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A Comprehensive Study of the Effects of Chemotherapy on Friction Ridge Detail

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The University of Southern Mississippi

A COMPREHENSIVE STUDY OF THE EFFECTS OF CHEMOTHERAPY
ON FRICTION RIDGE DETAIL

by

M. Mariel Lowe

A Thesis
Submitted to the Honors College of
The University of Southern Mississippi
in Partial Fulfillment
of the Requirements of the Degree of
Bachelor of Science
in the School of Criminal Justice

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Abstract

Past research and case studies have shown that chemotherapy drugs appear to lessen the quality of friction ridge skin, thereby impacting cancer patients who are already experiencing a number of unpleasant side effects. Palmar-plantar erythrodysesthesia, more commonly referred to as Hand-Foot Syndrome (HFS), is a common side effect of many chemotherapy agents and includes redness, swelling, and peeling of the skin of the hands and feet. This syndrome has been linked to a number of cases involving fingerprint loss, including a prior longitudinal study that evidenced degradation in response to capecitabine, a common chemotherapy agent. This research builds upon the prior study by assessing the effects of taxane class drugs and doxorubicin on the fingerprints. Impressions were collected from seven patients, five of which were prescribed taxane class drugs, and two of which were administered doxorubicin. Data was collected prior to treatment and at the three-month mark, which represents the halfway point of the general six-month administration cycle. Impressions were inputted into AFIX Tracker software to determine the number of minutiae points by way of the Smart-Extract feature. The data suggests no definitive decrease between taxane class drugs and the quality of the impressions. A singular patient who had been prescribed doxorubicin, however, experienced quality decrease, and may have been affiliated with HFS. No other significant HFS was discovered with any of the patients, which further certifies the link between HFS and ridge degradation.

Keywords: Friction ridge skin, Chemotherapy, Hand-Foot Syndrome, AFIX Tracker

TABLE OF CONTENTS

LIST OF FIGURES	vii
LIST OF TABLES	viii
CHAPTER 1 – INTRODUCTION	1
Section 1.1 – Exclusivity of Friction Ridge Skin	1
Section 1.2 – Prior Research Initiatives	1
Section 1.3 – Distinctiveness of Study and Brief Methodology	2
CHAPTER 2 – LITERATURE REVIEW	3
Section 2.1 – Skin Layers	3
Section 2.2 – Formation of Friction Ridge Patterns and Minutiae	4
Section 2.3 – Case Studies Depicting Hand-Foot Syndrome	6
Section 2.4 – Capecitabine and Ridge Degradation.....	8
Section 2.5 – Longitudinal Study and Ridge Degradation	9
Section 2.6 – Taxane Class Drugs and Anti-Microtubule Mechanism.....	10
Section 2.7 – Liposomal Doxorubicin (Doxil) and Anthracycline Mechanism	12
CHAPTER 3 – METHODOLOGY	13
Section 3.1 – Overview of Academic Partnerships and Objectives.....	13
Section 3.2 – Study Population.....	13
Section 3.3 – Research Design.....	14
Section 3.4 – Data Analysis and Interpretation	16
CHAPTER 4 – RESULTS	17
CHAPTER 5—CONCLUSION	21

Section 5.1 – Discussion of HFS Theories	21
Section 5.2 – Study Limitations and Future Challenges.....	22
REFERENCES	23
APPENDICES	28
Appendix A: Consent Form.....	28
Appendix B: Participant Survey	32
Appendix C: USAMCI Institutional Review Board Approval.....	33
Appendix D: USM Institutional Review Board Approval.....	34

List of Figures

Figure 1: Keratinocyte Layers.....	3
Figure 2: Volar Pad Development.....	4
Figure 3: Formation of Friction Ridge Skin.....	5
Figure 4: Longitudinal Study Results: Ridge Quality in Relation to Cycle of Treatment.	10
Figure 5: Comparison of Power and Ink Lift Methods.....	15

List of Tables

Table 1: Baseline Averages from AFIX Tracker Database.....	17
Table 2: Comparisons of Baseline and Three Month Scores of Doxorubicin Patient.....	18

Exclusivity of Friction Ridge Skin

Fingerprint impressions are unique to each individual, allowing for an efficient mode of identification. In a medical context, the degradation of these impressions has the capacity to negatively impact patient quality of life. A reduced impression quality would also lessen the efficiency of this method of identification, which may create significant issues for patients who must provide their fingerprints for business or traveling purposes. Past research suggests a correlation between chemotherapy drugs and a reduced quality of friction ridge skin. By determining degradation factors, medical professionals may be alerted to needed adjustment of treatment plans or, in the very least, may be provided definitive side effect information for patient notification.

Prior Research Initiatives

Various research studies have associated capecitabine, a relatively common chemotherapy drug, to ridge degradation, and in extreme cases, lack of ridge detail. The majority of articles were written in response to individuals who were discovered to have no ridge detail when asked to provide identification for traveling purposes.^{1,2} After subsequent investigation, all reported cases were chemotherapy patients who had been prescribed capecitabine. Based on this data, a longitudinal study was conducted to isolate the effects of capecitabine on a chemotherapy patient throughout the treatment process. The results showed a direct relationship between capecitabine and ridge degradation, with ridge detail returning to relatively normal levels approximately 65 days following cessation of treatment.³

Distinctiveness of Study and Brief Methodology

This study will build upon a prior study through an assessment of the effects of multiple chemotherapy drugs on impression quality. The study analyzed levels of degradation, or lack thereof, in relation to drug class and treatment cycle. It also correlated reduced ridge visibility with age, dosage, frequency of treatment, history of treatment, and physical activities, all of which may promote research implications. Data was collected from chemotherapy patients who have been prescribed the aforementioned drug types at the University of South Alabama Mitchell Cancer Institute in Mobile, Alabama.

Chapter 2—Literature Review

Skin Layers

Throughout the litigation process, evidence that is dependable, such as the exclusivity of a fingerprint, augments the position on which a case is founded. Fingerprint impressions, more commonly referenced in forensic science as friction ridge skin, are unique to every individual. Their uniqueness is based upon fundamental biological principles of the skin. Friction ridge skin is grounded in the dermis, the second of three skin layers.⁴ The outer layer of skin, the epidermis, functions primarily as a barrier between lower levels of tissue and foreign substances in the surrounding atmosphere. Though the epidermis is made up of a multitude of cell types, all of which serve a specialized function, keratinocytes are the primary type of cell in the epidermis, constituting 90-95 percent of the layer.⁵



*Figure 1 Keratinocyte Layers*⁴

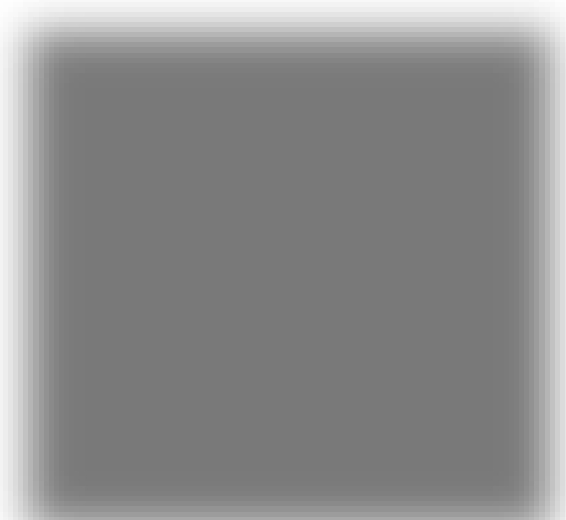
Figure 1.1 illustrates the five layers of keratinocytes characteristic of the epidermis of the hand. Each layer is distinct based upon cellular structure and rigidity. As cells in the basal layer undergo mitosis and are propelled upward, the cells gradually

harden.⁴ This process, known as keratinization, involves the production of the protein keratin, a fortifying cellular agent required to manage the daily strain sustained by the epidermis. Fully differentiated layers are sloughed off at the surface, creating a continuous balance of production, keratinization, and depletion.⁴

The dermis is the second skin layer, serving as a structural foundation for the epidermis and a regulation site for temperature and sensory reaction.⁴ Eccrine sweat glands, which primarily regulate body temperature, originate in the dermis or hypodermis, dependent on their length, and extend to the surface of friction ridge skin.⁴ Also rooted in the dermis are subjacent projections of tissue, that correspond to the peaks and valleys of a fingerprint pattern. Primary ridges support the “peaks” of a fingerprint, while secondary skin ridges support the “valleys” of a given pattern.

Beneath the dermis lies the hypodermis, which is made up of flexible, fatty tissue. The hypodermis provides for skin contouring and is composed of adipose tissue that stores lipids for energy production.⁵

Formation of Friction Ridge Patterns and Minutiae



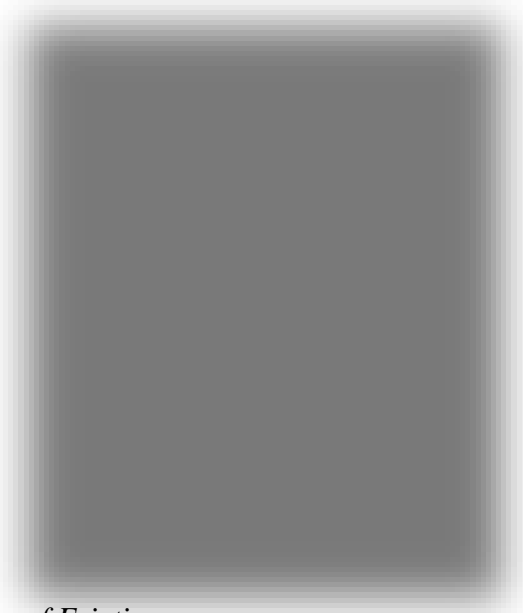
*Figure 2 Volar Pad Development*⁶

The singularity of friction ridge skin is the result of natural biological development. During gestation, friction ridge skin is formed between 10.5 and 16 weeks.⁴ The fundamental concepts of cell proliferation and volar pad development determine the construction of unique friction ridge skin.⁴ Volar pads form as a

result of inflammation of the tissue beneath the epidermis. This swelling of tissue begins at the thumb at approximately 7 weeks, as depicted in Figure 1.2⁶, and slowly progresses to each adjacent finger.⁴ After eleven weeks, the volar pads begin to change shape as cells present in surrounding tissue rapidly divide and combine with volar pad tissue. This

process yields a recognizable delineation of the hand and fingers at approximately 16 weeks.⁷

The foremost theory of ridge formation holds that basal cells in the epidermis rapidly divide at approximately 10.5 weeks.⁸ Cell groupings join together and develop into randomized patterns.⁴ Figure 1.3⁶ illustrates this theory. As each finger increases in size, the ridges that have developed are distanced, and additional ridges form to fill in the space.¹¹



The cell's ability to fill in space in order to maintain consistency corresponds to minutiae formation. Minutiae, or distinct locales present on friction ridge skin, create distinction between fingerprint impressions. Essentially, minutiae are variations of ridge structure and fall under two distinct categories: ridge endings and bifurcations.¹²

In addition to the minutiae present on friction ridge skin, each impression can be

divided into one of three classes of ridge patterns: loops, whorls, and arches, all of which are dependent on volar pad size and regression behavior.⁴ In summary, the height of the volar pad and the shape it takes as surrounding areas of tissue begin to slowly grow may affect the size and orientation of the pattern.^{4, 13-15} Loops are the most common type of pattern, occurring in approximately 60 percent of the population. They originate from one side of the print, curve around, and continue toward the side from whence it originated.¹⁶

*Figure 3 Formation of Friction Ridge Skin*⁶

¹⁷ Whorls are circular in shape, and are the second most common type of pattern, occurring in approximately 35 percent of the population.¹⁷ The last pattern type, arches, are the least common pattern, with a 5 percent occurrence in the population. Arches begin on one side of the print and exit on the opposite side.^{16,17} Loops, whorls, and arches can be classified according to two points, known as core and delta points. Core points are the approximate center of a pattern, or the location at which central ridges are at their steepest. Each pattern has a core. A delta can be defined as the point at which ridges diverge. Loop patterns have one delta, while whorl patterns have two deltas.¹⁶

Case Report Studies Depicting Hand-Foot Syndrome

This research study measured the degradation, or lack thereof, of ridge detail in conjunction with drug class and treatment cycle. Additional medical history that may account for degradation, including age, dosage, frequency of treatment, past history, and physical activities will also be observed. As previously denoted, each individual has unique friction ridge skin. In a medical context, the degradation or loss of friction ridge skin adversely affects patients whose quality of life has already been diminished. According to Al-Ahwal (2012), clinicians should place greater focus on the potential loss of ridge detail, which could add significantly more stress to cancer patients whose lives have already been severely altered.² The author describes the case report of a 53-year old male patient diagnosed with stage IV adenocarcinoma metastasized to the liver, lungs, and rectum.² As part of a palliative care regimen, the patient was administered capecitabine, an anti-metabolic drug that prevents the growth of cancer cells by inhibiting DNA and RNA production.¹⁸ After fifteen days of treatment, the patient presented with grade 1 Hand-Foot Syndrome (HFS) following the second and third cycles of

chemotherapy. Following the fifth and sixth chemotherapy administration cycles, the patient exhibited grade 3 HFS and fingerprint loss.²

Hand-Foot Syndrome, scientifically referred to as palmar-plantar erythrodysesthesia (PPE), is a common adverse response to chemotherapy drug administration. HFS manifests as erythema (reddening) and dysesthesia (numbing sensation) localized to the palms of the hands and the soles of the feet. Patients with severe cases of HFS present with swelling and blistering of the skin accompanied by desquamation (the shedding of skin layers).⁹ The National Cancer Institute classifies HFS into three grades that correspond to severity. Grade 1 HFS is characterized as erythema with no pain or discomfort; Grade 2 HFS presents as skin peeling, blistering, and bleeding accompanied by edema (fluid build-up); Grade 3 HFS most significantly affects routine activities and is characterized as ulceration in addition to previous grade symptoms.¹⁰

A separate report, published by Wong, Choo, and Tan, presents the case of a 62-year old male patient diagnosed with metastatic nasopharyngeal carcinoma. Following treatment, doctors placed the patient on a capecitabine regimen in July 2005 to sustain remission status.¹ After follow-up appointment, the patient was prescribed a continuation of the dosage. In December 2008, three years following the initial capecitabine treatment, airport officials were unable to locate ridge detail, and the patient was detained for several hours at airport customs and impeded from entering the country.¹ The authors' note that many patients who undergo long-term capecitabine administration may experience loss of prints and should be notified to avoid inconvenience.¹

Capecitabine and Ridge Degradation

Capecitabine, or Xeloda, is an anti-metabolic drug that is orally administered to catalyze the effects of Fluorouracil, a substance that prevents cancerous growth by inhibiting DNA and RNA production.¹⁹ Without DNA and RNA, cells are unable to properly function and reproduce. Though the prevalence of HFS is markedly higher with capecitabine administration, there are additional drugs associated with HFS. The following are examples of drugs that have been cited with HFS symptoms: Cytaribine, Floxuridine, Fluorouracil, Idarubicin, Liposomal doxorubicin, Doxorubicin, Sunitinib, Sorafenib, Pazopanib, and Vemurafenib.³

The developmental process of capecitabine-induced HFS is currently being studied.^{3, 20, 22-24} Current hypotheses on the subject speculate that both cancerous and epidermal cells are susceptible to the toxic effects of capecitabine.³ Other hypotheses suggest changes in the skin occur when small amounts of chemotherapy seep out of the blood vessels in the extremities and are introduced to surrounding tissue.³ Still other hypotheses suggest that chemotherapy drugs, like excess water and salts, are emitted from the body as waste products by way of pores that are linked to eccrine sweat glands.

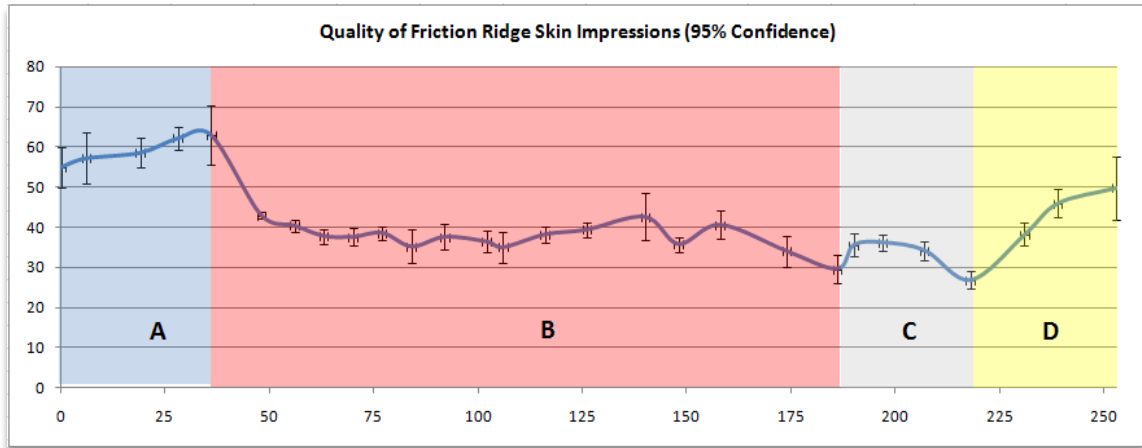
3, 25

Several of these hypotheses appear to be plausible based on the conversion process of Fluorouracil into an effective cancer targeting substance.^{3, 5} The introduction of capecitabine into the system causes numerous reactions to take place, leading to the eventual conversion of Fluorouracil to 5-FU.³ Specifically, the enzyme thymidine phosphorylase, or TP, aggregates at cancerous sites in large quantities and converts Fluorouracil to 5-FU, thereby limiting its toxic effects to cancerous tissue.¹⁹ Studies have

shown that TP is more prevalent in friction ridge skin than other areas of the body, suggesting that the increased proliferation of keratinocytes in the epidermis draws 5-FU to these areas in much the same way that the substance is drawn to areas with high proliferation of cancerous cells.^{3, 19}

Longitudinal Study of Ridge Degradation

A longitudinal study conducted by Schenck documented the effects of capecitabine on a single patient from initial administration to final treatment.³ The study evidenced diminished friction ridge skin in relation to capecitabine administration. The study also attested to the permanency of friction ridge skin; though ridges were exposed to toxic medication, detail was restored to close to initial condition approximately 65 days after treatment, with no change in pattern or minutiae arrangement.³ These results are depicted in Figure 1.4. Section “A” displays quality of ridge detail at the beginning of treatment, “B” showcases the quality throughout duration of treatment, “C” is indicative of quality at cessation of treatment, and “D” signals the return of normal ridge detail. The study evidences a direct result between capecitabine and a decline in impression quality.³ These findings verify previous literature that estimates keratinocyte maturation to be between 30 to 40 days.⁶ The decline of observed quality correlates to a significant disruption in basal layer proliferation, suggesting that these rapid areas of growth were susceptible to 5-FU in much the same way as cancerous growth and required approximately 30 to 40 days for friction ridge detail to be apparent on the upper epidermal layer.³



*Figure 4 Longitudinal Study Results: Ridge Quality in Relation to Cycle of Treatment*³
 The author challenges researchers to build upon this research initiative by

documenting the results of varying capecitabine dosages as well as the effects additional chemotherapy drugs on friction ridge detail.³ The present study addressed one portion of this challenge, calling for observation of the effects of Taxane class drugs and Doxorubicin on friction ridge skin.

Taxane Class Drugs and Anti-Microtubule Mechanism

Taxane class drugs are anti-microtubule reagents whose principle mechanism is the stabilization of guanosine diphosphate (GDP)-bound tubulin in the microtubule.²⁶ The protein tubulin polymerizes in vitro to form microtubules, or fibrous cellular projections that support cellular activity, including spindle fiber formation during mitosis.²⁷ Many anti-microtubule reagents stop cellular growth by preventing polymerization; however, taxane class drugs operate with a reverse mechanism. Taxane class drugs inhibit mitosis by binding to tubulin and preventing it from depolymerizing.³⁰ In summary, once spindle fibers are formed, taxane class drugs prevent the fibers from decreasing in size, and therefore, prohibit chromosomes from separating, a crucial step in mitosis.

Taxane drugs, derived from the plant genus *Taxus*, include Paclitaxel (Taxol) and Docetaxel (Taxotere).²⁶ These drugs are administered by injection, with common side effects including swelling, rash, and painful separation of the nail from the nail bed.²⁶ HFS is a reported side effect of taxane class drugs, with paclitaxel at a ten percent occurrence and docetaxel at a five percent occurrence.^{26, 28-29} Taxane-induced HFS is reported more frequently with relatively large doses that are administered in quick succession.²⁶

Several case reports detail both paclitaxel and docetaxel-induced HFS.^{30,31} The first case report details a 72-year old patient diagnosed with stage T1 breast cancer and prescribed a weekly injection of paclitaxel over a span of twelve weeks.³⁰ Following the sixth dosage of paclitaxel, the patient was diagnosed with grade 3 HFS, characterized by redness, desquamation, and dysesthesia. The patient was instructed to wear long articles of clothing and generously apply sun block to the affected areas, which yielded improvement and continuation of the 12-week treatment.³⁰ The second and final case report details a 52-year old patient diagnosed with metastatic breast carcinoma. The patient was administered two weekly cycles of docetaxel, after which, the patient presented with grade 3 HFS characterized by severe redness and swelling.³¹ Although the patient was prescribed a dosage that has not presented HFS in the past, professionals are certain that the patient's metastatic condition altered metabolism of the drug, causing symptoms at a lower dosage.³¹ Despite the incidence of HFS, no reports exist describing the potential effect of taxane drugs on friction skin ridges.

Liposomal Doxorubicin (Doxil) and Anthracycline Mechanism

Liposomal Doxorubicin, or Doxil, is an antitumor anthracycline, a drug class derived from the *Streptomyces* fungus species. The drug is composed of doxorubicin encased in a liposome, or lipid, to allow for direct contact with cancerous tumor growths upon injection without detection by the immune system.³² Though the exact targeting mechanism of the drug is currently unclear, scientists Denard, Lee, and Ye of the University of Texas Southwestern (UTSW) Medical Center have contributed to research on this subject. Their research evidences that a viral infection prompts the detachment of a protein, CREB3L1, and its corresponding amine group from the cellular membrane. The protein and amine travel to the nucleus, where genetic code is transcribed, including code that inhibits cellular proliferation.^{33,34} The UTSW group has found that doxorubicin prompts the formation of lipid molecules known as ceramides, which aid in detaching CREB3L1 from the membrane.^{33,35} Though the exact mechanism of cellular breakdown by doxorubicin is unclear, these findings provide information that can be built upon through further analysis.

There are several noted changes in the skin as a result of doxorubicin administration; HFS is a common side effect of doxorubicin, occurring five to six weeks following treatment in approximately 30 percent of cases. In approximately 10 to 29 percent of all patients, the drug darkens and discolors the nail bed.³²

Chapter 3—Methodology

Overview of Academic Partnership and Objectives

Collection of fingerprints took place in the Chemotherapy Infusion Suite of the University of South Alabama Mitchell Cancer Institute (USAMCI), located at 1660 Springhill Avenue in Mobile, Alabama. Michael A. Finan, M.D., Director of the Mitchell Cancer Institute, and Dr. Rodney P. Rocconi, M.D., Associate Director for Clinical Research, agreed to a research partnership with the University of Southern Mississippi's School of Criminal Justice following in tandem approval of the University of Southern Mississippi and South Alabama Internal Review Boards. Dr. Jenna Wildman, a resident enrolled in the University of South Alabama College of Medicine, and Lynley Walsh, a nurse at the Mitchell Cancer Institute, assisted with data collection.

Primary objectives of study protocol were to conduct a study of the effects of taxane class drugs and liposomal doxorubicin on friction ridge skin. Principal aims included sharing data with USAMCI in order to provide essential information for patient notification. Secondary objectives included analysis of treatment plans and prior medical history in conjunction with generated quality scores to determine statistical trends.

Study Population

Partnership with USAMCI was utilized to identify seven patients who had been prescribed taxane class drugs or liposomal doxorubicin. Specifically, five patients were enrolled in the study who were administered taxane class drugs and two participants who were administered doxorubicin. Though the original proposed study aimed for a larger study population, the population was limited in order to be conducive to time constraints. Chemotherapy combinations containing the studied drugs were admitted to the study and

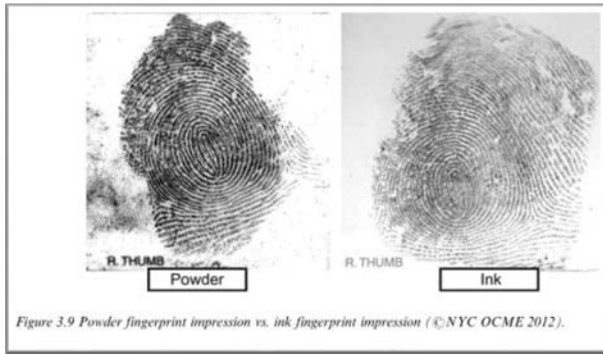
additional drugs present were noted. After all patients were admitted to the study, ridge detail impressions were collected for further analysis and interpretation.

Data was collected upon diagnosis and at the halfway point of treatment (3 months). This research initiative was classified as a pilot study that the researcher intends to build upon in the future. The researcher aims to gather impressions throughout the entire chemotherapy treatment period that typically lasts 6 months. Impressions were gathered prior to the first chemotherapy cycle, at the halfway point (3 months), and will be gathered at completion of chemotherapy (6 months). Additionally, a post-chemotherapy impression will be obtained to assess resolution of ridge detail at 90 days +/- 14 days. These impressions will only be gathered in the event that the data evidences definitive degradation.

Exclusion criteria included individuals who were not prescribed taxane class drugs or doxorubicin. No individual who met inclusion criteria was excluded from the study due to race, ethnicity, socioeconomic status, or gender. Patients were provided with a consent form and were informed of their rights to refuse participation. Prior to collection and at the discretion of the guidelines for Human Subjects Research and the researcher, all probable participants demonstrated an understanding of the extent of the study, including any and all potential benefits and harm. All consent forms were signed prior to data collection.

Research Design

Friction ridge skin impressions were collected utilizing the powder/label technique.³⁶ A relatively common postmortem lift technique, this method showcases clearer ridge detail in comparison to the traditional ink method, as indicated in Figure



*Figure 5 Comparison of Powder and Ink Lift Methods*³⁶

1.5.³⁶ The powder/label technique necessitates the direct application of black fingerprint powder to the skin by a fingerprint brush. Following the light coating of powder onto the skin, the adhesive side of a white mailing label

was slowly applied to one side of the

finger to reduce doubling the impression and was then flattened onto the remainder of the finger.³⁶ The label was applied to the backside of a clear acetate ten-print card, correspondent to the appropriate finger from which the impression was collected. Residue was cleaned from the skin using hand wipes.³⁶

During the collection period, the researcher and all collaborators maintained a central logbook in which patient name corresponded to a unique study identification number. The logbook was stored at USAMCI in a locked cabinet with access provided only by the clinical trial staff of the USAMCI. All investigators and clinical trial staff had completed and maintained HIPPA training and certification. Dr. Wildman and Lynley Walsh assisted with clinical data collection and was informed and educated of the identification system, which remained prevalent throughout the study. When patient information was needed, study identification numbers were provided via email to these individuals, who provided the corresponding materials.

All clinical data was de-identified and maintained on a password-protected spreadsheet on the researcher's computer. All collected impressions were labeled with the

study number and transported by the researcher back to the University of Southern Mississippi School of Criminal Justice Fingerprint Laboratory for analysis.

Data Analysis and Interpretation

Collected data was analyzed using a scoring system existent in a database known as AFIX Tracker.³⁷ The software has the capability to allow for both comparison of a collected print to a database and individual analysis of a single impression. The latter capability was utilized and is referred to as the “Smart-Extract” feature, which assesses impression quality by automatically identifying the number of minutiae points on a particular print. This number is referred to as a quality score. Each individual set of ten prints was scanned into the software and the scores of each finger recorded five separate times in order to gather a more holistic data set.

Statistical analyses were performed to evaluate impression quality, impression scores correlated to chemotherapy agents received and associated clinical factors, as well as chemotherapy administration details such as dosage, length of chemotherapy duration, and delays or reductions in chemotherapy. Additional variables include age of the patient, prior history, and physical activities.

Chapter 4—Results

To begin the study, 200 sets of fingerprint impressions from the AFIX Tracker Database were selected at random and an average score for each finger was generated. This was done in order to provide readers with a general understanding of the average number of minutiae per finger with respect to normal quality and surface area. It should be noted that the first scores refer to the right hand thumb, followed by the right index finger, and so forth. The sixth score corresponds to the left hand thumb, followed by the left index finger, and so forth. The results are shown in the Table 1.1 below.

Baseline Averages from AFIX Tracker Database	
Avg. 1	79.495
Avg. 2	59.525
Avg. 3	60.955
Avg. 4	50.270
Avg. 5	35.205
Avg. 6	81.950
Avg. 7	55.675
Avg. 8	58.845
Avg. 9	47.445
Avg. 10	34.705

Table 1 Baseline Averages from AFIX Tracker Database

After reviewing the taxane class drug data that corresponds to baseline and three-month data, no definitive decrease in ridge quality was indicated. Although several of the scores obtained from AFIX Tracker decreased, the researcher noted increases in ridge quality as well, which is a testament to the surface area captured during collection and not that of chemotherapy. Additional variables that may have affected scores included the amount of powder applied, which causes slightly darker and lighter sections of an individual print that make reading by a scanner difficult. Regardless of the variables associated with decrease, it can be said that chemotherapy was not a variable to be

accounted for. If all of the taxane class drug impressions collected at three months had decreased, one could conclude that chemotherapy was a factor, but based on increases at three months, the methodology itself must be cited as cause for both increase and decrease. After examining the impressions directly, the researcher could find no marked decrease in ridge visibility or marked increase in lines and creasing.

In contrast, one of the patients prescribed doxorubicin experienced significant ridge degradation in each impression. The AFIX Tracker scores associated with this participant are listed in Table 2 below. It should be noted that the first score corresponds to the right hand thumb, followed by the right index finger, and so forth. The sixth score from the top corresponds to the left hand thumb, followed by the left index finger, and so forth.

Baseline AFIX Scores (1-10)	Three-Month Scores (1-10)
114	61.6
65.4	53.6
82.8	29.6
36.8	7
20.4	4.6
143.6	63.6
66.2	32.8
55.2	8.6
30.2	4
29.6	3.8

Table 2 Comparisons of Baseline and Three-Month Scores of Doxorubicin Patient

The researcher noticed significant decrease in ridge visibility in the majority of the impressions as a result of increased creasing that obstructs ridges from view. After meeting with the patient and a relative to collect data at the three-month mark, a comment was made regarding the patient's issue with HFS. Though the symptom was not documented in the patient's chart, a nurse verified that medical personnel rarely ask patients questions regarding HFS.

The scores associated with the final doxorubicin participant were similar to those of the taxane class. There were both decreases and increases, which must be attributed to surface area and technique, and not to chemotherapy. However, the researcher noted slight decrease in ridge visibility, though AFIX was able to output increased scores.

Study participants were between 27 and 84 years of age and were administered chemotherapy concoctions including paclitaxel and avastin, gemcitabine and docetaxel, paclitaxel and carboplatin, doxil and avastin, and simply, doxil. It should be noted that the patient following the gemcitabine and docetaxel regimen was prescribed a new set of chemotherapy drugs that are not being researched in this study, and therefore, the participant has been excluded from it.

For those administered taxane class drugs, dosages ranged from 144 mg weekly to upward of 270 mg every three to four weeks. Patients prescribed doxil were administered approximately 60 mg of the drug every month. Several patients had prior history with these concoctions, while some patients have had reductions in dosage and changes in medication. To briefly cite the research survey distributed among participants, there were variations in physical activities and hobbies, including gardening and carpentry. Despite the numerous differences in concoctions, dosage, medical history, and physical activities, there was no definitive decrease in ridge detail for a majority of the study population.

Furthermore, past research indicates that HFS has presented in taxane class drugs following the sixth weekly dosage of paclitaxel. Research on doxorubicin claims that HFS is evidenced five to six weeks following treatment in approximately thirty percent of cases. There was no evidence of the severe swelling, peeling, or blistering indicative of HFS in any of the patients. Though no severities were noted, based on the interaction

with the doxorubicin patient who experienced degradation, HFS may very well have presented at a lower grade.

Chapter 5—Conclusion

Discussion of HFS Theories

It is quite clear based on prior research initiatives that all of the chemotherapy drugs in question affect the human body in a way that is synonymous to cause HFS, though the exact mechanism in which chemotherapy causes this syndrome is unknown. The lack of both visible signs of HFS and corresponding fingerprint degradation does not disprove that these two variables may be related.

There are a variety of theories that attempt to account for the mechanism of HFS. There are also a number of ways in which chemotherapy targets cancerous growth. In each mechanism, however, HFS has been cited in many cases. Dosage spacing of taxane class drugs ranged from every week to every three to four weeks. After assessing the case studies that evidenced HFS with respect to paclitaxel and docetaxel³⁰⁻³¹, the researcher found that patients diagnosed with HFS received smaller dosages of taxane class drugs compared to study participants. Factors that may have influenced the presence of HFS include the metabolism of the drug in relation to premedications and the rate at which the drugs are administered.

In the case of doxorubicin, the research indicates that HFS occurs in thirty percent of cases. In the research participants, dosages were administered every four weeks. Both doxorubicin participants were administered similar dosages every four weeks, though the patient who exhibited degradation was only administered doxil, as opposed to additional chemotherapy concoctions. Similar inferences from taxane class drug actions may be applied here as well; perhaps the drug brought about a decrease in ridge quality as a result of an interaction distinct from the other doxorubicin patient.

Study Limitations and Future Challenges

Due to time constraints pertaining to the study, there were only two individuals enrolled who were prescribed doxorubicin. Enrolling additional patients on this drug would have made for a more conclusive study, and therefore, more comprehensive data in regards to percentages of disruption found in ridge detail.

An additional verification for contemplation includes the methodology itself, specifically, the powder and label technique. Though research has shown that this technique is sublime in comparison to the traditional ink technique, Figure 1.5 showcases a larger surface area associated with the traditional technique, which may result in a surface area consistency.

Perhaps most significantly, in order to prove or disprove theories that correlate HFS to fingerprint loss, future researchers should consider collecting fingerprint impressions at all grades of this syndrome to observe the presence or absence of ridge detail. Additional variables to include in relation to HFS are the premedications administered in relation to chemotherapy as well as the rate the chemotherapy is administered.

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Appendices

Appendix A – Consent Form



A Comprehensive Study of the Effects of Chemotherapy on Friction Ridge Detail

Research Subject and Information Consent Form

The information presented in this document will help you to understand the various aspects of a research study. Please thoroughly read through this document to make an informed decision. If you have any questions, please ask your physician.

I. Investigators and Study Personnel

Name	Department	Role
Rodney Rocconi, M.D.	USA-MCI	Principal Investigator
Jenna Wildman, M.D.	USA-College of Medicine	Clinical Research
Mariel Lowe	USM-SCJ	Clinical Research
Dean Bertram, Ph.D.	USM-SCJ	Student Advisor

II. Study Locations

University of South Alabama Mitchell Cancer Institute	Mobile, AL
University of Southern Mississippi School of Criminal Justice	Hattiesburg, MS

GENERAL INFORMATION ABOUT RESEARCH STUDY

The University of South Alabama Mitchell Cancer Institute is devoted to providing quality patient care and promoting strong health through innovative research. In order to effectively provide for our patients, samples are often needed to measure the effects of various chemotherapy drugs. In this study, we are aiming to study the effects of chemotherapy administration on the surface of the fingertips, particularly, the quality of the impression at critical stages of drug administration. By doing so, the researchers are able to build upon and uphold previous research, which describes a number of chemotherapy drugs to be associated with a decrease in impression quality. The drugs that will be researched within the parameters of this study have been associated with a condition known as Hand-Foot Syndrome (HFS). The condition causes irritation and sensitivity of the skin, which is responsible for diminished quality of fingerprint impressions.

Because you will be administered one of the drugs of interest for our study, this consent form is asking for your permission to do the following:

1. Collect fingerprint impressions at four critical stages of the treatment process: at diagnosis, at the halfway point of treatment, at final treatment, and at the follow-up appointment following the end of treatment.

Patient Consent Form May 2015



USA Institutional Review Board	
Approved:	8/7/2015
Expires:	8/6/2016
IRB number:	15-177/780558-2

Patient Initials _____

Page 1 of 4

2. Analyze collected impressions using a software program that will determine the quality of the impression.
3. Collect and store personal demographic information (age, race, gender, etc.) in order to link this information to specific data. In addition, administered chemotherapy, doses, length of treatment, and any delays or reductions in your treatment will be noted and applied during data analysis.
4. Provide you with a survey that will relay additional information about you in order to better understand differences in impression quality.
5. Store your confidential data for analysis, to eventually be used to complete an Honors Thesis and fulfill requirements for an Honors Degree by the USM-SCJ Clinical Research Contact.

The duration of this particular research study is approximately 9 months, with impressions taken at the beginning, duration, and cessation of treatment. Each fingerprinting session will last approximately 10-15 minutes. It is the goal of the researchers to collect impressions following treatment as well, preferably at follow-up appointment. In order to collect impressions, a small amount of black, magnetic fingerprint powder will be applied directly to the surface of the fingertips and will then be removed by a small piece of adhesive. This adhesive will be applied to the back of a clear piece of acetate for storage purposes, and any remaining residue will be removed using alcohol and paper products. This procedure will take place during a scheduled visit in the Infusion Suite, located at the University of South Alabama Mitchell Cancer Institute.

Collecting fingerprint impressions is a noninvasive procedure with minimal risk. Due to the presence of metals and toners in the magnetic powder, there is a slight risk of an allergic reaction, though this phenomenon is exceedingly rare, especially in part due to the short length of time in which the powder will be exposed to the surface of the skin.

The fingerprint impressions that are collected will be taken back to The University of Southern Mississippi's School of Criminal Justice Fingerprint Laboratory and uploaded to a software program that is designed to generate a score, which corresponds to the quality of the impression. These quality scores will be analyzed, keeping in mind your individual patient information. If the data supports previous literature, which suggests a correlation between treatment factors and a decrease in impression quality, medical professionals may be alerted to this potential side effect and the percentage of occurrence for patient notification. In addition, if a pattern develops between your individual patient information and a decrease in impression quality, future researchers may build upon this research to determine why this pattern exists.

**AUTHORIZATION TO USE AND DISCLOSE INDIVIDUALLY IDENTIFIABLE
 HEALTH INFORMATION FOR RESEARCH PURPOSES**

Purpose

Federal privacy laws protect the use and release of your identifiable health information, which is called protection health information (PHI). Under these laws, your protected health information cannot be used or disclosed to the research team for this research study unless you give your permission. Study records that identify you will be kept confidential as required by law.

Patient Consent Form May 2015



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Patient Initials _____
 Page 2 of 4

What protected health information will be used or disclosed?

- Demographic information (age, race, weight, height, etc.)
- Administered chemotherapy drugs and dosage
- Length of treatment and any delays or reductions in treatment

Who will use my protected health information and to whom will it be disclosed?

The research staff is the only set of individuals who will be permitted access to your protected health information. Please note that the research staff represents the University of South Alabama Mitchell Cancer Institute and the School of Criminal Justice located on the University of Southern Mississippi campus. Measures have been taken to ensure data security.

Will access to my medical records be limited during the study?

In accordance with the USA Health System Privacy Notice document, you are permitted to obtain access to your protected health information collected or used in this study. However, to maintain the integrity of this research study, you may not have access until the end of the study.

Data security

A logbook containing patient names and corresponding study identification numbers will be stored in a locked cabinet in a locked room with access permitted to individuals who do not have access to the study. All clinical data corresponding to each participant will be stored on a password-protected spreadsheet on a single computer at the USA Mitchell Cancer Institute.

Following print collection, all impressions will be taken back to the USM School of Criminal Justice and stored in a locked cabinet in a locked room with access permitted to individuals who do not have access to the study. The Clinical Research Contact at USMSCJ will provide the study identification number corresponding to the impression, at which point, all data communicated between USAMCI and USMSCJ will be stored on a password-protected spreadsheet on the computer of the USMSCJ Clinical Research Contact.

BENEFITS OF BEING A PARTICIPANT

You will not receive any direct benefits as a result of being a participant of this research study, nor will you be penalized if participation is declined. You may cancel your authorization at any point in the study, and you may do so by contacting the any of the following entities listed below. If your authorization is cancelled, you will be removed from the study.

QUESTIONS AND CONTACTS

If you have any questions about the research, you may ask at this time. You may also call the Clinical Research Contact at (251) 802-4895 or USAMCI at (251) 665-8000.

Patient Consent Form May 2015



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IRB number:	15-177/780558-2

Patient Initials _____
 Page 3 of 4

If you have any questions concerning your rights as a research participant, you are welcome to call the USA Institutional Review Board at (251) 460-6308.

If you agree to participate, the information that you provide will provide knowledge of additional information concerning the side effects of particular chemotherapy drugs for patient notification. The intended purpose of this study aims to determine the existence of a correlation between diminished ridge quality and chemotherapy drugs administered during treatment. There are a number of factors that may be associated with decreased impression quality in addition to the drugs that you are being administered, including the length of your treatment, any delays or reductions in your treatment, and dosage. In addition to determining if a correlation exists, this study may provide additional research questions that may be further explored in a research setting.

RISKS AND DISCOMFORTS ASSOCIATED WITH THE RESEARCH STUDY

Hand-Foot Syndrome (HFS) is a side effect that is often referenced in conjunction with chemotherapy administration and has been described in the General Information section of this document. If you exhibit symptoms of HFS or any other changes of the skin at any point in your treatment, there is a possibility that you will experience slight discomfort during fingerprint impression collection. Please know that the researchers responsible for data collection will be collecting impressions with the greatest care in order to mitigate any discomfort.

COST AND PAYMENT OF STUDY PARTICIPATION

Participation in this study is of no cost to you. Additionally, you will not be compensated for your participation.

YOU WILL RECEIVE A COPY OF THIS FORM

SIGNATURE OF OBTAINED CONSENT

You have read, or have had read to you, and understand the purpose and procedures of this research. You have had an opportunity to ask questions which have been answered to your satisfaction. You voluntarily agree to participate in this research as described.

 Signature of Research Participant

 Date

 Signature of Clinical Contact Obtaining Consent

 Date



USA Institutional Review Board	
Approved:	8/7/2015
Expires:	8/6/2016
IRB number:	15-177/780558-2

Appendix B – Participant Survey

Research Participant Survey

Thank you once again for agreeing to participate in our research study. The data collected as a result of your participation will provide professionals in both the medical and justice communities with information about the effects that chemotherapy drugs have on fingerprint impressions. This particular topic is a fairly up-and-coming area that is not often studied, so we thank you for your significant contribution!

This particular study focuses on chemotherapy that has a documented effect on the skin of the hands. This effect has often been correlated with a decrease in the quality of fingerprint impressions. The following survey provides you with a list of activities that requires excessive use of your hands. By answering these, you are providing us with additional information that can account for diminished quality of fingerprint impressions.

Please circle the following areas in which you participate. If an activity is a hobby that you do not engage in on a daily basis, please describe how often you use your hobby next to the activity.

Table with 4 columns and 10 rows listing activities: Archaeology, Automotive Industry, Carpentry, Culinary Industry, Dentistry, Electrical Engineering, Farming, Gardening, Knitting, Landscaping, Massage Therapy, Medicine (Please specify.), Orthodontics, Plumbing, Sculpting, Sports (Indicate the sport.), Typing, and **Other.

** If you participate in any additional activity that requires significant and excessive use of your hands, please indicate the activity below and describe how often you participate in the activity.



USA Institutional Review Board table with fields: Approved: 8/7/2015, Expires: 8/6/2016, IRB number: 15-177/780558-2

Appendix C – USAMCI Institutional Review Board Approval

irb@usouthal.edu



TELEPHONE: (251) 460-6308
CSAB 138 · MOBILE, AL. 36688-0002
FAX: (251) 461-1595

INSTITUTIONAL REVIEW BOARD
August 31, 2015

S:

Appendix D – USM Institutional Review Board Approval Form



INSTITUTIONAL REVIEW BOARD

118 College Drive #5147 | Hattiesburg, MS 39406-0001

Phone: 601.266.5997 | Fax: 601.266.4377 | www.usm.edu/research/institutional.review.board

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 15060804

PROJECT TITLE: A Comprehensive Study of the Effects of Chemotherapy on Friction Ridge Detail

PROJECT TYPE: New Project

RESEARCHER(S): Mariel Lowe

COLLEGE/DIVISION: College of Science and Technology

DEPARTMENT: School of Criminal Justice

FUNDING AGENCY/SPONSOR: N/A

IRB COMMITTEE ACTION: Expedited Review Approval

PERIOD OF APPROVAL: 10/13/2015 to 10/12/2016

Lawrence A. Hosman, Ph.D.

Institutional Review Board