downloaded from a database created by Cotton et al (http://www.bu.edu/dnamixtures/pages/help/introduction)[29]. The database holds .fsa files of single source and mixture DNA profiles that were amplified at a variety of template amounts with various amplification kits, and separated on a 3130 genetic analyzer (Applied Biosystems, Foster City, CA) at multiple injection times according to the procedures and materials outlined by Cotton et al[29]. The mixture profiles contained material from multiple contributors at a range of ratios, changing the subject and contrast of the minor and major contributors.

Specific profiles- single source (Table 1) and mixtures (Table 2) were chosen for this study. All .fsa files selected from the database were amplified using the AmpFlSTR® Identifiler® PCR Amplification Kit (Life Technology, Carlsbad, CA). The single source profiles were from subjects A, B, and C, had been amplified at 0.0625, 0.125, 0.25, 0.5, and 1.0 ng, and injected at 2, 5 and 10 sec on the genetic analyzer. Two-contributor mixtures profiles using subjects A and B with ratios of 1:1 and 1:9 were isolated and had been amplified at 0.0625, 0.125, 0.25, 0.5, 1.0, and 4.0 ng, and injected at 2, 5, and 10 sec on the genetic analyzer. Three-contributor mixture profiles using subjects A, B, and C with ratios of 3:1.5:1(2) and 3:6:1 were isolated and had been amplified at 0.4, 1 or 1.7, and 3.5 or 4.0, and injected at 2, 5, and 10, sec on the genetic analyzer[29].

Table 1. List of Chosen Single Source Profiles. Single source profiles from contributors A, B, and C amplified at 0.0625-1.0 ng using Identifiler® amplification kit and injected for 2-10 seconds on a 3130 genetic analyzer.

Sample	Contributor	Amount (ng)	Injection (s)
A 0.0625 A1 V1.0	Subject A	0.625	2
A 0.0625 A1 V1.2	Subject A	0.625	5
A 0.0625 A1 V1.3	Subject A	0.625	10
A .125 A1 V1.0	Subject A	0.125	2
A .125 A1 V1.2	Subject A	0.125	5
A .125 A1 V1.3	Subject A	0.125	10
A .25 A1 V1.0	Subject A	0.25	2
A .25 A1 V1.1	Subject A	0.25	5
A .25 A1 V1.2	Subject A	0.25	10
A 0.5 A1 V1.0	Subject A	0.5	2
A 0.5 A1 V1.2	Subject A	0.5	5
A 0.5 A1 V1.3	Subject A	0.5	10
A 1 A1 V1.0	Subject A	1	2
A 1 A1 V1.2	Subject A	1	5
A 1 A1 V1.3	Subject A	1	10
B 0.0625 A1 V1.0	Subject B	0.625	2
B 0.0625 A1 V1.2	Subject B	0.625	5
B 0.0625 A1 V1.3	Subject B	0.625	10
B .125 A1 V1.0	Subject B	0.125	2
B .125 A1 V1.2	Subject B	0.125	5
B .125 A1 V1.3	Subject B	0.125	10
B .25 A1 V1.0	Subject B	0.25	2
B .25 A1 V1.1	Subject B	0.25	5
B .25 A1 V1.2	Subject B	0.25	10
B 0.5 A1 V1.0	Subject B	0.5	2
B 0.5 A1 V1.2	Subject B	0.5	5
B 0.5 A1 V1.3	Subject B	0.5	10
B 1 A1 V1.0	Subject B	1	2
B 1 A1 V1.2	Subject B	1	5
B 1 A1 V1.3	Subject B	1	10
C 0.0625 A1 V1.0	Subject C	0.625	2
C 0.0625 A1 V1.2	Subject C	0.625	5
C 0.0625 A1 V1.3	Subject C	0.625	10
C 0.5 A1 V1.0	Subject C	0.5	2
C 0.5 A1 V1.2	Subject C	0.5	5
C 0.5 A1 V1.3	Subject C	0.5	10
C 1 A1 V1.0	Subject C	1	2
C 1 A1 V1.2	Subject C	1	5
C 1 A1 V1.3	Subject C	1	10

Table 2. List of Chosen Mixture Profiles. Two-contributor profiles from subjects A and B amplified at 0.0625-4.0 ng and three-contributor profiles from subjects A, B, and C amplified at 0.4-4.0 ng using Identifiler® amplification kit and injected for 2-10 seconds on a 3130 genetic analyzer.

Sample	Contributor	Amount (ng) Total	Amount (ng) / Minor	Inj. (s)	Ratio
AB 0.0625 A1 1,1 V1.0	A, B	0.0625	0.031	2	1/1
AB 0.0625 A1 1,1 V1.2	A, B	0.0625	0.031	5	1/1
AB 0.0625 A1 1,1 V1.3	A, B	0.0625	0.031	10	1/1
AB 0.125 A1 1,1 V1.0	A, B	0.125	0.063	2	1/1
AB 0.125 A1 1,1 V1.2	A, B	0.125	0.063	5	1/1
AB 0.125 A1 1,1 V1.3	A, B	0.125	0.063	10	1/1
AB .25 A1 1,1 V1.0	A, B	0.25	0.125	2	1/1
AB .25 A1 1,1 V1.2	A, B	0.25	0.125	5	1/1
AB .25 A1 1,1 V1.3	A, B	0.25	0.125	10	1/1
AB .5 A1 1,1 V1.0	A, B	0.5	0.250	2	1/1
AB .5 A1 1,1 V1.2	A, B	0.5	0.250	5	1/1
AB .5 A1 1,1 V1.3	A, B	0.5	0.250	10	1/1
AB 1 A1 1,1 V1.0	A, B	1	0.500	2	1/1
AB 1 A1 1,1 V1.2	A, B	1	0.500	5	1/1
AB 1 A1 1,1 V1.3	A, B	1	0.500	10	1/1
AB 4 A1 1,1 V1.0	A, B	4	2.000	2	1/1
AB 4 A1 1,1 V1.2	A, B	4	2.000	5	1/1
AB 4 A1 1,1 V1.3	A, B	4	2.000	10	1/1
AB .0625 A1 1,9 V1.0	A, B	0.0625	0.006	2	1/9
AB .0625 A1 1,9 V1.2	A, B	0.0625	0.006	5	1/9
AB .0625 A1 1,9 V1.3	A, B	0.0625	0.006	10	1/9
AB 0.125 A1 1,9 V1.0	A, B	0.125	0.013	2	1/9
AB 0.125 A1 1,9 V1.2	A, B	0.125	0.013	5	1/9
AB 0.125 A1 1,9 V1.3	A, B	0.125	0.013	10	1/9
AB .25 A1 1,9 V1.0	A, B	0.25	0.025	2	1/9
AB .25 A1 1,9 V1.2	A, B	0.25	0.025	5	1/9
AB .25 A1 1,9 V1.3	A, B	0.25	0.025	10	1/9
AB .5 A1 1,9 V1.0	A, B	0.5	0.050	2	1/9
AB .5 A1 1,9 V1.2	A, B	0.5	0.050	5	1/9
AB .5 A1 1,9 V1.3	A, B	0.5	0.050	10	1/9
AB 1 A1 1,9 V1.0	A, B	1	0.100	2	1/9
AB 1 A1 1,9 V1.2	A, B	1	0.100	5	1/9
AB 1 A1 1,9 V1.3	A, B	1	0.100	10	1/9
AB 4 A1 1,9 V1.0	A, B	4	0.400	2	1/9
AB 4 A1 1,9 V1.2	A, B	4	0.400	5	1/9
AB 4 A1 1,9 V1.3	A, B	4	0.400	10	1/9
BAC 0.4 A1 1.5,3,2 V1.0	A, B, C	0.4	0.092	2	1.5/3/2

BAC 0.4 A1 1.5,3,2 V1.2	A, B, C	0.4	0.092	5	1.5/3/2
BAC 0.4 A1 1.5,3,2 V1.3	A, B, C	0.4	0.092	10	1.5/3/2
BAC 1 A1 1.5,3,1 V1.0	A, B, C	1	0.182	2	1.5/3/1
BAC 1 A1 1.5,3,1 V1.2	A, B, C	1	0.182	5	1.5/3/1
BAC 1 A1 1.5,3,1 V1.3	A, B, C	1	0.182	10	1.5/3/1
BAC 4 A1 1.5,3,1 V1.0	A, B, C	4	0.72	2	1.5/3/1
BAC 4 A1 1.5,3,1 V1.2	A, B, C	4	0.72	5	1.5/3/1
BAC 4 A1 1.5,3,1 V1.3	A, B, C	4	0.72	10	1.5/3/1
BAC 7 A1 1.5,3,1 V1.0	A, B, C	7	1.27	2	1.5/3/1
BAC 7 A1 1.5,3,1 V1.2	A, B, C	7	1.27	5	1.5/3/1
BAC 7 A1 1.5,3,1 V1.3	A, B, C	7	1.27	10	1.5/3/1
BAC 0.4 A1 6,3,1 V1.0	A, B, C	0.4	0.04	2	6/3/1
BAC 0.4 A1 6,3,1 V1.2	A, B, C	0.4	0.04	5	6/3/1
BAC 0.4 A1 6,3,1 V1.3	A, B, C	0.4	0.04	10	6/3/1
BAC 1.7 A1 6,3,1 V1.0	A, B, C	1.7	0.17	2	6/3/1
BAC 1.7 A1 6,3,1 V1.2	A, B, C	1.7	0.17	5	6/3/1
BAC 1.7 A1 6,3,1 V1.3	A, B, C	1.7	0.17	10	6/3/1
BAC 3.5 A1 6,3,1 V1.0	A, B, C	3.5	0.35	2	6/3/1
BAC 3.5 A1 6,3,1 V1.2	A, B, C	3.5	0.35	5	6/3/1
BAC 3.5 A1 6,3,1 V1.3	A, B, C	3.5	0.35	10	6/3/1

After the profiles were isolated from the database, they were viewed in GeneMapper IDX v1.4 (Applied Biosystems, Foster City, CA) software with no stutter filter and an analytical threshold of 30 RFU. Each profile was viewed to assess degradation, and any drop out in any of the loci for the profiles was noted. As the single source profiles were to be used as references in the *Bulletproof* software and could have a maximum of two alleles per locus, all artifacts – such as stutter, pull-up, minus A, etc. – were marked and removed from the profiles. The average peak height per locus for each profile was also calculated, taking the sum of all the peaks across the profile and dividing by the number of loci (i.e. 16 for Identifiler®). For implementation into the *Bulletproof* software, the profiles needed to be converted into tables in .csv format containing the

sample name, genetic marker, allele call, and peak height. For this reason, the genotype table of each profile with this information was exported into .csv format from GeneMapper IDX v1.4 after visualization and editing of the profiles. Because of this format – "comma-separated values" file- none of the sample names contained commas, as this would prevent implementation into the software. After the conversion, the files could be uploaded into the software as evidence and reference samples.

2.2 Preparation of Software

Access to the *Bulletproof* probabilistic genotyping software was garnered from a virtual request on the eDNA consortium website (www.ednalims.com/probabilistic-genotyping). After receiving approval of the request, a laboratory account was set up on the web-based interface, allowing for implementation of probabilistic genotyping on mock-cases using uploaded evidence and references. *Bulletproof* was relatively easy to use, as after an account was made within the browser, the program did not require any training samples to be implemented. Also, the primer manual as well as a phone tutorial from Dr. Kent Harman, President and CEO of Genetic Technologies, Inc., provided all the information needed to immediately start a case.

Parameter	Value
Detection Threshold	30
FST Correction	0.01
Drop-in Probability	0.01
Drop-in Hyperparameter Curve Shape	0.01
Use Degradation	☑
Use Stutter	☐
Stutter Prop	dbeta(x,1,1)
Maximum Size List for Deconvolution Elements	20
Required Deconvolution Summed Posterior Genotype Prob.	0.99
Random Start Points	4
Randomizer Variance	10
Run MCMC Sensitivity	☐
MCMC Sample Iterations for Sensitivity Plots	2000
MCMC Variation of Randomizer for Sensitivity Plots	10
Run MCMC Integral	☑
Limit Evaluations	☐
Maximum Number of Evaluations	10000
Relative Error	0.1
Scale Factor	700

Figure 2. Laboratory Parameters for Mock-Cases Run on Software. Pre-set parameters were set for the probabilistic genotyping of evidence in the investigations.

The laboratory parameters were set ahead of time for all of the investigations (Figure 2). Degradation was not found in any of the samples, however, based on trial runs

using the same profiles but varying the use of the degradation feature, its utilization produced more expected results. Therefore, the degradation parameter was checked so that the software could take this feature into account when deconvoluting the mixtures and calculating LR. The AT was set at 30 RFU and possible stutter peaks were ignored (i.e. the stutter parameter was not utilized) for all of the evidentiary profiles. The stutter parameter for *Bulletproof* is modelled after a stutter gamma distribution.

The mock-cases were created, and evidence and reference samples were uploaded according to the procedures outlined in the software primer[28]. The allele frequencies for the LR calculations were based on those listed by the National Institute of Technology (NIST) according to the Hispanic Population.

2.3 Likelihood Ratio and Evidence Template

All references were amplified at 0.5 ng and injected at 5 sec unless otherwise specified.

In order to investigate the effect of increasing evidence template on LR, two-contributor and three-contributor profiles with increasing total template were chosen as evidence in the mock-cases, holding constant the injection times (5 sec), the ratio of contributors, Hp, and Hd, and the laboratory parameters (Table 3).

Table 3. List of Chosen Profiles for LR and Evidence Template Investigation. Two-contributor mixture profiles containing Subjects A and B at varying template (0.0625-4.0 ng) and varying ratios (1:1 and 1:9) and three-contributor mixture profiles containing Subjects A, B, and C at varying template (0.4-7.0 ng) and varying ratios (1.5:3:2(1) and 6:3:1).

Run #	Sample	Contributor	Amount (ng)	Amount/Cont.	Ratio
1	AB 0.0625 A1 1,1 V1.2	A, B	0.0625	0.0315	1:1
2	AB 0.125 A1 1,1 V1.2	A, B	0.125	0.0625	1:1
3	AB 0.5 A1 1,1 V1.2	A, B	0.5	0.25	1:1
4	AB 1 A1 1,1 V1.2	A, B	1	0.5	1:1
5	AB 4 A1 1,1 V1.2	A, B	4	2.0	1:1
6	AB 0.0625 A1 1,9 V1.2	A,B	0.0625	0.006, 0.0565	1:9
7	AB 0.125 A1 1,9 V1.2	A, B	0.125	0.013, 0.112	1:9
8	AB 0.5 A1 1,9 V1.2	A, B	0.5	0.05, 0.45	1:9
9	AB 1 A1 1,9 V1.2	A, B	1	0.1, 0.9	1:9
10	AB 4 A1 1,9 V1.2	A, B	4	0.4, 3.6	1:9
11	BAC 0.4 A1 1.5,3,2 A1 V1.2	B, A, C	0.4	.092, .185, .123	1.5:3:2
12	BAC 1 A1 1.5,3,1 A1 V1.2	B, A, C	1	.273, .545, .182	1.5:3:1
13	BAC 4 A1 1.5,3,1 A1 V1.2	B, A, C	4	1.08, 2.18, .72	1.5:3:1
14	BAC 7 A1 1.5,3,1 A1 V1.2	B, A, C	7	1.91, 3.81, 1.27	1.5,3,1
15	BAC 0.4 A1 6,3,1 V1.2	B, A, C	0.4	.24, .72, .04	6,3,1
16	BAC 1.7 A1 6,3,1 V1.2	B, A, C	1.7	1.02, .51, .17	6,3,1
17	BAC 3.5 A1 6,3,1 V1.2	B, A, C	3.5	2.1, 1.05, .35	6,3,1
18	BAC 7 A1 6,3,1 A1 V1.2	B, A, C	7	4.2, 2.1, .7	6,3,1

The Hp for the runs including two-contributor evidence (runs 1-10 in Table 3) was conserved: subject A and subject B were contributors to the evidence. Hd for the

two-contributor evidence was conserved: subject A and an unknown individual were contributors to the evidence. The 1:9 A:B mixture evidence was also run with Hd including subject B and an unknown individual for comparison. The Hp for the runs including three-contributor evidence (runs 11-18 in Table 3) was conserved: subject A, subject B, and an unknown individual were contributors to the evidence. Hd for the three-contributor evidence was conserved: subject A and two unknown individuals were contributors to the evidence. In this way, the likelihood of the presence of subject B given the evidence of varying DNA amount and ratio of contributors determined the final LR of Hp and Hd.

2.4 Likelihood Ratio and Evidence Injection Time

In order to investigate the effect of increasing evidence injection time on the genetic analyzer on LR, two-contributor and three-contributor profiles with increasing injection time were chosen as evidence in the mock-cases, holding constant the total template amount, the ratio of contributors, Hp, and the laboratory parameters (Table 4).

Table 4. List of Chosen Profiles for LR and Evidence Injection Time Investigation. Two-contributor mixture profiles containing Subjects A and B and three-contributor mixture profiles containing Subjects A, B, and C at varying injection times (2, 5, and 10 seconds).

Run	Sample	Contributor	Inj. Time (s)	Amount (ng)	Amount/ Cont.	Ratio
1	AB 0.125 A1 1,9 V1.0	A, B	2	0.125	0.013, 0.112	1:9
2	AB 0.125 A1 1,9 V1.2	A, B	5	0.125	0.013, 0.112	1:9
3	AB 0.125 A1 1,9 V1.3	A, B	10	0.125	0.013, 0.112	1:9
4	AB 1 A1 1,9 V1.0	A, B	2	1	0.1, 0.9	1:9
5	AB 1 A1 1,9 V1.2	A, B	5	1	0.1, 0.9	1:9
6	AB 1 A1 1,9 V1.3	A, B	10	1	0.1, 0.9	1:9
7	BAC 0.4 A1 6,3,1 V1.0	B, A, C	2	0.4	.24, .72, .04	6,3,1
8	BAC 0.4 A1 6,3,1 V1.2	B, A, C	5	0.4	.24, .72, .04	6,3,1
9	BAC 0.4 A1 6,3,1 V1.3	B, A, C	10	0.4	.24, .72, .04	6,3,1
10	BAC 1.7 A1 6,3,1 V1.0	B, A, C	2	1.7	1.02, .51, .17	6,3,1
11	BAC 1.7 A1 6,3,1 V1.2	B, A, C	5	1.7	1.02, .51, .17	6,3,1
12	BAC 1.7 A1 6,3,1 V1.3	B, A, C	10	1.7	1.02, .51, .17	6,3,1

This investigation was performed in duplicate with two different Hd for the same dataset (Table 4). The Hp for the runs including two-contributor evidence (runs 1-6 in Table 4) was conserved: subject A and subject B were contributors to the evidence. The Hp for the runs including three-contributor evidence (runs 7-12 in Table 4) was conserved: subject A, subject B, and an unknown individual were contributors to the evidence.

For the first set of runs, in the Hd for the two-contributor evidence, subject A and an unknown individual were contributors to the evidence. In the Hd for the three-contributor evidence, subject A and two unknown individuals were contributors to the

evidence. In this way, the likelihood of the presence of subject B given the evidence from varying injection times using both small (0.125 or 0.4 ng) and large (1.0-1.7 ng) amounts of DNA determined the final LR of Hp and Hd.

For the second set of runs, in the Hd for the two-contributor evidence, subject B and an unknown individual were contributors to the evidence. In the Hd for the three-contributor evidence, subject B and two unknown individuals were contributors to the evidence. In this way, the likelihood of the presence of subject A -given the evidence from varying injection times using both small (0.125 or 0.4 ng) and large (1.0-1.7 ng) amounts of DNA- determined the final LR of Hp and Hd.

2.5 Likelihood Ratio and Reference Template

In order to investigate the effect of increasing reference template amount on LR, single source profiles (subjects A, B, and C) with increasing template amounts were chosen as references for the Hp in the mock-cases, holding constant the injection time (5 sec), the evidence (three-contributor consisting of subjects B, A, and C at a 6:3:1 ratio at 0.4 ng), Hd, and the laboratory parameters (Table 5).

Table 5. List of Chosen Profiles for LR and Reference Template Investigation. Single source profiles for subjects A, B, and C at varying template amounts (0.0625-1.0 ng).

Run #	Sample	Contributor	Amount (ng)
1	A 0.0625 A1 V1.2	A	0.0625
2	A 0.125 A1 V1.2	A	0.125
3	A 0.25 A1 V1.2	A	0.25
4	A 0.5 A1 V1.2	A	0.5
5	A 1 A1 V1.2	A	1
6	B 0.0625 A1 V1.2	B	0.0625
7	B 0.125 A1 V1.2	B	0.125
8	B 0.25 A1 V1.2	B	0.25
9	B 0.5 A1 V1.2	B	0.5
10	B 1 A1 V1.2	B	1
11	C 0.0625 A1 V1.2	C	0.0625
12	C 0.5 A1 V1.2	C	0.5
11	C 1 A1 V1.2	C	1

The Hp for the runs was conserved: subject A, subject B, and subject C were contributors to the evidence. However, one of the reference samples for one of the subjects for each run had a varying template amount. For example, in run #1 (Table 5), the references given to support Hp are sample A, which was amplified at 0.0625 ng and injected at 5 sec, sample B, and sample C. The difference between run #1 and #2 is the amount of subject A that can be used as a reference to support Hp -less DNA available increases the probability of allelic drop out, and thus less information for the software to work with when determining likelihood.

Hd for the evidence was conserved: subject A, subject B, and an unknown individual are contributors to the evidence. In this way, the likelihood of the presence of subject C -given the evidence and varying DNA amount (and thus amount of information given) of the reference samples- determined the final LR of Hp and Hd.

2.6 Likelihood Ratio and Reference Injection Time

In order to investigate the effect of increasing reference injection time on LR, single source profiles (subjects A, B, and C) with increasing injection times were chosen as references for the Hp in the mock-cases, holding constant the template amount (0.5 ng), the evidence (three-contributor consisting of subjects B, A, and C at a 6:3:1 ratio at 0.4 ng), Hd, and the laboratory parameters (Table 6).

Table 6. List of Chosen Profiles for LR and Reference Injection Time Investigation. Single source profiles for subjects A, B, and C at varying injection times (2-10 sec).

Run #	Sample	Contributor	Inj. Time (Sec)
1	A 0.5 A1 V1.0	A	2
2	A 0.5 A1 V1.2	A	5
3	A 0.5 A1 V1.3	A	10
4	B 0.5 A1 V1.0	B	2
5	B 0.5 A1 V1.2	B	5
6	B 0.5 A1 V1.3	B	10
7	C 0.5 A1 V1.0	C	2
8	C 0.5 A1 V1.2	C	5
9	C 0.5 A1 V1.3	C	10

The Hp for the runs was conserved: subject A, subject B, and subject C were contributors to the evidence. However, one of the reference samples for one of the subjects for each run had a varying injection time. For example, in run #1 (Table 6), the references given to support Hp are sample A, which was amplified at 0.5 ng and injected at 2 sec, sample B, which was amplified at 0.5 ng and injected at 5 sec, and sample C, which was amplified at 0.5 ng and injected at 5 sec. The difference between run #1 and #2 is the injection time of subject A and thus the amount of information from subject A.

Hd for the evidence was conserved: subject A (sample A amplified at 0.5 ng and injected at 5 sec), subject B (sample B amplified at 0.5 ng and injected at 5 sec) and an unknown individual are contributors to the evidence. In this way, the likelihood of the presence of subject C -given the evidence and varying injection time (and thus amount of information given) of the reference samples- determined the final LR of Hp and Hd.

2.7 Likelihood Ratio and Stutter Consideration

The effect of the utilization of *Bulletproof*'s stutter parameter on LR was examined, as well. Upon visualization of the two-contributor mixtures at a 1:9 ratio and the three-person mixtures, drop-out at one or more loci was observed. This drop-out could, and most likely would, affect the information the software had available to determine the likelihood of a certain contributor. Using a stutter filter in GeneMapper would further limit the information available, as peaks in the stutter position that might also host true alleles of a minor contributor would be lost. The stutter parameter in *Bulletproof,* if utilized, takes stutter into account when analyzing the evidence. This accountability has a greater impact on evidence with more extreme minor contributors.

In order to investigate the effect of the software stutter parameter on LR, two-contributor and three-contributor profiles with increasing total template were chosen as evidence in the mock-cases, holding constant the injection times (5 sec), the ratio of contributors, Hp, and Hd (Table 7).

Table 7. List of Chosen Profiles for LR and Stutter Consideration Investigation. Two-contributor mixture profiles containing Subjects A and B at varying template (0.0625-4.0 ng) and three-contributor mixture profiles containing Subjects A, B, and C at varying template (0.4-3.5 ng) run with stutter parameter utilized (Y) and not utilized (N).

Run	Sample	Cont.	Stutter	Amount (ng)	Ratio	Amount (ng)/ Minor
1	AB 0.0625 A1 1,9 V1.2	A, B	Y	0.0625	1:9	0.006
2	AB 0.125 A1 1,9 V1.2	A, B	Y	0.125	1:9	0.0013
3	AB 0.25 A1 1,9 V1.2	A, B	Y	0.25	1:9	0.025
4	AB 0.5 1,9 V1.2	A, B	Y	0.5	1:9	0.05
5	AB 1 1,9 V1.2	A, B	Y	1	1:9	0.1
6	AB 4 1,9 V1.2	A, B	Y	4	1:9	0.4
7	AB 0.0625 A1 1,9 V1.2	A, B	N	0.0625	1:9	0.006
8	AB 0.125 A1 1,9 V1.2	A, B	N	0.125	1:9	0.0013
9	AB 0.25 A1 1,9 V1.2	A, B	N	0.25	1:9	0.025
10	AB 0.5 1,9 V1.2	A, B	N	0.5	1:9	0.05
11	AB 1 1,9 V1.2	A, B	N	1	1:9	0.1
12	AB 4 1,9 V1.2	A, B	N	4	1:9	0.4
13	BAC 0.4 A1 6,3,1 V1.2	B, A, C	Y	0.4	6:3:1	.04
14	BAC 1.7 A1 6,3,1 V1.2	B, A, C	Y	1.7	6:3:1	.17
15	BAC 3.5 A1 6,3,1 V1.2	B, A, C	Y	3.5	6:3:1	.35
16	BAC 0.4 A1 6,3,1 V1.2	B, A, C	N	0.4	6:3:1	.04
17	BAC 1.7 A1 6,3,1 V1.2	B, A, C	N	1.7	6:3:1	.17
18	BAC 3.5 A1 6,3,1 V1.2	B, A, C	N	3.5	6:3:1	.35

The Hp for the runs including two-contributor evidence (runs 1-12 in Table 7) was conserved: subject A and subject B were contributors to the evidence. Hd for the two-contributor evidence was conserved: subject A and an unknown individual were contributors to the evidence. The Hp for the runs including three-contributor evidence (runs 13-20 in Table 7) was conserved: subject A, subject B, and subject C were contributors to the evidence. Hd for the three-contributor evidence was conserved: subject A, subject B, and an unknown individual were contributors to the evidence. These mock-cases (one of the mixture samples as evidence, Hp, and Hd) were run once with the stutter parameter utilized and once with the stutter parameter unutilized. In this way, the

likelihood of the presence of subject C -given the evidence of varying DNA amount and whether or not stutter was accounted for- determined the final LR of Hp and Hd.

2.8 Comparison of Software Mixture Composition vs True Mixture Composition

In order to compare what *Bulletproof* estimated the contributor proportions were of given evidence to compared to the evidence's actual proportions, the results of the LR and evidence template investigation was studied. The profiles utilized in that investigation (Table 3) had a wide range of template amounts and ratios that would allow for a comparison of mixture composition estimates.

Bulletproof gives results for both Hp and Hd: likelihood value, model validation, electropherogram fitted model, deconvolution, and parameter estimates for the contributors included in the hypotheses. For each run, the estimated proportion of each contributor ("Mix-Prop") was compared to the actual proportion of each contributor based on the known ratios and total template amount.

3. RESULTS/ DISCUSSION

The purpose of this thesis work was to explore the capability of the probabilistic genotyping software, *Bulletproof,* and to investigate how variation on profile quality, reference sample template, injection time, and stutter consideration affect the calculated likelihood ratio.

The mock cases were run in *Bulletproof* with Hp and Hd as specified in each section. In the set-up of the runs, all prosecutor hypotheses intentionally explained the data more accurately than the defense hypotheses. Thus, a relatively large, positive LR for each run was expected. The actual numerical LR value was dependent on the variable features of the profiles.

3.1 Likelihood Ratio and Two-Contributor Evidence Mass

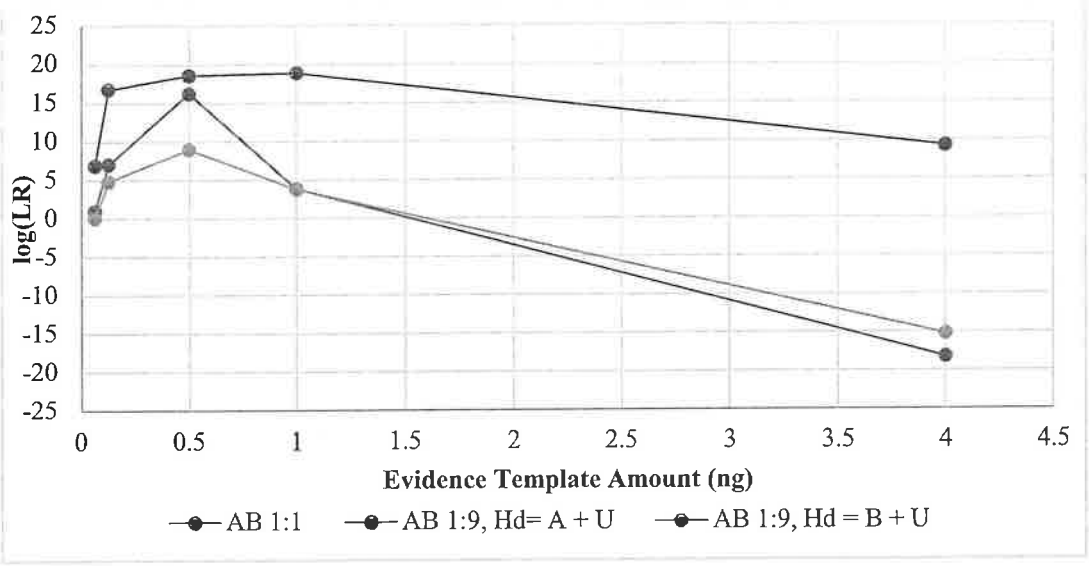

Figure 3. Log(LR) with a Change in Two-Contributor Evidence Template Amount. Evidence samples containing contributors A and B with ratios of 1:1 and 1:9 respectively at an amplified mass of 0.0625, 0.125, 0.5, 1.0, and 4.0 ng DNA. LR = $\frac{P(E|Hp=A+B}{P(E|Hd=A+U}$, with "U" as an unknown contributor. (A:B = 1:9 also run with LR = $\frac{P(E|Hp=A+B}{P(E|Hd=B+U}$)

The cases shown in Figure 3 use two A, B mixtures at ratios of A:B = 1:1 and A:B = 1:9. For these comparisons, Hp = A + B and Hd = A + U. The A:B = 1:9 evidence was also analyzed with Hd = B + U. In this comparison of the impact of two-contributor evidence template amount on likelihood ratio, the highest LR was achieved when the evidence template amount was 0.5 ng for two contributors at a 1:1 ratio (log(LR)= 16.19) and between 0.5-1.0 ng at a 1:9 ratio (log(LR) = 18.82) with Hd = A + U. The software increasingly made more sense of the data (and thus was able to rightly assign Hp a higher likelihood value) when the amount of the evidence increased up to 1 ng at a ratio of 1:9. At 4 ng of template DNA, the LR decreased. This is explained by the marked increase in

off-ladder alleles due to pull-up, spikes, and stutter peaks above the AT that occurred in the profiles with the increases in template mass.

The data shown in Figure 3 shows that deconvolution is more effective when evidence samples of high contrast ratios are used. It was also observed that large numbers of artifacts, such as found in the 4 ng profiles, resulted in significant negative changes to the LR. Thus, removing all known artifacts from profiles is necessary before *Bulletproof* can make sense of the data. The more overlapping "information" the software has- such as artifacts and contributor allele sharing of the same PH- the more difficult it is for deconvolution. The presence of artifacts masquerading as alleles increases the difficulty of determining genotypes.

With the knowledge that Hp was the correct hypothesis, LR should be positive. In the instance that the LR is negative for the two-contributor evidence at a 1:1 ratio at 4 ng (Figure 3), this discrepancy can be attributed to the increased stutter and bleed-through artifacts overlapping with or adding to the number of "true" allele peaks, thus making it difficult to determine which peaks belong to subject A, B, or an unknown contributor. Visualization of the A:B 1:1 mixture at 4 ng in GeneMapper with no stutter filter applied revealed 40 artifacts across the profile, some of which are represented in Figure 4. With the stutter filter applied, 11 artifacts were observed. In GeneMapper, the A:B 1:9 mixture at 4 ng contained 19 artifacts without the stutter filter, and 1 artifact with the stutter filter. Upon re-analysis of the 4 ng samples at both 1:1 and 1:9 ratios with the *Bulletproof* stutter filter on, thus removing peaks below a certain threshold, the LR for both runs

increased significantly (Table 8). Note that the application of the stutter filter in either GeneMapper or Bulletproof would not remove non-stutter artifacts.

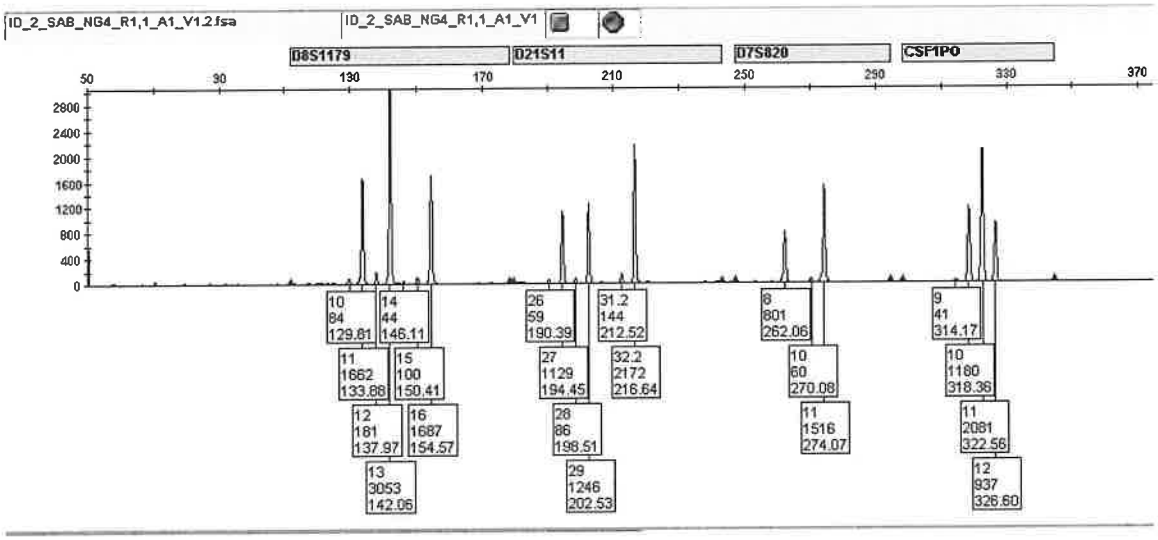

Figure 4. Three Loci of the A:B 1:1 mixture at 4 ng in GeneMapper with No Stutter Filter Applied.

Table 8. Comparison of LR given Software Stutter Filter on 4 ng Two-Contributor Evidence. Utilization of *Bulletproof* internal software filter on 4 ng evidence of both 1:1 and 1:9 ratios containing contributors A and B increased the LR as compared to non-utilization.

Evidence	Stutter Filter	Ratio	Log(LR)
AB 4 ng	No	1-1	-18.21
AB 4 ng	Yes	1-1	3.54
AB 4 ng	No	1-9	9.209
AB 4 ng	Yes	1-9	18.54

Unlike the LR trend with Hd=A+U given the A:B 1:9 mixture, LR trend with Hd=B+U given the same evidence and same Hp (A+B) was much lower. In the Hd =

B+U, B is assumed to be present by both hypotheses (the prosecution and the defense), thus the LR is measuring the likelihood of the presence of subject A. In the mixture, A is the minor contributor and has have overlapping peaks with major contributor alleles, confirmed in the electropherogram overlay in the software, which are more difficult to de-convolute than when A is known (Hd =A+U).

3.2 Likelihood Ratio and Two-Contributor Evidence Injection Time

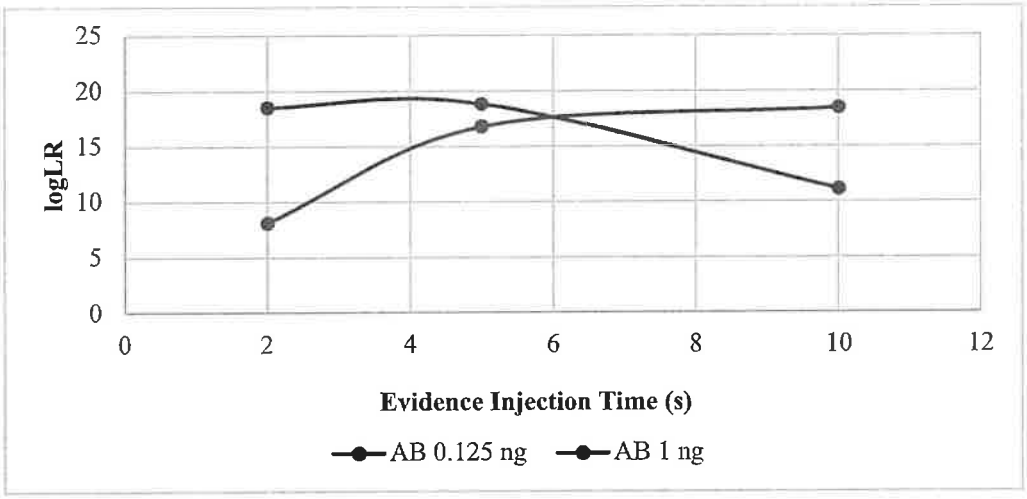

Figure 5. Log(LR) with a Change in Two-Contributor Evidence Injection Time with Hd including Subject A. Evidence samples containing contributors A and B at a 1:9 ratio respectively at an amplified mass of 0.125 and 1.0 ng. All samples injected on 3130 at 2, 5, or 10 seconds. LR = $\frac{P(E|Hp=A+B}{P(E|Hd=A+U}$, with "U" as an unknown contributor.

The comparisons shown in Figure 5 illustrate the impact of evidence injection times. For this comparison, Hp = A + B and Hd = A + U. The highest LR was observed from the 1 ng mixture injected at 5 seconds (logLR = 18.82). The scenario in which the 10 second injection was the most beneficial for deconvolution occurred with the lowest evidence template amount of 0.125 ng. Ideal injection time should be determined based

on laboratory validation, as it is based on the mass of DNA amplified, the CE instrument, and the STR amplification kit. In cases of very low evidentiary template, longer injection times allow more DNA from the sample to enter the capillary for analysis, and thus produce higher peak heights across the profile[30]. For sample mixtures, it may be difficult to define an ideal injection time, since some mixture components may be present in a high amount and other mixture component(s) may be present in a low amount.

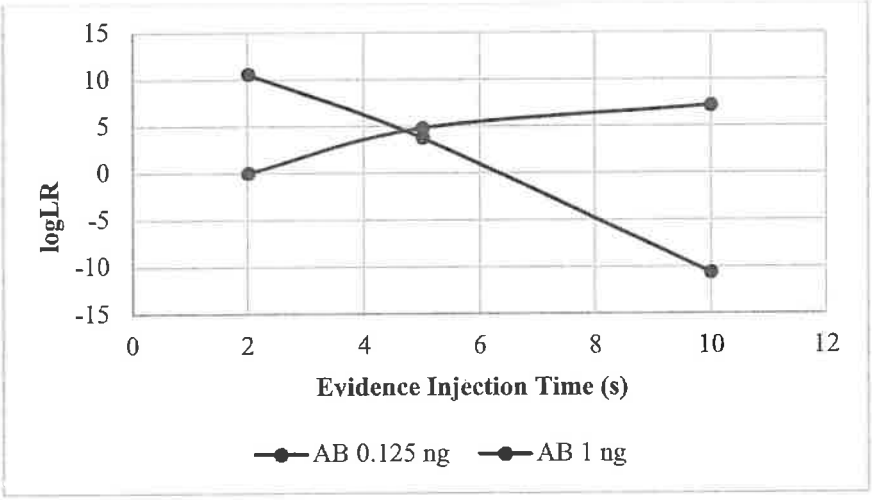

Figure 6: Log(LR) with a Change in Evidence Injection Time with Hd including Subject B. Evidence samples containing contributors A and B at a 1:9 ratio at a total amount of 0.125 and 1.0 ng. All samples injected on CE at 2, 5, or 10 seconds. LR = $\frac{P(E|Hp=A+B}{P(E|Hd=B+U}$, with "U" as an unknown contributor.

Using the same type of comparison with subject B as the known for the hypothesis of the defense (Figure 6), the highest LR was achieved when the two-contributor evidence at 1 ng template was injected at 2 seconds (log(LR) = 10.55). As with Subject A in Hd, the 10 second injection time was the most beneficial for deconvolution for the lowest template amount of 0.125 ng.

When comparing the two Hd scenarios, *Bulletproof* could more efficiently deconvolute the evidence profile (produced a higher LR) when Hd included Subject A and observed the likelihood that B is present, and LRs were more varied when Hd included Subject B. The overall observation of the investigation is that when Hd includes subject A, the remaining alleles of the evidentiary profile were more easily attributed to subject B (the major contributor).

3.3 Likelihood Ratio and Three-Contributor Evidence Mass

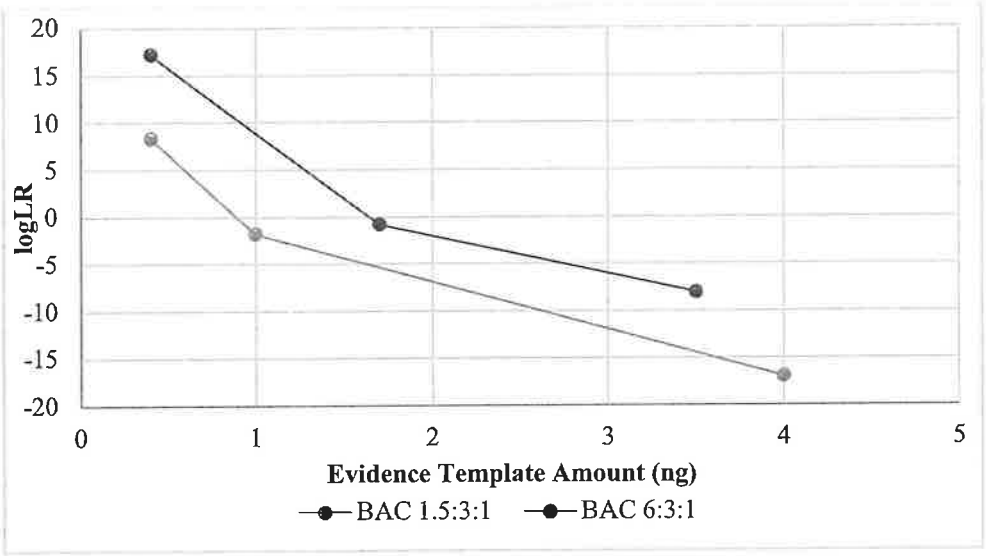

Figure 7. Log(LR) with a Change in Three-Contributor Evidence Mass. Evidence samples containing contributors B, A, and C with a ratio of 1.5:3:1(or 2) and 6:3:1 at a total amount of 0.4, 1.0, and 4.0(or 3.5). LR = $\frac{P(E|Hp=A+B+U}{P(E|Hd=A+U1+U2}$, with "U" as an unknown contributor.

The comparison shown in Figure 7 uses two three-contributor mixtures. The mixture ratios are B:A:C of 1.5:3:1(or 2) and 6:3:1. For both mixtures, Hp = A+B+U and Hd = A+U_1+U_2. In the comparison of three-contributor evidence mass, (Figure 7), the

highest LR was achieved when the evidence was 0.4 ng for three contributors at both 1.5:3:2 (log(LR) = 8.295) and 6:3:1 (log(LR) = 17.18) ratios. Deconvolution became less effective as the mass amplified up to 1 ng and 3.5-4 ng at both ratios. This is explained by visualization of the profiles in GeneMapper, in which the 0.4 ng three-contributor profiles contained only true alleles and some stutter peaks. The higher template amounts contained more stutter peaks as well as pull-up, which increases the difficulty of deconvolution. For example, in GeneMapper, the B:A:C 1.5:3:2 mixture at 0.4 ng contained 2 stutter peaks across the profile. However, the mixture at 1.5 ng contained 21 stutter as well as pull-up peaks.

These results give a conclusion that is compatible with the conclusion of the two-contributor evidence; the three-contributor evidence results suggest deconvolution is negatively affected when evidence samples containing mixtures are amplified with too much DNA or analyzed using high injection times such that artifacts are created. For the three-contributor evidence, the only evidence that gave a positive LR was the lowest mass of 0.4 ng. Because the contributors to these three-person mixtures are known, we can see that there is extensive allele sharing. Thus, there are more alleles to deconvolute with their associated stutter peaks, and more possible genotype combinations. With an increase in mass, not only do the PH of the true alleles increase, but so does the PH of any artifacts, some of which will surpass the AT, making deconvolution more difficult. This gives insight into the importance of removing recognized artifacts from any profiles used with the software, i.e. analyst review before profile implementation and software

analysis. The results further highlight the need for adherence to the validated amplified target amount that is dependent on the STR kit used when conducting casework.

3.4 Likelihood Ratio and Three-Contributor Evidence Injection Time

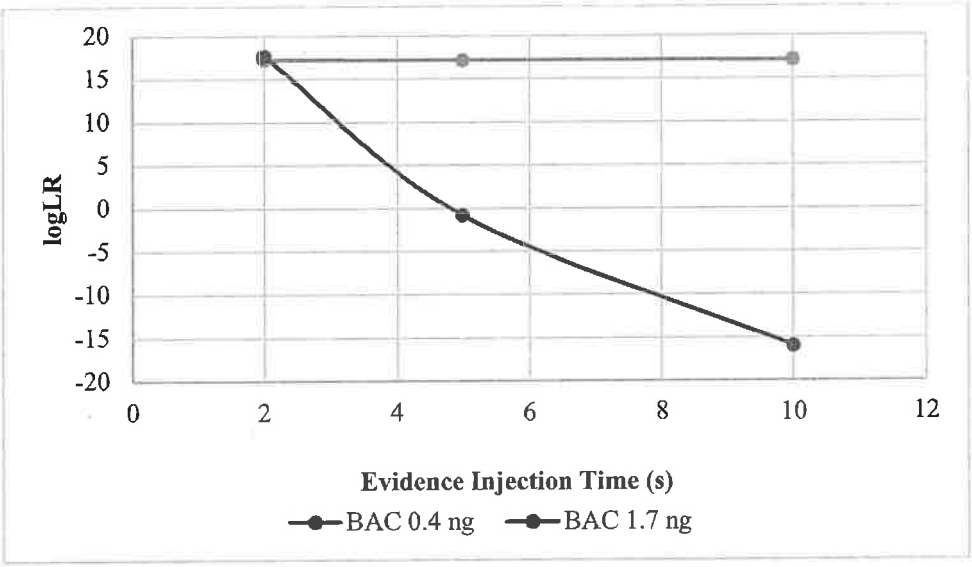

Figure 8. Log(LR) with a Change in Three-Contributor Evidence Injection Time with Hd including Subject A. Evidence samples containing contributors B, A, and C at a 6:3:1 ratio at a total amount of 0.4 and 1.7 ng. All samples injected on CE at 2, 5, or 10 seconds. LR = $\frac{P(E|Hp=A+B+U}{P(E|Hd=A+U1+U2}$, with "U" as an unknown contributor.

The comparisons shown in Figure 8 illustrate the impact of evidence injection times. For this comparison, Hp = A+B+U and Hd = A+U_1+U_2. The highest LR was observed when the evidence at 1.7 ng was at 2 seconds (log(LR) = 17.70), although all three injection times produced similar LR. A log(LR) of ~17 was obtained from all injections of the 0.4 ng template and the two second injection of the 1.7 ng template.

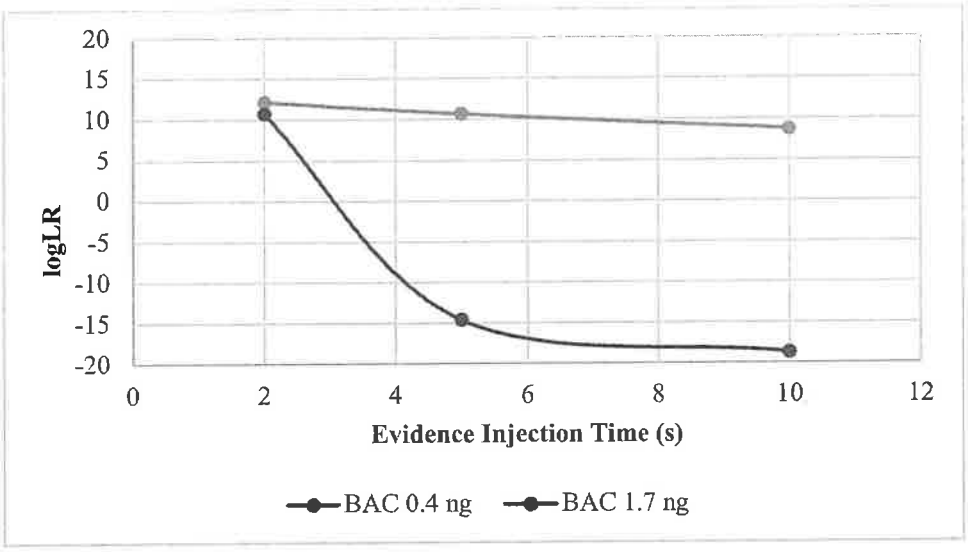

Figure 9: Log(LR) with a Change in Evidence Injection Time with Hd including Subject B. Evidence samples containing contributors B, A, and C at a 6:3:1 ratio at a total amount of 0.4 and 1.7 ng. All samples injected on CE at 2, 5, or 10 seconds. LR = $\frac{P(E|Hp=A+B+U}{P(E|Hd=B+U1+U2}$, with "U" as an unknown contributor.

Using the same type of comparison with subject B as the known for the hypothesis of the defense (Figure 9), the highest LR values were observed when the 0.4 ng and 1.7 ng template samples were injected at 2 sec. When comparing the two Hd scenarios, *Bulletproof* deconvolutes the evidence similarly when either subject A or subject B was included as a contributor. Both comparisons showcase the sharp LR decrease with an increase in injection time for the 1.7 ng template sample, while LR was fairly conserved with a varied injection time for the 0.4 ng evidence. As stated with the two-contributor investigation, longer injection times allow more DNA from the sample to enter the capillaries and be detected, thus producing higher peak heights across the profile, including that of artifacts.

3.5 Likelihood Ratio and Reference Mass

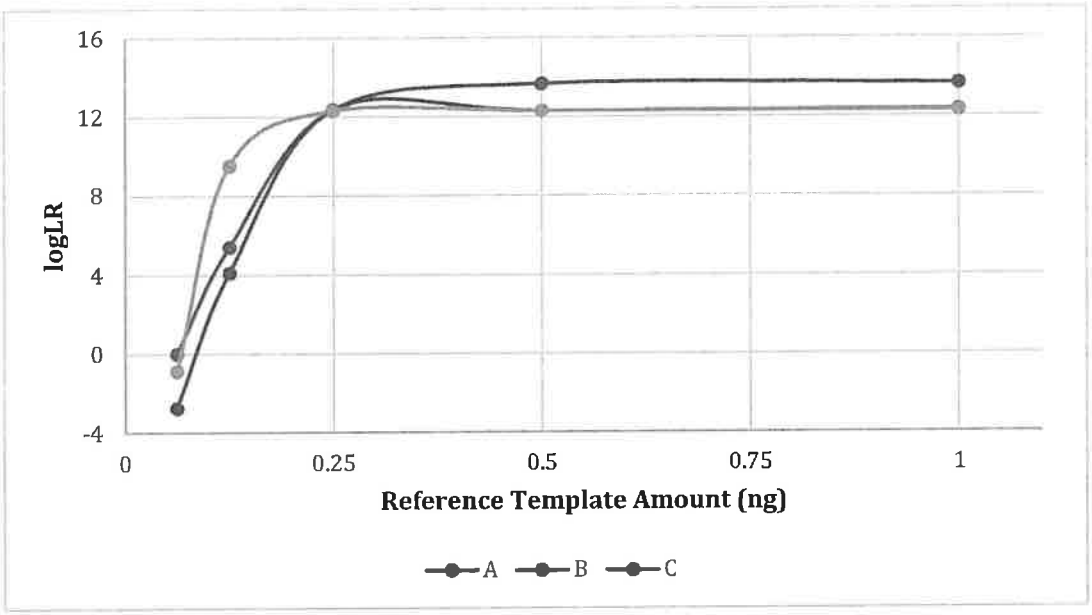

Figure 10. Log(LR) with a Change in Reference Mass. Reference samples for contributors A, B, and C at 0.0625, 0.125, 0.25, 0.5, and 1.0 ng using a 0.4 ng three-contributor (B-A-C) evidentiary profile of a 6-3-1 ratio respectively. LR = $\frac{P(E|Hp=A+B+C}{P(E|Hd=A+B+U}$, with "U" as an unknown contributor.

The comparisons shown in Figure 10 use a 0.4 ng three-contributor mixture at a ratio of B:A:C = 6:3:1 with reference profiles at various template amounts. For these comparisons, Hp = A + B +C and Hd = A + B + U. In this comparison of the impact of reference mass amount on likelihood ratio (Figure 10), the highest LR values were observed when the reference template amount was 0.5 ng and higher for subject A (log(LR) = 13.67), however there was a similar and consistent plateau for LR at after 0.25 ng for the other two subjects (log(LR) = 12.32). The software increasingly made more sense of the data (and thus was able to rightly assign Hp a higher likelihood value) when

the amount of the references' templates included all "true" alleles and no artifacts above the AT values (with stutter filters off).

The effect of the reference sample's template on LR was investigated because there may be cases where the only DNA reference available is from old or degraded samples. Or perhaps the reference is an alternate sample- also known as a psuedoreference- (in cases where a person of interest did not voluntarily give a known sample, but left behind on an item on which they deposited their DNA). In these circumstances, the amount of DNA used for analysis may not be ideal. The overall observation was that the minimum amount of DNA needed for a reference to achieve the highest LR for a three-contributor sample is 0.25 ng for known samples A, B, and C. Looking at the profiles in GeneMapper, there were less alleles available in the lowest template reference samples, thus less information for the software to analyze. For example, in the 0.0625 ng Subject A profile, there was one allele missing from 9 heterozygous loci and 1 locus exhibiting total dropout for 11 total alleles missing from the profile. However, in the 0.25 ng Subject A profile, all 16 loci exhibited alleles and no alleles were missing from the profile.

3.6 Likelihood Ratio and Reference Injection Time

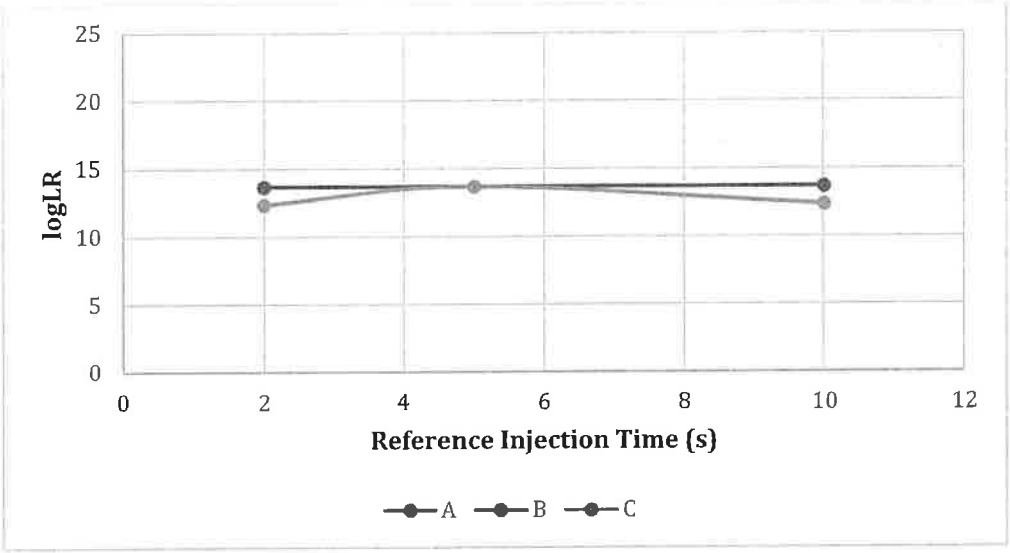

Figure 11: Log(LR) with a Change in Reference Injection Time. Reference samples for contributors A, B, an C at 0.5 ng. All samples injected on 3130 at 2, 5, or 10 seconds. LR = $\frac{P(E|Hp=A+B+C}{P(E|Hd=A+B+U}$, with "U" as an unknown contributor.

The cases shown in Figure 11 use a 0.4 ng three-contributor mixture at a ratio of B:A:C = 6:3:1 with reference profiles at various CE injection times. For these comparisons, Hp = A + B +C and Hd = A + B + U. In this comparison of the impact of reference injection time on likelihood ratio, the highest LR was produced with subject A at all injection times (log(LR) = 13.67). For subjects B and C, approximately the same LR was produced for all three injection times (log(LR) = 12.32-13.67). This suggests, coupled with subject A's LR variability with evidence injection time, that the reference sample of subject A impacts the deconvolution of the evidence and thus the resulting LR slightly more than the reference sample of the subject B and subject C.

However, an observation of the reference injection time investigation was that injection time made very little impact on LR, most likely due to the fact that all artifacts

needed to be removed beforehand on the reference samples. Thus, the information had all information needed for deconvolution at all injection times, without interference. These results, and the results of the previous investigations featuring the evidence mass and injection times as variables, outline the need for analysts to review both evidentiary *and* reference samples beforehand to label and exclude artifacts. Ideally, only true alleles are included in the information given to the software so that deconvolution can be as efficient as possible.

3.7 Likelihood Ratio and Stutter Consideration

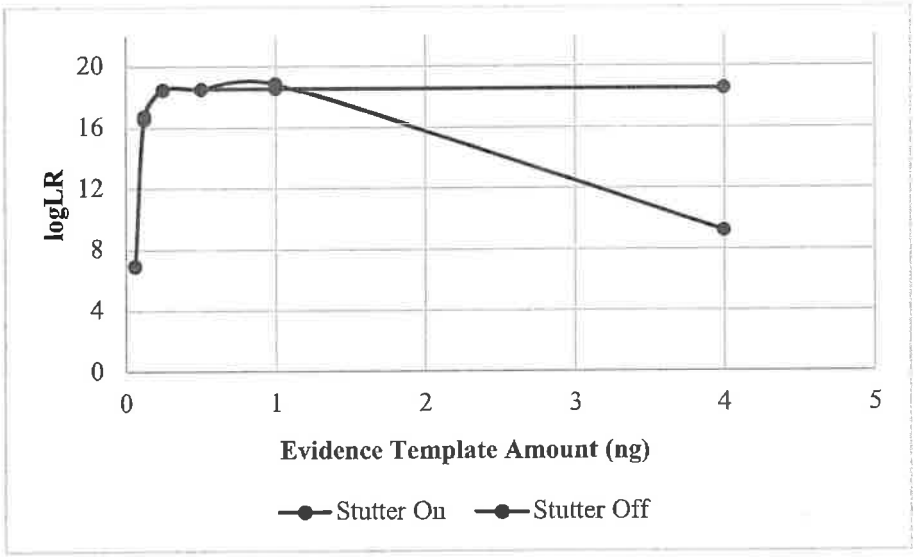

Figure 12. Log(LR) with a Change in Stutter Parameter for a 2-Contributor Mixture. Evidence samples containing A and B contributors at a 1:9 ratio at 0.0625, 0.125, 0.25, 0.5, 1.0, and 4.0 ng total amount. LR = $\frac{P(E|Hp=A+B}{P(E|Hd=A+U}$, with "U" as an unknown contributor.

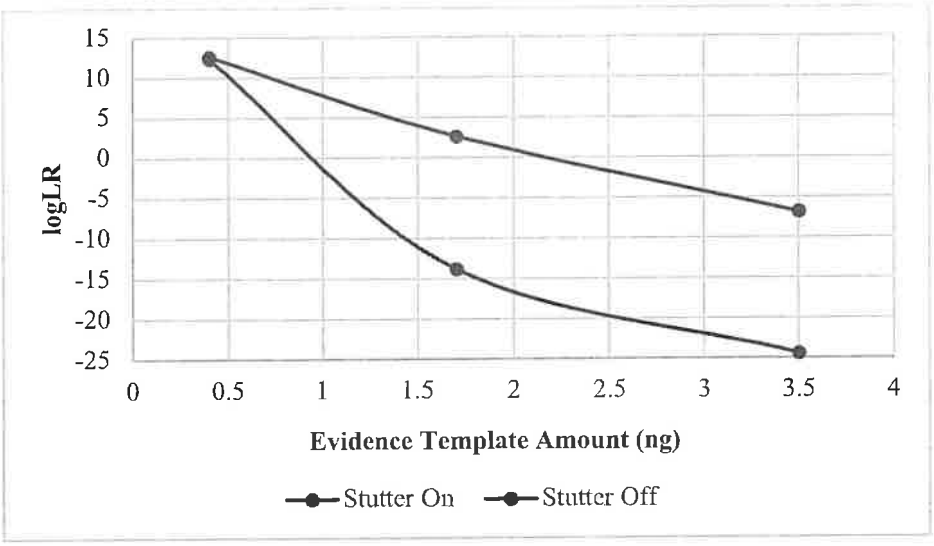

Figure 13. Log(LR) with a Change in Stutter Parameter for a 3-Contributor Mixture. Evidence samples containing B, A, and C contributors at a 6:3:1 ratio at 0.4, 1.7, and 3.5 ng total amount. LR = $\frac{P(E|Hp=A+B+C}{P(E|Hd=A+B+U}$, with "U" as an unknown contributor.

The effect of the application of the *Bulletproof* stutter parameter on LR was also examined. For a two-contributor evidence sample (Figure 12), the highest LR values were observed with the stutter parameter off (log(LR) = 18.82). However, the two lowest LR values were also observed with the stutter parameter off (log(LR) = 6.87, 9.21), and use of the *Bulletproof* stutter filter produced more *consistent* LR results for a two-contributor sample. For a three-contributor evidence sample (Figure 13), use of the stutter filter produced consistently higher LR results for a three-contributor sample.

As stated previously, the stutter filter in GeneMapper has the benefit of removing some artifacts that are known not to be true alleles, with the cost of possibly removing true alleles that are in stutter position in a mixture sample. This project weighed this cost/benefit in the context of LR with and without the *Bulletproof* parameter utilized. The

overall observation was that using the stutter parameter produced more consistently positive LR estimations for both two- and three-contributor evidence samples. As *Bulletproof* states in their primer, and as supported here, using a stutter filter and/or their stutter parameter proves better for deconvolution even at the expense of missing information[28]. More comparisons would be needed to confirm whether this is consistently the case when the evidence in question represents a minor contributor with peak heights similar in RFU to stutter peaks.

3.8 Comparison of Software Mixture Composition vs Actual Composition

Table 9. Comparison of Software Mixture Composition Based on Hp to Actual Mixture Composition. Evidence samples containing contributors A and B with ratios of 1:1 and 1:9 at a total amount of 0.0625, 0.125, 0.5, 1.0, and 4.0 ng, and A,B, and C with a ratio of 1.5:3:1(or 2) and 6:3:1 at a total amount of 0.4, 1.0, 4.0(or 3.5), and 7 ng.

Evidence	Actual Ratio	Hp: Subj A Prop Est	Hp: Subj B Prop Est	Hp: Unknown Prop Est	Estimated Ratio
AB 0.0625	1:1	0.8416	0.1584	N/A	~8:2
AB 0.125	1:1	0.5246	0.4754	N/A	~1:1
AB 0.5	1:1	0.546	0.4454	N/A	~1:1
AB 1	1:1	0.5545	0.4455	N/A	~1:1
AB 4	1:1	0.5069	0.4931	N/A	~1:1
AB 0.0625	1:9	5.48E-12	1	N/A	~0:1
AB 0.125	1:9	0.2438	0.7562	N/A	~2:8
AB 0.5	1:9	0.2237	0.7763	N/A	~2:8
AB 1	1:9	0.2337	0.7663	N/A	~2:8
AB 4	1:9	0.2076	0.7924	N/A	~2:8
BAC 0.4	3:1.5:2	0.4176	0.2122	0.3702	~4:2:4
BAC 1	3:1.5:1	0.5829	0.268	0.1491	~6:3:1
BAC 4	3:1.5:1	0.3532	0.2473	0.3995	~4:2:4
BAC 7	3:1.5:1	0.3473	0.1563	0.4964	~3:2:5
BAC 0.4	3:6:1	0.3296	0.5283	0.1421	~3:5:1
BAC 1	3:6:1	0.2649	0.5731	0.162	~3:6:2
BAC 4	3:6:1	0.2921	0.4611	0.2468	~3:5:2
BAC 7	3:6:1	0.2643	0.3787	0.357	~3:4:4

Amongst the results output of the *Bulletproof* software, the estimated proportions of the contributors assumed in Hp are provided. These estimates were compared to the known proportions of each contributor in the two-contributor and three-contributor evidence samples (Table 9). The estimated ratios produced by *Bulletproof* (column 6) are very similar to the actual ratios of the evidence (column 2). There is greater discrepancy between the estimations and actual values with the lower template values (AB mixture at 0.0625 ng and BAC mixture at 0.4 ng). Additionally, the software performed best on two-contributor evidence (predicting the correct proportions for four out of five of the 1:1 ratio samples), and produced *similar* ratios to the actual proportions of the three-contributor evidence.

Having accurate (or close-to-accurate) evidence contributor proportion is important because with correct ratios/proportions, the software can more accurately understand the information given (i.e. peak heights, probability of allele sharing, probability of drop out, etc.) and can more accurately deconvolute the contributor genotypes to an evidence profile.

4. CONCLUSION

The goal of this thesis was to investigate the capability of a specific probabilistic genotyping software in deconvoluting evidence and estimating likelihood ratio with specific changes in evidence or reference profiles. Probabilistic genotyping is rapidly becoming more common in DNA casework analysis in today's time, and it is important for future cases, and in turn future trials, that the analyses are efficient and its results accurate. This study has shown the importance of using appropriate amounts of DNA template for amplification and also the importance of removing profile artifacts prior to software analysis.

Additional work is needed to give a true estimation of the capability, and thus limits of the *Bulletproof* software. There were instances in the investigations in which LR was negative, meaning the hypothesis of the defense appeared to be more probable than the hypothesis of the prosecution. Knowing that all Hp were in fact more probable than Hd by design, this shows a realistic limitation of the software, as it still requires prior manual analysis of all samples. An expansion of this study could perhaps use more evidentiary samples with a broader range of ratios, templates, and number of contributors.

LIST OF ABBREVIATED JOURNAL ARTICLES

Am J Hum Genet. ..... American Journal of Human Genetics

BMC Genet ..... BMC Genetics

Evid Technol Mag ..... Evidence Technology Magazine

Forensic Sci Int Genet. ..... Forensic Science International. Genetics.

Forensic Sci Int Genet Suppl. Ser. Forensic Science International. Genetics Supplemental Series.

Genome Res. ..... Genome Research

J. Forensics Res ..... Journal of Forensics Research

J. Forensic Sci. ..... Journal of Forensic Sciences

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