**The Capstone Committee for Jay Michael Truitt Certifies that this is the approved version of the following dissertation:**

# Evaluating the use of Dermoscopy in the Primary Care Setting in Improving Clinical Outcomes in the Treatment of Melanoma: A Systematic Review

**Committee:**

Daniel Jupiter, PhD, Chair

Xiaoying Yu, MD, PhD, MS

Janice Wilson, MD

# Evaluating the use of Dermoscopy in the Primary Care Setting in Improving Clinical Outcomes in the Treatment of Melanoma: A Systematic Review

**by**

**Jay Michael Truitt, MD, PhD, PharmD**

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# Evaluating the use of Dermoscopy in the Primary Care Setting in Improving Clinical Outcomes in the Treatment of Melanoma: A Systematic Review

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Jay Michael Truitt, MPH

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Supervisor: Daniel Jupiter

Melanoma is a significant public health problem and is the most lethal type of skin cancer. Rural and underserved populations have disproportionately worse melanoma-related health outcomes and mortality rates. In these populations, primary care providers are usually the first evaluate, make diagnoses, and initiate referrals/treatments. Dermoscopy, which is a magnification technique using visible light, is increasingly being used in the primary care setting as a tool to improve diagnostic accuracy. Dermoscopy training and the use of teledermoscopy in primary care settings are potential solutions for improving melanoma-related clinical outcomes. The objective of this systematic review was to determine if the use of dermoscopy in a primary care setting can improve clinical outcomes in the treatment of melanoma. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to search for and evaluate relevant studies in four electronic databases (Pubmed, Ovid, CINAHL, and Web of Science) from January 1, 1993 to December 31, 2018. Studies utilizing dermoscopy/teledermoscopy and reporting clinical outcomes associated with melanoma treatment were included. Studies not performed in a primary care/telemedicine setting, and those not concerning melanomas/pigmented skin lesions were excluded. Twenty studies met review criteria, but the heterogeneity of the outcomes measured precluded performance of a meta-analysis, thus data were synthesized in a

narrative review. The use of dermoscopy/teledermoscopy in the setting of an adequately trained primary care provider was associated with improved diagnostic accuracy for detecting melanomas, decreased morbidity due to unnecessary removals of benign lesions, and reduced number of dermatology referrals. Cost effectiveness was explored in three of the studies, with two of three finding a significant cost advantage to dermoscopy. Patient acceptability and satisfaction was addressed in one of the studies and was positive. None of the included studies directly addressed the stage of diagnosis, time to diagnosis, or mortality measurements. Thus, widespread implementation of dermoscopy/teledermoscopy in the primary care setting has the potential to improve diagnostic accuracy of suspicious lesions for melanoma and reduce melanoma-related patient morbidity. However, reliable information regarding the amount and type of dermoscopy training needed, the cost effects, patient acceptability/satisfaction and mortality benefits need further exploration.

# TABLE OF CONTENTS

# List of Tables

# List of Figures

# List of Abbreviations

| | |
|---|---|
| ABCD | Area, Border, Color, Diameter |
| BLINCK | Benign, Lonely, Irregular, Nervous, Change, Known Clues |
| BRCA2 | Breast Cancer Type 2 |
| CASP | Critical Appraisal Skills Program |
| CDK4 | Cyclin Dependent Kinase 4 |
| CDKN2A | Cyclin-Dependent Kinase Inhibitor 2A |
| CINAHL | Cumulative Index to Nursing & Allied Health Literature |
| DA | Diagnostic Accuracy |
| MITF | Melanocyte Inducing Transcription Factor |
| MM | Malignant Melanoma |
| NPV | Negative Predictive Value |
| OR | Odds Ratio |
| PCP | Primary Care Provider |
| PPV | Positive Predictive Value |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| RCT | Randomized Control Trial |
| SIT | Sequential Intervention Trial |
| US | United States of America |

# Chapter 1: Introduction

## RESEARCH QUESTION:

Does the use of dermoscopy in a primary care setting improve clinical outcomes in the treatment of melanoma?

## OBJECTIVES:

The objective of this capstone project was to present a systematic review of evidence regarding whether the use of dermoscopy in a primary care setting can improve clinical outcomes in the treatment of melanoma. Clinical outcomes were defined as any of the following: stage of diagnosis, time to diagnosis, diagnostic accuracy, waiting time to treatment, financial costs, morbidity/mortality measurements, patient acceptability/satisfaction, or physician confidence.

## RATIONALE FOR THE REVIEW:

There has been a growing interest in the use of dermoscopy in primary care settings, especially by family physicians and mid-level practitioners, in order to improve melanoma detection and treatment.[12,13]. These medical providers are the primary healthcare contact for many patients, especially those in rural and underserved populations. Thus, in the absence of an accepted consensus and a deficit of prior systematic reviews, this proposed systematic review will provide valuable insight to primary care providers and dermatologists on the usefulness of dermoscopy in a primary care setting in the treatment of melanoma.

# Chapter 2: Background

## EPIDEMIOLOGIC DESCRIPTION OF MELANOMA:

Melanoma is a significant public health problem and is the 19th most common cancer worldwide, and the fifth and sixth most common cancer in men and women, respectively, in the US when considering all age groups.[1,14] Melanoma arises from uncontrolled division of melanocytes, which are the cells responsible for the production of a type of pigment called melanin. Melanocytes are primarily located in the epidermis of the skin, but are also found in other areas of the body, such as mucosal surfaces, the eyes, and the meninges of the central nervous system. Cutaneous melanoma occurs in the skin, with the four most common types being lentigo maligna, nodular, superficial spreading and acral lentiginous.[15] Although melanoma is not the most common form of skin cancer, it is the most lethal and can metastasize to other parts of the body via the blood stream or lymphatic system, and is responsible for the majority of skin cancer-related deaths.[16] Worldwide there are an estimated 300,000 new melanoma cases per year (76,380 in the US) and 55,000 melanoma-related deaths per year (10,130 in the US).[2,14,16,17] Australia has the highest incidence overall with an age-standardized rate of 33.6 new cases of melanoma per 100,000 people (12.7 in the US).[14] The incidence of melanoma was generally higher in males versus females, with Australia having the highest age-standardized rate in males with 40.4 new cases of melanoma per 100,000 people (14.9 in US), and Denmark have the highest age-standardized rate in females with 33.1 cases of melanoma per 100,000 people (11.0 in US).[14] Both the overall incidence and number of melanoma-related deaths are steadily rising.[2,14,16,17]. Factors that may be contributing to this trend include earlier detection and higher lifetime ultraviolet light exposure due to use of tanning beds, increased

recreational sun exposure, and the rising average life expectancies in the world population, etc.[18,19]

There are both host and environmental risk factors for developing melanoma. Host factors include older age (median age of diagnosis is 50 years old), lighter skin color, white race (white people have 20 times greater risk than black people), male sex (likely from occupational sun exposure), history of previous skin cancers, family history of melanoma (those with close relatives with melanoma have 2 to 3 times higher risk), atypical nevi, large congenital nevi, high number of total nevi, and certain genetically inherited disorders. Genetic conditions that increase the risk of melanoma include xeroderma pigmentosum, hereditary breast and ovarian cancer syndrome (BRCA2 mutation), Werner syndrome, Li-Fraumeni syndrome, and familial melanoma that can caused by mutations in genes such as CDK4, CDKN2A, P53, and MITF.[16,18,20-25] Environmental factors include occupational and recreational sun exposure, cumulative and episodic sun burns, indoor tanning, immunosuppression (as in HIV-positive individuals, organ transplant recipients, chronic oral steroid treatment for autoimmune diseases, etc.), and socioeconomic status (people with lower socioeconomic status tend to present later in the disease course and have more advanced disease at diagnosis).[16,20,26-29]

However, it is the stage at which the patient is diagnosed that largely determines a patient's probability of survival. The five-year survival for melanoma in the US is 99% for localized, 70% for regional, and 18% for distant disease.[30] The overall 5 year survival rate in the US has improved over time from 80% in 1975 to 94% in 2010, but the mortality rate has been unchanged while incidence has continued to climb, thus suggesting that heightened surveillance and earlier detection is largely responsible for the observed improvement in survival.[30] Even though progress in survivability is being made with targeted immunotherapies, such as BRAF

inhibitors, in advanced stages of melanoma, the most successful treatment remains early detection and excision of the lesion while it is still localized.[30,31]

Unfortunately, some populations have disproportionately high rates of melanoma deaths. Living in poorer counties or counties with lower mean education levels is associated with worse melanoma-related health outcomes.[3,4] Melanoma incidence and mortality rates in rural counties are higher than the corresponding rates in their urban counties. More specifically, rural counties have a 2.8% higher incidence of melanoma and an 11.1% higher melanoma mortality rate than urban counties.[5] Many of these deaths could be prevented through early detection and adequate access to health services.[6] Innovative approaches such as dermoscopy training for primary care providers, and the use of teledermoscopy in primary care settings, are potential solutions for increasing the quality of and access to dermatological care, especially for rural and other underserved populations.

Dermoscopy is a noninvasive in vivo imaging technique that uses skin surface microscopy to examine the symmetry, homogeneity, borders, vascular structures, color, and pigment distribution of skin lesions.[7] Teledermoscopy is the process of capturing dermoscopy images remotely and sending those images to dermatologists for expert review.[8] Dermoscopy, when used as a tool by dermatologists during in-person visits, has been shown to have significantly improved diagnostic accuracy for detecting melanoma skin cancers, as compared to naked eye examination alone.[9,10] Since the results gleaned from dermoscopy can vary by the experience of the clinician, using the tool requires extensive training in order to become proficient in this technique.[11] As such, dermatologists have generally been the clinicians who have learned and used dermoscopy. However, there has been a growing interest in the use of dermoscopy in primary care settings, especially by family physicians and mid-level practitioners,

in order to improve melanoma detection and treatment.[12,13]. These medical providers are the primary healthcare contact for many patients, especially those in rural and underserved populations. Thus, in the absence of an accepted consensus and a deficit of prior systematic reviews, this systematic review will provide valuable insight to primary care providers and dermatologists on the usefulness of dermoscopy in a primary care setting in the treatment of melanoma.

# Chapter 3: Methods

## SEARCH STRATEGY:

This systematic review used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to search for relevant studies on dermoscopy use in a primary care setting in melanoma treatment.[32] Searches were done for articles published between January 1, 1993 to December 31, 2018 using the Pubmed, Ovid, CINAHL, and Web of Science electronic databases. The year 1993 was used as the starting year since this was the publication year (except for one record in 1955) of the earliest study discovered in a trial search using the keyword "dermoscopy" in the above-mentioned databases. The key words used in the systematic review searches included the following word combinations: "melanoma and dermoscopy", "melanoma and teledermoscopy", "pigmented lesions and dermoscopy", "pigmented lesions and teledermoscopy", "clinical screening and dermoscopy", "clinical screening and teledermoscopy", "primary care and dermoscopy", "primary care and teledermoscopy", "general practitioner and dermoscopy", and "general practitioner and teledermoscopy". Duplicate records from these searches were removed.

## INCLUSION AND EXCLUSION CRITERIA:

The inclusion criteria for selecting articles were: 1) was a peer-reviewed publication, 2) was done in a primary care or telemedicine setting, 3) dermoscopy was read in-person by a non-dermatologist and/or remotely by a dermatologist, and 4) included data on at least one clinical outcome associated with melanoma treatment (stage of diagnosis, time to diagnosis, diagnostic accuracy, waiting time to treatment, financial costs, morbidity/mortality measurements, patient acceptability, or patient satisfaction). The exclusion criteria were the following: 1) was written in

a language other than English, 2) used an animal model, 3) was a review article, 4) was a letter to the editor that did not include original data, or 5) did not concern melanoma or pigmented skin lesions.

**DATA EXTRACTION:**

Relevant information was extracted from the selected articles and entered into a spreadsheet that included the characteristics of the studies (study details, study design, study populations, etc.), and the clinical outcomes of the studies (stage of diagnosis, time to diagnosis, diagnostic accuracy, waiting time to treatment, financial costs, morbidity/mortality measurements, patient acceptability, and patient satisfaction, etc.). Outcomes were reported from the selected articles without further calculation of quantitative measures of diagnostic accuracy of the data. The heterogeneity of the outcomes measured precluded execution of a meta-analysis; thus, data were synthesized in a narrative review and summarized using a descriptive table and discussion.

**QUALITY ASSESSMENT:**

Quality of the articles was assessed using the Critical Appraisal Skills Program (CASP) checklists to determine relevance to the research question, choice of outcome measures, quality of the intervention, appropriateness of statistical analysis, quality of reporting, risk of bias, and generalizability. This assessment tool has study design-specific checklists evaluating various domains of the studies and includes a series of questions in relation to each domain that are answered with a "yes", "no" or "cannot tell" response. To compare studies more readily, for each domain, a score of 2 was given for "yes", 1 for "cannot tell" and 0 for "no", and the scores summed, with a maximum quality score of 24.[33] Following the Scottish Intercollegiate Network

Guidelines, qualitative descriptors were provided based on overall score to denote quality of the study and risk of bias. A score of 18-24 corresponded to a "High quality study" with minimal risk of bias and results of this study unlikely to be changed by further research. A score of 12-17 corresponded to an "Acceptable quality study" with some associated bias. A score less than 12 corresponded to a "Low quality study" with significant flaws in study design.[34]

Results were summarized in both narrative and table format and included the following: author information, study type, intervention, number of participants, characteristics of participants, outcome measures, study quality/risk bias, author impressions, and level of dermoscopy training. Final recommendations were based on the Centre for Reviews and Dissemination guidelines for developing a narrative synthesis for systematic reviews.[35] This includes developing a possible theory of how the intervention works, textual descriptions of studies, exploring interstudy comparability, examining robustness of the assessment, and developing a final synthesis to answer the proposed research question.

# Chapter 4: Results

## SEARCH RESULTS AND SELECTION PROCESS:

Figure 1 shows the study PRISMA flow chart. There were 585 articles identified, of which 233 were duplicates. For the remaining 352 articles, a title/abstract screen was performed using the inclusion/exclusion criteria, and an additional 271 articles were excluded. Eighty-one articles underwent full-text review, and 61 additional articles were dismissed, with 19 not involving dermoscopy or teledermoscopy, 30 not based in a primary care setting, 9 not peer reviewed, and 3 not having original data, leaving 20 articles that met the inclusion and exclusion criteria.[36-55]

## DESCRIPTION OF STUDIES:

Table 1 summarizes the author information, study type, intervention, number of participants, characteristics of participants, outcome measures, study quality/risk bias, author impressions, and level of dermoscopy training/physician confidence with dermoscopy for each included study. These studies included seven diagnostic accuracy studies, four primary care provider surveys, three randomized controlled trials (RCTs), three cohort studies, one case series, one case-control study, and one sequential intervention trial (SIT). Thirteen of the studies used dermoscopy, while seven used teledermoscopy. All articles examined were studies in a primary care setting. Outcome measures were diverse, with the majority of the studies reporting on the diagnostic accuracy and reliability of dermoscopy/teledermoscopy in the diagnosis of melanoma in a primary care setting. Twelve of these studies reported the proportion of correct decisions, while eleven of the studies examined the sensitivity and specificity, eight the diagnostic accuracy, and three the positive and negative predictive values of diagnostic tests. A number of

studies reported on patient morbidity-related outcomes, with five of the papers reporting the biopsy rate for a correct melanoma diagnosis and four reporting on the number needed to excise (a measure of the number of excisions that are performed to successfully treat one melanoma). Four studies examined primary care providers' opinions on the usefulness and barriers to use of dermoscopy/teledermoscopy in the primary care setting. Three studies performed cost-effectiveness analyses on the use of dermoscopy/teledermoscopy in the primary care setting. Two studies measured the time to treatment, and one assessed patient satisfaction.

**SUMMARY OF FINDINGS:**

The included studies showed that when either dermoscopy or teledermoscopy-based referral systems were used in the primary care setting they significantly increased the accuracy of diagnosis of melanomas.[38,39,42,46,52,54,55] This is likely explained by the improved ability to discern benign lesions from malignant ones under increased magnification.[36,50-52] However, the use of dermoscopy did not always lead to better diagnostic accuracy. The studies that explored the effect of dermoscopy experience, training, or education demonstrated that an untrained or inexperienced person had no improvement in diagnostic accuracy versus a provider using a regular clinical visual examination.[50-52,55] These studies also showed that training could lead to significant increases in diagnostic accuracy, even to the point that a well-trained PCP could develop a diagnostic acuity that could approach that of medical providers specializing in skin cancer care.[16,51] Other clinical outcomes also improved with increasing diagnostic accuracy, including a reduction of morbidity-related clinical outcomes. Studies showed an inverse relationship between diagnostic accuracy and the number of unnecessary dermatology referrals and excision procedures, as well as the number needed to excise to diagnose melanoma.[39,42,45,51]

Other clinical outcomes of melanoma were explored in both the patient and physician attitudes toward dermoscopy. The one study that assessed patient's attitude towards dermoscopy specifically considered teledermoscopy consults, and 97 percent of patients rated themselves as satisfied/very satisfied with this service.[44] The attitude of the medical providers was largely positive, with the perception that dermoscopy/teledermoscopy has the potential to improve diagnostic accuracy, even in the hands of non-dermatologists. However, the actual usage of the dermatoscope in regular practice was restricted to a small percentage of primary care providers. Some of the main reasons given were cost of the device and the lack of training on appropriate use.[40,47,48,53]

The potential cost effectiveness and time saving effects were addressed in a few of the included studies. Cost effectiveness was addressed in three of the studies, with all three stating that teledermoscopy offered some type of cost advantage over the traditional referral system, but only in two of these studies were the effects statistically significant. Examples of cost savings were decreased cost from the expense associated with additional face-to-face specialty care visits and unnecessary excision/biopsy procedures.[41,43,44] One study addressed the potential time savings from teledermoscopy by showing that patients could be diagnosed and have excisions of malignant lesions completed in less time than when following a regular referral timeline.[38]

**QUALITY ASSESSMENT:**

Risk-of-bias outcomes from the Critical Appraisal Skills Program (CASP) checklists are included in table 1, which demonstrated a wide range in quality across the studies, but no studies were excluded based on the risk-of-bias assessment.

# Chapter 5: Discussion

**SUMMARY:**

The use of dermoscopy by primary care providers is still relatively uncommon, as is reflected in the literature: there are only a small number of studies examining its use in the primary care setting, and even these studies are predominately from high income areas such as the US, Australia, and Europe. The heterogeneous nature and diverse clinical outcomes explored in these studies precluded performing a quantitative meta-analysis of the data. This systematic review, through narrative synthesis, was still able to provide evidence to demonstrate the usefulness of dermoscopy in increasing diagnostic accuracy through improvements in sensitivity and specificity, and decreasing unnecessary referrals and excisions, and reducing the number needed to excise in the treatment of cutaneous melanoma in a primary care setting. This review also provided evidence that dermoscopy and teledermoscopy are superior to regular clinical visual examination (i.e. naked eye examination) when evaluating lesions suspicious for melanoma. This is also supported by a number of previous primary care dermoscopy reviews, and a Cochrane review on using dermoscopy in making the diagnosis of melanoma.[16,57,58.] This usefulness was found to be limited to primary care providers who are adequately trained to use dermoscopy.[19,59] However, what "adequately trained" means in terms of hours/days or type of education was not addressed in this review. One example in the literature showed that dermatologists could experience significant improvement in dermoscopy performance in as little as two days of intensive dermoscopy training, but it is unclear if this amount/type of training would be as beneficial to a primary care provider.[56]

## PUBLIC HEALTH IMPLICATIONS:

Dermoscopy and teledermoscopy have the potential to have a huge impact on how melanoma is diagnosed and treated, especially for those in rural, poor, and underserved areas who lack access to specialty care such as dermatologists. In these areas, as well as others, primary care providers will continue to be the first medical professionals to encounter suspicious lesions. It is imperative that these providers be equipped with the best possible cost-effective tools to make a quick and accurate diagnosis, in order to facilitate receipt of appropriate treatment in a timely manner. As evidenced by this review, a primary care provider who is well trained in dermoscopy can increase their diagnostic acuity of melanoma to close to that of a specialty trained dermatologist. This reduces unnecessary dermatology and surgical referrals, and decreases unnecessary excisions of benign lesions, that waste collective medical resources and increase specialty wait times for other more urgent cases. In effect, properly trained primary care providers in dermoscopy and teledermoscopy can provide better triage service to a greater number and to a more in need patient population base, ultimately leading to a decrease in overall melanoma mortality rates.

## STRENGTHS AND LIMITATIONS:

Strengths include the use of a broad search strategy across four databases, and including a wide variety of study types, leading to the inclusion of twenty suitable studies. This review focused on the role of dermoscopy in the primary care setting, which is unlike previous reviews that were in both specialist and primary care settings. Limitations include identification of a small number of publications despite a broad search strategy. Included studies have diverse study designs and outcomes and varying quality that prevents performing a meta-analysis of the data, and thus narrative synthesis was performed instead. Examined studies include few randomized

controlled trials. Results of the review have limited external validity and should not be generalized to low income or developing countries, since all the studies originate from high-income areas. Due to paucity of suitable studies meeting the search criteria, this review was unable to make definitive conclusions on many of the proposed clinal outcome in melanoma treatment, such as cost effectiveness of dermoscopy, time to treatment or diagnosis, melanoma stage at diagnosis, patient satisfaction, and effects on mortality rates.

**GAPS IN EVIDENCE:**

There are no long-term prospective studies that have investigated mortality rate changes with dermoscopy use in a primary care setting. Studies are needed to explore the cost effectiveness of using teledermoscopy versus teledermatology with clinical images versus the traditional referral pathway, to determine if these services are justified from a cost perspective. There are no studies of dermoscopy/teledermoscopy use in a primary care setting in lower income countries or in poorer areas of high-income countries, which are likely the areas that would benefit the most from better trained PCPs.

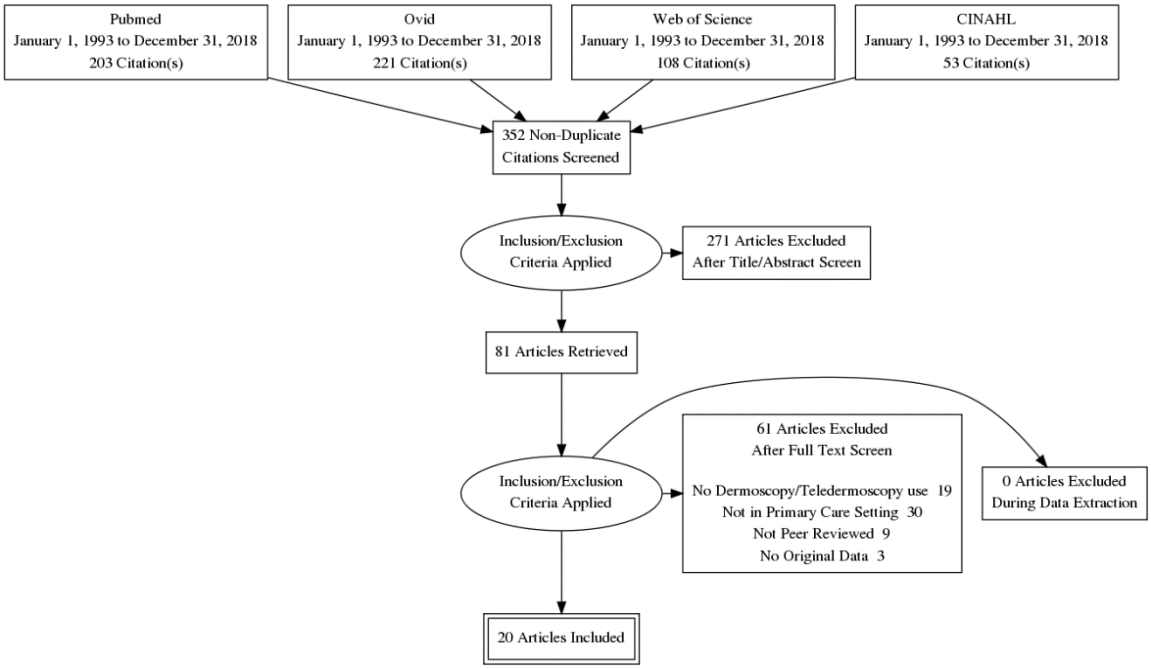
**CONCLUSIONS:**

This systematic review provides support for utilizing dermoscopy in the primary care setting for the treatment of melanoma, especially when the primary care providers are well trained in dermoscopy. Evidence from this review demonstrated that when dermoscopy was used in a primary care setting it increased diagnostic accuracy, decreased unnecessary specialist referrals, reduced unneeded excisions of benign lesions, and lowered the number of excisions needed to treat a single melanoma. Studies that included dermoscopy training for the PCPs amplified these results. However, this review did not adequately address patient

acceptability/satisfaction, mortality benefits, or the cost effectiveness of dermoscopy use in the primary care setting, or the amount of training needed to make a PCP competent in using dermoscopy. These areas would need to be addressed in future research.

# Appendix A: Figures and Tables

**FIGURE 1: PREFERRED REPORTING ITEMS FOR SYSTEMATIC REVIEWS AND META-ANALYSES (PRISMA) FLOW CHART FOR THE INCLUDED STUDIES:**



## TABLE 1: SUMMARIZED RESULTS OF THE INCLUDED STUDIES:

| Study (year) | Study Design | Location | Summary | Interventions and Patient Characteristics [M/F%, mean age in yrs (age range), and # of lesions or participants] | Clinical Outcomes | CASP Quality Assessment |
|---|---|---|---|---|---|---|
| Ahmadi et al. (2017)[36] | Case Series | Netherlands | Retrospective cross-sectional study of PCPs from 3 different practices using dermoscopy as one of the diagnostic tools to evaluate skin lesions | Primary care patients<br>42.2%/57.8%<br>54.7 (60–79)<br>580 lesions | Diagnostic Accuracy and Morbidity Measurements:<br>PPV: Melanoma 25 %<br>Biopsy rate: 1.9%<br>Excision rate: 10.3% | High Quality |
| Argenziano et al. (2006)[37] | RCT | Spain, Italy | RCT in primary care comparing PCPs using naked eye only visual examination (ABCD) versus PCPs using dermoscopy (3-point checklist) | Control:<br>Naked eye:<br>37.6%/62.4%<br>40 (2-90)<br>1325 lesions<br><br>Intervention:<br>Dermoscopy:<br>37.7%/62.3%<br>41 (3-94)<br>1203 lesions | Diagnostic Accuracy<br>Control:<br>Sensitivity: 54.1%<br>Specificity: 71.3%<br>PPV: 11.3%<br>NPV: 95.8%<br>2/6 MMs missed<br><br>Dermoscopy:<br>Sensitivity: 79.2%<br>Specificity: 71.8%<br>PPV: 16.1%<br>NPV: 98.1%<br>1/6 MMs missed | Acceptable Quality |
| Borve et al. (2015)[38] | Case Control | Sweden | Case-control study in 20 primary healthcare centers comparing traditional paper-based referrals to smartphone teledermoscopy-based referrals | Control:<br>Paper-based referrals:<br>42.9%/57.1%<br>61 (18-97)<br>746 lesions<br><br>Intervention:<br>Smart phone teledermoscopy referrals:<br>38.6%/61.4%<br>54 (18-93)<br>816 lesions | Diagnostic accuracy and time to diagnosis and treatment:<br>Control:<br>3/4 invasive MMs assigned medium or low priority.<br>3/5 MMs in situ assigned low priority.<br>Mean response time of 5 days (range 0-82 days)<br>82.2% of patients received treatment on one face-to-face visit.<br><br>Intervention:<br>All invasive MM's received high priority.<br>All MMs in situ received medium priority or greater<br>Mean response time of 109 min (range 2 min to 48 hours.<br>93.4% of patients received treatment on one face-to-face visit.<br>Waiting time for surgical treatment significantly shorter ($p<0.0001$). | Acceptable Quality |

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|---|---|---|---|---|---|---|
| Bourne et al. (2012)[39] | DA | Australia | Sequential DA study with 4 PCPs using 3-point checklist vs Menzies vs clinical assessment vs BLINCK dermoscopy algorithm on images of the same lesions. | Control:<br>Clinical assessment<br><br>Interventions:<br>3-point check list<br>Menzies<br>BLINCK<br><br>All groups:<br>47.8%/52.2%58 (30-60)<br>200 lesions | Diagnostic Accuracy and Morbidity Measurements:<br>Control:<br>Clinical assessment:<br>Sensitivity: 52.6%<br>Specificity: 74.8%<br>Number needed to excise:22<br><br>Interventions:<br>3-point check list:<br>Sensitivity: 59.4%<br>Specificity: 42.2%<br>Number needed to excise:11<br><br>Menzies:<br>Sensitivity: 54.7%<br>Specificity: 69.0%<br>Number needed to excise:13<br><br>BLINCK<br>Sensitivity: 90.8%<br>Specificity: 50.0%<br>Number needed to excise: 6 | High Quality |
| Chappuis et al. (2016)[40] | Survey | France | Survey of PCPs in France assessing dermoscopy training, usage, and dermatology referrals | PCP's in France<br>57.6%/42.4%<br>8 participants <30, 169 participants 30–50, and 246 participants >50<br>425 survey participants | Morbidity Measurements and Physician dermoscopy training:<br>Lower referral rates to dermatologists in dermoscopy users<br>8% of PCP's had a dermatoscope available.<br>PCPs who were male and those >50 years old most likely to use dermatoscope (p=0.001).<br>52% of those with dermatoscopes used it more than once weekly.<br>54% of dermoscopy users had no formal dermoscopy training. | High Quality |
| Ferrandiz et al. (2017)[41] | RCT | Spain | RCT from 5 primary care centers that compared DA and cost-effectiveness of traditional teleconsultations (no dermoscopy) to teledermoscopic consultations. | Control:<br>Clinical Images:<br>47.1%/52.9%<br>57.3 (NR)<br>226 lesions<br><br>Intervention:<br>Clinical and dermoscopy images:<br>37.7%/62.3%<br>55.0 (NR)<br>228 lesions | Diagnostic accuracy and cost effectiveness<br>Control:<br>Clinical image:<br>Sensitivity: 86.6%<br>Specificity: 72.3%<br>PPV: 57.0%<br>NPV: 92.9%<br>Accuracy index: 79.20%<br><br>Intervention:<br>Clinical and dermoscopy images:<br>Sensitivity: 92.9%<br>Specificity: 96.2%<br>PPV: 84.4%<br>NPV: 98.2%<br>Accuracy index: 94.3%<br>Lower cost-effectiveness ratio (65.13 vs 80.84). | High Quality |

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|---|---|---|---|---|---|---|
| Grimaldi et al. (2009)[42] | DA | Italy | Sequential design DA of the PCPs' ability to diagnosis suspicious pigmented skin lesions with clinical observations vs dermoscopy vs teledermoscopy triage | Control:<br>Clinical exam<br><br>Intervention:<br>Dermoscopy<br><br>Teledermoscopy triage<br><br>All groups:<br>Sex and age NR<br>235 lesions | Diagnostic accuracy and morbidity measurements:<br>PCP clinical vs PCP dermoscopy: p<0.001, OR 0.35.<br>PCP clinical vs teledermoscopy triage: p<0.001, OR 0.18.<br>PCP dermoscopy vs teledermoscopy triage: p<0.05, OR 0.52. | High Quality |
| Koelink et al. (2014)[43] | RCT | Netherlands | Cluster RCT with PCP naked eye vs dermoscopy examination | Control:<br>Naked eye:<br>38.4%/61.6%<br>54.7 (NR)<br>230 lesions<br><br>Intervention:<br>Dermoscopy:<br>31.8%/68.2%<br>53.2 (NR)<br>207 lesions | Diagnostic accuracy, morbidity measurements, and cost effectiveness<br>Control:<br>Naked eye examination: 22.5% of MMs correctly diagnosed.<br><br>Intervention:<br>Dermoscopy examination: 61.5% of MMs correctly diagnosed.<br><br>OR of correct diagnosis in the intervention group vs control group = 1.51 (95% CI:0.96-2.37) p=0.07 (not statistically significant).<br><br>No significant difference in the incremental cost-effectiveness ratio. | Acceptable Quality |
| Livingstone et al. (2015)[44] | Case Series | UK | Prospective case series to examine the cost effectiveness, and patient satisfaction with expert diagnosis vs teledermoscopy referral | PCP patients<br>Sex and age NR | Cost effectiveness, time to diagnosis and treatment, and patient satisfaction:<br>Teledermatology referrals saved £12,460 over the 3-year period.<br>97 percent of patients rated themselves as satisfied/very satisfied.<br>7 days median wait for the photos to be taken and 1-2 weeks for results. | Acceptable Quality |

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| Menzies et al. (2009)[45] | SIT | Australia | SIT designed study where PCPs compared pigmented skin lesions using naked eye examinations vs dermoscopy vs short term sequential digital dermoscopy | Control:<br>Naked eye exams:<br>Sex and age NR<br>374 lesions<br><br>Interventions:<br>Dermoscopy:<br>Sex and age NR<br>374 lesions<br><br>Short term digital dermoscopy:<br>Sex and age NR<br>192 lesions | Diagnostic accuracy and morbidity measurements<br>Control:<br>Naked eye exam:<br>Sensitivity for MM: 37.5%<br>Specificity for MM: 84.6%<br>PPV for MM: 20.7%<br>NPV for MM: 92.7%<br><br>Interventions:<br>Dermoscopy:<br>Sensitivity for MM: 53.1%%<br>Specificity for MM: 89.0%<br>PPV for MM: 34.0%<br>NPV for MM: 94.7%<br><br>Short term sequential digital dermoscopy:<br>Sensitivity for MM: 71.9%<br>Specificity for MM: 86.6%<br>PPV for MM: 36.4%<br>NPV for MM: 94.7%<br><br>Overall<br>Increased sensitivity for MM and 63.5% in benign excised pigmented skin lesions. | High Quality |
| Moreon-Ramirez et al. (2006)[46] | DA | Spain | Sequential design DA study examining clinical only teledermatology consultations vs teledermatology consultations with dermoscopy images | Control:<br>Clinical only teledermatology consult<br><br>Intervention:<br>Teledermatology consult with dermoscopy images<br><br>All groups:<br>29.5%/70.5%<br>38.8 (1-73)<br>61 lesions | Diagnostic accuracy:<br>Sensitivity of the clinical only teledermatology consult and the teledermatology consult with dermoscopy images was 1 for both, whereas specificities were 0.65 and 0.78, respectively (P<0.05).<br>Diagnostic confidence level was higher for the teledermatology consults with dermoscopy images (4.75 vs. 4.14, P<0.05). | Acceptable Quality |
| Morris et al. (2017a)[47] | Survey | US | Descriptive cross-sectional survey of US family physicians to examine dermoscopy use | Family physicians in the US<br>58.4%/41.6%<br>40-49 (NR)<br>705 survey participants | Level of dermoscopy training/physician confidence with dermoscopy:<br>57.1% of respondents were either confident or very confident of recognizing malignant skin lesions.<br>8.3% of respondents currently use a dermatoscope, with 63.6% intending to start using a dermatoscope within the next year.<br>Respondents stated that time and training requirements to become proficient was the second biggest barrier in using a dermatoscope. | Low Quality |

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| Morris et al. (2017b)[48] | Survey | US | Descriptive cross-sectional survey of US medical providers (including physicians) to examine dermoscopy use | Primary and secondary care physicians in the US<br>65.3%/34.7%<br>age NR<br>1466 survey participants | Level of dermoscopy training/physician confidence with dermoscopy:<br>53.2 % of respondents were either confident or very confident of recognizing malignant skin lesions.<br>14.6% of respondents currently use a dermatoscope, with 51.8% intending to start using a dermatoscope within the next year.<br>Respondents stated that confidence in how to use a dermatoscope was a major barrier to using the device in their practice | Low Quality |
| Rodgers et al. (2016)[49] | DA | US | Sequential design DA evaluating pigmented skin lesions comparing Histology/expert opinion vs clinicians using the amalgamated dermoscopic algorithm | PCPs and dermatologists in the US<br>46.7%/53.3%<br>31-40 (NR)<br>5641 lesions | Diagnostic accuracy<br>Dermatologists:<br>Sensitivity: 94.8%<br>Specificity: 78.5%<br><br>Non-dermatologists:<br>Sensitivity: 93.7%<br>Specificity: 72.1%<br><br>>1 year dermoscopy experience:<br>Sensitivity: 95.4%<br>Specificity: 77.3%<br><br><1 year dermoscopy experience:<br>Sensitivity: 91.3%<br>Specificity 74.2% | Acceptable Quality |
| Rodgers et al. (2017)[50] | DA | US | Sequential design DA evaluating pigmented skin lesions comparing histology/expert opinion vs clinicians using the amalgamated dermoscopic algorithm vs asymmetry, color, variation rule vs the 3-point checklist | Primary and secondary care physicians in the US<br>46.7%/53.3%<br>31-40 (NR)<br>5646 lesions | Diagnostic accuracy:<br>The amalgamated dermoscopic algorithm:<br>Sensitivity 94%<br>Specificity: 75.5%<br><br>Asymmetry, color, variation rule:<br>Sensitivity 88.6%<br>Specificity: 78.6%<br><br>3-point checklist:<br>Sensitivity: 71.9%<br>Specificity: 81.4%<br><br>Untrained (using the amalgamated dermoscopic algorithm):<br>Sensitivity: 93.6%<br>Specificity: 69.0%<br><br>Trained (using amalgamated dermoscopic algorithm):<br>Sensitivity: 95.4%<br>Specificity: 73.2% | Acceptable Quality |

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| Rosendahl et al. (2012)[51] | Cohort | Australia | Prospective cohort study using the Skin Cancer Audit Research Database to determine the impact of dermoscopy use on diagnosis of melanoma by PCPs | Dedicated skin cancer practitioners:<br>11992 lesions<br><br>PCPs:<br>1942 lesions<br><br>High dermoscopy use:<br>17917 lesions<br><br>Medium dermoscopy use:<br>2657 lesions<br><br>Low dermoscopy use:<br>1093 lesions<br><br>All groups<br>Sex and age NR | Diagnostic accuracy and morbidity measurements:<br>Dedicated skin cancer practitioners:<br>MM number needed to treat: 8.5<br><br>PCPs:<br>MM number needed to treat: 17.0<br><br>High dermoscopy use:<br>MM number needed to treat: 8.9<br><br>Medium dermoscopy use:<br>MM number needed to treat: 10.9<br><br>Low dermoscopy use:<br>MM number needed to treat: 14.6 | High Quality |
| Secker et al. (2016)[52] | DA | Netherlands | Sequential design DA study comparing a PCP's ability to diagnosis pigmented skin lesions before and after dermoscopy training | Pretest (no dermoscopy training):<br><br>Integrated post-test (clinical and dermoscopic images with education):<br><br>All groups<br>48.2%/51.8%<br>45.2 (28-63)<br>20 lesions | Diagnostic accuracy and morbidity measurements:<br>Pretest (no dermoscopy training):<br>Sensitivity for MM: 49.0%<br>Specificity for MM: 75.0%<br><br>Integrated post-test (clinical and dermoscopic images with education):<br>Sensitivity for MM: 66.0%<br>Specificity for MM: 70.0%<br><br>Overall decrease in unnecessary excisions and referrals. | Acceptable Quality |
| Stratton et al. (2016)[53] | Survey | US | Online survey asking US nurse practitioners questions about knowledge and acceptance of mobile teledermoscopy | Nurse practitioners in the US<br>45.0%/55.0%<br>47 (6-84)<br>62 survey participants | Level of dermoscopy training/physician confidence with dermoscopy:<br>Few respondents stated that they have used teledermoscopy.<br>Respondents scored high on the following: perceiving teledermoscopy would have a positive impact on their practice, that it would be interesting to learn and easy to use, it would help with rapid and accurate diagnosis of skin cancers, and were willing to use if they received training. | Acceptable Quality |
| Van der Heijden et al. (2013)[54] | Cohort | Netherlands | Cohort study examining the diagnostic accuracy of face to face consult with a dermatologist vs Teledermoscopy consults with PCPs taking images of the same patients | Control:<br>Face-to face consult with dermatologist<br><br>Intervention:<br>Teledermoscopy referral from PCP<br><br>All groups:<br>45.0%/55.0%<br>47 (6-84)<br>76 lesions | Diagnostic accuracy:<br>Agreement face-to-face vs pathological diagnosis k=0.90 (almost perfect).<br>Agreement of teledermoscopy vs face-to-face diagnosis k=0.55–0.73 (moderate-substantial).<br>Agreement teledermoscopy vs pathological diagnosis k=0.41–0.63 (moderate). | High Quality |

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| Westerhoff et al. (2000)[55] | DA | Australia | PCP diagnosis of pigmented skin lesions without dermoscopy training vs with dermoscopy training before and after an educational intervention | Control:<br>PCPs with no dermoscopy training:<br><br>Intervention:<br>PCPs with dermoscopy training:<br><br>All groups<br>sex and age NR<br>100 lesions | Diagnostic accuracy:<br>Control:<br>No dermoscopy training:<br>Pretest:<br>Sensitivity: 52.9%<br>Specificity: 58.1%<br>Post-test:<br>Sensitivity 54.8%<br>Specificity: 55.8%<br><br>Intervention:<br>With dermoscopy training:<br>Pretest:<br>Sensitivity: 57.8%<br>Specificity: 55.5%<br>Post-test:<br>Sensitivity: 75.9%<br>Specificity: 57.8%<br><br>Significant improvement diagnosis sensitivity of MM with training between pretest and post-test ($p<0.05$). | High Quality |

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# Curriculum Vitae

## EDUCATION

**2019 – 2022** **Dermatology Residency (*Anticipated Completion June 2022)***
Texas Tech University Health Science Center, Lubbock, TX, USA

**2018 – 2019** **Internal Medicine Residency**
Preliminary Year
University of New Mexico School of Medicine, Albuquerque, NM, USA

**2017 – 2019** **Master of Public Health (MPH) (*Anticipated Graduation Dec 2019)***
Epidemiology Tract
University of Texas Medical Branch, Galveston, TX, USA
Master Thesis (In Progress): Evaluating the use of Dermoscopy in the Primary Care Setting in Improving Clinical Outcomes in the Treatment of Melanoma: A Systematic Review
GPA 4.00

**2008 - 2017** **Doctor of Medicine (M.D.)**
Honored 10 classes, High Passed 8 classes, Passed 2 classes
Alpha Omega Alpha Honor Medical Society Member (top 25% of class)
University of Texas Medical Branch, Galveston, TX, USA

**Doctor of Philosophy (Ph.D.)**
Cell and Molecular Biology
Doctoral Thesis: Role of the IKKβ/NF-κB Pathway in Alcoholism
GPA 3.95
Magma Cum Laude
University of Texas at Austin, Austin, TX, USA

**2004 - 2008** **Doctor of Pharmacy (PharmD.)**
**Registered Pharmacist (R.Ph.) in Wyoming and Texas**
GPA 3.57
Cum Laude
University of Wyoming, Laramie, WY, USA

**2003** **Health Science Curriculum**
GPA 4.00
University of Wyoming, Laramie, WY, USA

**1996 - 2001** **Bachelors of Science in Chemistry**
**Bachelors of Science in Biology**
**Minors: Math, Business Administration, and Physics**
Beta Beta Beta National Biological Honor Society
GPA 3.67

Cum Laude
Adams State College, Alamosa, CO, USA

**1998** **Health Science Curriculum**
GPA 4.00
Colorado State University, Fort Collins, CO, USA

**1992 - 1996** **High School Diploma (College preparatory)**
Valedictorian: GPA 4.125
Lovington High School, Lovington, NM, USA

## LEADERSHIP

**2017 – 2018** **Senior Co-Director, National Student Research Forum Meeting**
Helped organized a national-level research meeting at the University of Texas Medical Branch. Responsible for leading planning meetings, determining meeting schedule, screening potential abstracts, and recruiting speakers, presenters, judges, and volunteers

**2014 - 2017** **Director, Linares Learning and Training Center in Austin**
Founded the Austin, TX branch of the Linares Learning Center. Worked with local schools, homeschool organizations, and individual parents to provide educational workshops using evidence-based neuropsychological methodologies to improve reading and math skills in children and those with dyslexia or dyscalculia..

**2016 – 2017** **Planning Committee Member, American Physician Scientists Association (APSA) South Regional Conference**
Helped in general organization and meeting planning and was responsible for the poster/oral presentations sessions and the rewards ceremony for the APSA research meeting at University of Texas Medical Branch

**2010 - 2016** **Team Leader, Mobile Loaves and Fishes**
Led a team one day a month in preparing and delivering wholesome meals, clothing essentials, and hygiene products to the homeless in Austin, TX.

**2016** **Nomination Committee Member, Association of American Medical Colleges (AAMC) Humanism in Medicine Award**
Helped to organize and prepare the nomination packet for the University for Texas Medical Branch's faculty nominee.

**2013 – 2015** **Planning Committee Student Chair, Waggoner Center Advance Meeting**
Led a committee of students to organize and facilitate an alcohol and addiction research meeting at University of Texas at Austin for 3 years.

**2011 – 2015** **Manager, Waggoner Center Stereotaxic Laboratory**
Created a laboratory dedicated to precision delivery of experimental substances in the brains of rodents using stereotaxic equipment. Responsible for overall management of the laboratory, training personal, scheduling, upkeep/repair, and troubleshooting technical problems with experiments.

**2006 – 2015** **Graduate Research Mentor**
Mentored 3 PhD, 3 PharmD, and 6 undergraduate students at the University of Texas at Austin and University of Wyoming. Responsible for designing research projects for rotating graduate students and undergraduate research scholars. This included training them in laboratory techniques, supervising daily activities, teaching data analysis and critical thinking, and helping with poster and oral presentations for both local and international meetings.

**2012 - 2014** **Graduate Teaching Assistant, University of Texas at Austin**
Led discussion sessions, offered office hours for assistance to students, graded assignments, and assisted in teaching the course Neuropharmacology of Addiction Course at the University of Texas at Austin.

**2013** **Multimedia Coordinator, Research Society on Alcoholism**
Responsible for setting up/troubleshooting presentations for speakers at the annual Research Society on Alcoholism Scientific Meeting in Orlando, FL.

**2013** **Student Volunteer Coordinator, Texas Research Society on Alcoholism**
Led group of student volunteers in setting up and tearing down the venue for an alcohol and addiction research meeting in Austin, TX.

**2010 - 2013** **Recruitment Guide, MD/PhD Program**
Helped organize recruitment activities and led tours for the University of Texas Medical Branch/University of Texas at Austin Combined MD/PhD Program.

**2008 - 2010** **Scribe**
Prepared and edited lecture notes from medical school basic science curriculum at the University of Texas Medical Branch. This material was

subsequently collated and provided to first and second year medical students.

**2008 - 2010** **Small Group Leader, Christian Medical Association**
Led a men's weekly devotional meeting for University of Texas Medical Branch medical students, as well organized and participated in community service events and social activities.

**2006 - 2008** **Medical College Admission Test (MCAT) Course Director and Instructor**
Designed and taught the MCAT Prep Course for the Washington, Wyoming, Alaska, Montana and Idaho (WWAMI) Medical Education Program at the University of Wyoming.

**2001 - 2007** **Tutor, Student Success Services**
Tutored math and science classes for disadvantaged undergraduate students at the University of Wyoming and Laramie Community College.

**2001- 2007** **Instructor, Upward Bound**
Taught an afterschool program and tutored disadvantaged high school students in Laramie, WY.

**2001 - 2007** **Director, Student Learning Center**
Managed a walk-in university-sponsored learning center in the dormitories that focused on tutoring math and science classes for undergraduate students at the University of Wyoming.

**2002 - 2005** **Supplemental Instructor, University of Wyoming**
Taught Supplemental Instruction courses for General Biology I and II, General Chemistry I and II at the University of Wyoming. Responsibilities included attending regular lectures and providing biweekly review sessions on the course material.

**2004** **English Instructor, Campus Ventures**
Taught Intermediate and Advanced English classes at the University of San Luis Potosi in San Luis Potosi, Mexico during the summer.

**2001 - 2004** **Missions and Technology Director, Campus Ventures**
Established partnerships and organized community service projects/short term mission trips both domestically and internationally for college students from the University of Wyoming, Black Hills State, Northwest College, and Casper College. Also provided technological support, webpage management, and development of multimedia material for meetings and conferences.

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| **1996 - 2001** | **Tutor, Student Support Services**<br>Tutored math and science classes for disadvantaged undergraduate students at Adams State College. |

## HONORS

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| **2016 - 2019** | Alpha Omega Alpha Honor Medical Society--UTMB |
| **2017 – 2018** | Robert Bennett Scholarship-UTMB |
| **2017 – 2018** | Jason E. Perlman Memorial Fund-UTMB |
| **2017** | Dr. and Mrs. Seymour Fisher Academic Excellence Award in Neuroscience--UTMB |
| **2016 - 2017** | M. Jeanne Fairweather, M.D. Scholarship Award--UTMB |
| **2016 - 2017** | Robert Cantrell Feamster Foundation Award--UTMB |
| **2015 - 2016** | Humanism Award--UTMB |
| **2015** | Graduated Magna Cum Laude--University of Texas at Austin |
| **2012 - 2015** | Bruce Jones Alcohol and Addiction Research Fellowship--University of Texas at Austin |
| **2014** | National Institute of Health Volterra Travel Award |
| **2014** | Graduate Student Professional Development-University of Texas at Austin |
| **2012 - 2014** | Bruce Jones Travel Award-University of Texas at Austin |
| **2011 - 2012** | National Institute on Drug Abuse Training Grant Predoctoral Fellowship (T32 DA-07287)--University of Texas Medical Branch |
| **2008** | Graduated Cum Laude--University of Wyoming |
| **2007 - 2008** | John Baldwin Pharmacy Scholarship--University of Wyoming |

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| **2004 - 2008** | Dean’s List--University of Wyoming |
| **2006 - 2007** | Wyoming's Experimental Program to Stimulate Competitive Research (EPsCOR) Grant--University of Wyoming |
| **2001** | Graduated Cum Laude-- Adams State College |
| **2000 - 2001** | Beta Beta Beta National Biological Honor Society--Adams State College |
| **1996 - 2001** | Dean’s List--Adams State College |
| **1997 - 2000** | Rocky Mountain Athletic Conference Academic All-Conference |
| **1996 - 2000** | Woodard Memorial Scholarship--Adams State College |
| **1996 - 2000** | Elks National Foundation Most Valuable Student Award |
| **2000** | National Science Foundation Research Experience for Undergraduates (REU) Fellowship---Montana State University |
| **1999** | National Science Foundation REU Fellowship--Colorado State University |
| **1998** | McNair Scholar Fellowship--Colorado State University |
| **1996 - 1997** | Sam Walton Community Leader Award |
| **1996 - 1997** | Century Cable Communications’ Community Scholar |
| **1996 - 1997** | CRC Press LLC Freshman Chemist Achievement Award--Adams State College |
| **1996 - 1997** | National Association of Corrosion Engineers Award |
| **1995** | Eagle Scout--Boy Scouts of America |

## COMMUNITY SERVICE

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|---|---|
| **2014 – 2017** | **Linares Learning and Training Center in Austin, Volunteer Coordinator** |

Provided free educational workshops to homeschool organizations, and individual parents to improve reading and math skills in children and those with dyslexia or dyscalculia. (8 hrs/wk for 4 weeks each year).

**2013 – 2017** **Hospital Militar Regional (Regional Military Hospital), Volunteer**
Worked with local physicians to assist in providing healthcare for the families of the Mexican military in Irapuato, Mexico. (40 hr/wk for 1 week each year)

**2013 - 2017** **Arise Africa, Fundraiser Volunteer**
Helped to raise funds for orphaned children in Zambia to provide, food, shelter and educational needs (average of 1.0 hr/wk).

**2013 - 2016** **C.D Doyle Clinic, Student Provider Volunteer**
Helped to provide health care for the homeless community in Austin, TX. (4 hr once a month)

**2011 – 2016** **3M Half Marathon, Volunteer**
Staffed hydration stations and helped with clean-up for this race in Austin, TX (8 hrs/wk for 1 wk each year)

**2011 – 2016** **Community Emergency Response Team (CERT), Volunteer**
Assisted emergency responders during times of disaster and helped in prepare families in Central Texas to manage and respond effectively to disasters (average 1 hr/wk)

**2006 - 2017** **Special Olympics, Event Volunteer**
Assisted in running sporting events in multiple cities in both Texas and Wyoming. (8 hrs/wk twice each year)

**2010 - 2017** **Mobile Loaves and Fishes, Volunteer Team Leader**
Led a team in preparing and delivering wholesome meals, clothing essentials, and hygiene products to the homeless in Austin, TX (8 hrs/month).

**2010 – 2015** **UT-Austin Undergraduate Research Forums, Volunteer Judge**
Evaluated posters and oral presentations from undergraduate researchers (9 hrs/wk for 1 week each year)

**2009 - 2017** **Sabinas Casa Hogar (Sabinas Orphanage), Volunteer**

Helped with repairs and construction projects to improve the facilities at the orphanage in Monterrey, México (50 hrs/wk for 1 week each year).

**1996 - 2015** **Volunteer Tutor**
Tutored math, physics, statistics, science, pharmacy, and medical classes for 1st year medical students, pharmacy students, and undergraduate students at the following colleges: Adams State College, University of Wyoming, Laramie Community College, University of Texas Medical Branch, and University of Texas at Austin (average of 2 hrs/wk).

**2009 - 2010** **St. Vincent's Student Clinic, Volunteer**
Provided health care for uninsured patients in Galveston, TX (4 hrs once per month).

**2004 - 2008** **Downtown Clinic, Pharmacy Technician and Receptionist**
Assisted in patient intake and medication dispensing at free clinic for the uninsured in Laramie, WY (4 hrs/wk).

**2006 - 2007** **Downtown Clinic, Patient Assistance Program Manager**
Created and managed a database of pharmaceutical manufactures sponsored patient assistance drug programs and prepared the required paper to help uninsured patients get free/discounted medications (4 hrs/wk).

**1997 - 2001** **San Luis Valley Regional Science Fair, Judge and Event Coordinator**
Helped organize volunteers in setting up, tearing down, and judging the annual science fair for local primary and secondary schools in Alamosa, CO (16 hrs/wk for 1 wk per year).

**1996 - 2001** **Adams State College Chemistry Department, Magic Show Coordinator**
Organized and set up the annual educational science magic show for local primary schools in Alamosa, CO (12 hrs/wk for 1 wk per year)

**1996 - 1997** **Summer Science Program, Team Leader**
Taught elementary school children science during the summer program at local primary schools in Lovington, NM (20 hrs/wk for 2 wks per year)

## RESEARCH EXPERIENCE

**2010 - 2015** **Graduate Research Assistant**
UTMB/UT-Austin MD/PhD Program
Cell and Molecular Biology Graduate Program
University of Texas Medical Branch, Galveston, TX, and
University of Texas at Austin, Austin, TX.

PI's: Dr. Adron Harris, PhD and Dr. R. Dayne Mayfield, PhD, Dept. of Neuroscience
**Doctoral Thesis: Role of the IKKβ/NF-κB Pathway in Alcoholism**
(60 hrs/wk for 5 years)

**2010** **Graduate Research Assistant**
Cell and Molecular Biology Graduate Program
University of Texas at Austin, Austin, TX.
PI: Dr. Jon M Huibregtse, PhD, Dept. of Molecular Biology
**Understanding the Function of ISG15 Conjugation in Anti-Viral Proteins**
(60 hrs/wk for 3 months)

**2008** **Graduate Research Assistant**
Cell and Molecular Biology Graduate Program
University of Texas at Austin, Austin, TX.
PI: Dr. Marie Croyle, PhD, Dept. of Pharmacology
**Ebola Virus Vaccine Development**
(60 hrs/wk for 3 months)

**2006 - 2008** **Graduate Research Assistant**
Division of Social Work
University of Wyoming, Laramie, WY.
**Social Stress as an Inducer of Depressive-Type Behaviors in Female Rats**
PI: Dr. Gail Leedy, PhD, Division of Social Work
(15 hrs/wk)

**2003** **Research Assistant**
Arthropod-Borne and Infectious Diseases Laboratory
Colorado State University, Fort Collins, CO, USA
PI: Dr. H. Joel Hutcheson, PhD, Department of Microbiology
**Classification of Different Haplotypes of *Ixodes scapularis***
(20 hrs/wk for 3 months)

**2000** **Undergraduate Research Assistant**
Center for Biofilm Engineering
Montana State University, Bozeman, MT, USA
PI: Dr. Mark Pasmore, PhD, Department of Biochemistry
**Examination of Natural Microbial Control Agents for use in Medical Infection** (50 hrs/wk for 3 months)

**1999** **Undergraduate Research Assistant**
Department of Biochemistry
Colorado State University, Fort Collins, CO, USA

` PI: Dr. Robert Woody, PhD, Department of Biochemistry
**Circular Dichroism and Fluorescence Studies of the Pectate Lyase C Mutant**
(50 hrs/wk for 3 months)

**1998** **Undergraduate Research Assistant**
Department of Microbiology
Colorado State University, Fort Collins, CO, USA
PI: Dr. H. Joel Hutcheson, PhD, Department of Microbiology
**Classification of different haplotypes of *Ixodes scapularis***
(50 hrs/wk for 3 months)

## PUBLICATIONS

1. Nunez YO, **Truitt JM**, Gorini G, Ponomareva ON, Blednov YA, Harris RA, Mayfield RD. Positively correlated miRNA-mRNA regulatory networks in mouse frontal cortex during early stages of alcohol dependence. BMC Genomics. 2013 Oct 22;14:725. PMID: 24148570.

2. Warden A, **Truitt JM**, Merriman M, Ponomareva O, Jameson K, Ferguson LB, Mayfield, RD, Harris RA. Localization of PPAR isotypes in the adult mouse and human brain. Sci Rep. 2016 Jun 10;6:27618. PMID: 27283430.

3. **Truitt JM,** Blednov YA, Benavidez JM, Black M, Ponomareva O, Law J, Merriman M, Horani S, Jameson K, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ Reduces Ethanol Consumption in C57BL/6J Mice. eNeuro. 2016 Oct 31;3(5). pii: ENEURO.0256-16.2016. PMID: 27822501.

4. Harris RA, Bajo M, Bell RL, Blednov YA, Varodayan FP, **Truitt JM**, de Guglielmo G, Lasek AW, Logrip ML, Vendruscolo LF, Roberts AJ, Roberts E, George O, Mayfield J, Billiar TR, Hackam DJ, Mayfield RD, Koob GF, Roberto M, Homanics GE. Genetic and Pharmacologic Manipulation of TLR4 Has Minimal Impact on Ethanol Consumption in Rodents. J Neurosci. 2017 Feb 1;37(5):1139-1155. PMID: 27986929.

5. **Truitt JM,** Reichenberg JS, Sharghi KG, Sampson SM, Roenigk RK, Magid M. Isotretinoin: the ups are just as troubling as the downs. G Ital Dermatol Venereol. 2018 Aug;153(4):535-539. PMID: 29667796.

6. **Truitt JM**, Jameson K, Merriman M, Ponomareva O, Horani S, Clites B, Law J, Warden A, Harris RA, Mayfield RD. Brain region and cell type-specific expression profile of IKK isoforms in C57BL/6J mice. Pending journal selection. In preparation.

7. **Truitt JM,** Wilson, J, Jupiter, D. Evaluating the use of Dermoscopy in the Primary Care Setting in Improving Clinical Outcomes in the Treatment of Melanoma: A Systematic Review. Pending journal selection. In preparation.

8. Kibuule G, **Truitt JM**, Tarbox M. Modified Tzanck Smear to Evaluate for Herpes Simplex Virus. Pending journal selection. In preparation.

## POSTER PRESENTATIONS

1. **Truitt JM,** Smith, A, Sharp L, Tarbox M, Sturgeon A. Vancomycin Induced Acute Generalized Exanthematous Pustulosis. Texas Dermatological Society Fall Meeting. September 2019, San Antonio, TX.

2. Smith A. **Truitt JM**, Tarbox. Transfollicular Elimination of Sebaceous Glands in a Patient with Disseminated and Recurrent Infundibulofolliculitis. Texas Dermatological Society Fall Meeting. September 2019, San Antonio, TX.

3. **Truitt JM**, Wilson J, Yu X, and Jupiter D. Evaluating the use of Dermoscopy in the Primary Care Setting in Improving Clinical Outcomes in the Treatment of Melanoma: A Systematic Review. University of Texas Medical Branch Public Health Week Symposium. April 2018, Galveston, TX.

4. **Truitt JM**, Lowe A, Phillips R, Wilson J, and Kelly B. Histologically Aggressive Basal Cell Carcinoma is More Common on the Ear and Nose. 21st Annual Forum on Aging Poster Session. October 2017, Galveston, TX.

5. **Truitt JM**, Lowe A, Phillips R, Wilson J, and Kelly B. Histologically Aggressive Basal Cell Carcinoma is More Common on the Ear and Nose. Texas Dermatological Society Meeting. April 2017, Dallas, TX.

6. **Truitt JM**, Lowe A, Phillips R, Wilson J, and Kelly B. Histologically Aggressive Basal Cell Carcinoma is More Common on the Ear and Nose. University of Texas Medical Branch Public Health Week Symposium. April 2017, Galveston, TX.

7. **Truitt JM** and Lowe A. Histologically Aggressive Basal Cell Carcinoma is More Common on the Ear and Nose. American Academy of Dermatology Annual Meeting. March 2017, Orlando, FL.

8. **Truitt JM**, Blednov YA, Benavidez JM, Black M, Ponomareva O, Law J, Merriman M, Horani S, Jameson K, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ

reduces ethanol consumption in C57BL/6J mice. 38th Annual Research Society on Alcoholism Meeting, June 2015, San Antonio, TX.

9. Jameson K**, Truitt JM**, Merriman M, Horani S, Warden A, Ponomareva O, Harris RA, Mayfield RD. Brain region and cell type-specific expression profile of IKKβ in C57BL/6J mice. 38th Annual Research Society on Alcoholism Meeting. June 2015, San Antonio, TX.

10. Merriman M, **Truitt JM**, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Horani S, Lasek AW, Harris RA, Mayfield RD. Conditional knockdown of TLR4 signaling in the nucleus accumbens does not alter voluntary ethanol drinking. 38th Annual Research Society of Alcoholism Scientific Meeting, June 2015, San Antonio, TX.

11. Warden A**, Truitt JM**, Ponomareva O, Horani S, Jameson K, Merriman M, Mayfield RD, Harris RA. PPAR isoform distribution and cell type-specificity in C57BL/6J mice. 38th Annual Research Society of Alcoholism Scientific Meeting, June 2015, San Antonio, TX.

12. Jameson K, **Truitt JM**, Merriman M, Horani S, Warden A, Ponomareva O, Harris RA, Mayfield RD. IKK isoform expression in brain regions associated with alcohol dependence. College of Natural Sciences Undergraduate Research Forum. April 2015, Austin, TX.

13. Merriman M, Warden A, **Truitt JM**, Ponomareva O, Horani S, Jameson K, Mayfield RD, Harris RA. PPAR isoform expression in brain regions associated with alcohol dependence. College of Natural Sciences Undergraduate Research Forum. April 2015, Austin, TX.

14. Jameson K, **Truitt JM**, Merriman M, Horani S, Warden A, Ponomareva O, Harris RA, Mayfield RD. Brain region and cell type-specific expression profile of IKKβ in C57BL/6J mice. 3rd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2015, Austin, TX.

15. Merriman M, **Truitt JM**, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Horani S, Lasek AW, Harris RA, Mayfield RD. Selective knockdown of IKKβ in the central amygdala decreases voluntary ethanol drinking in mice. 3rd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2015, Austin, TX.

16. Clites BL, **Truitt JM**, Jameson K, Merriman M, Ponomareva O, Harris RA, Mayfield RD. Brain region and cell type-specific expression profile of IKKα and IKKγ in C57Bl/6J mice. 3rd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2015, Austin, TX.

17. **Truitt JM**, Horani S, Merriman M, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Lasek AW, Harris RA, Mayfield RD. Conditional knockdown of Tlr4 signaling in the nucleus accumbens does not alter voluntary ethanol drinking. 3rd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2015, Austin, TX.

18. **Truitt JM**, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Horani S, Merriman M, Lasek AW, Harris RA, Mayfield RD. Inhibition of Ikkβ reduces ethanol consumption in C57Bl/6J mice. 3rd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2015, Austin, TX.

19. Warden A, **Truitt JM**, Ponomareva O, Horani S, Jameson K, Merriman M, Mayfield RD, Harris RA. PPAR isoform distribution and cell-type specificity in C57Bl/6J mice. 3rd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2015, Austin, TX.

20. Jameson K, **Truitt JM**, Merriman M, Horani S, Warden A, Ponomareva O, Harris RA, Mayfield RD. Brain region and cell type-specific expression profile of IKKb in C57BL/6J mice. Texas Research Society on Alcoholism Annual Meeting. February 2015, Byran, TX.

21. **Truitt JM**, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Horani S, Merriman M, Lasek AW, Harris RA, Mayfield RD. Inhibition of Ikkβ reduces ethanol consumption in C57Bl/6J mice. Texas Research Society on Alcoholism Annual Meeting. February 2015, Byran, TX.

22. Clites BL, **Truitt JM**, Jameson K, Merriman M, Ponomareva O, Harris RA, Mayfield RD. Brain region and cell type-specific expression profile of IKKα and IKKγ in C57Bl/6J mice. Texas Research Society on Alcoholism Annual Meeting. February 2015, Byran, TX.

23. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Horani S, Merriman M, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. 37th Research Society on Alcoholism Annual Meeting. June 2014, Bellevue, WA.

24. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Horani S, Merriman M, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. Alcoholism and Stress: A Framework for Future Treatment Strategies Meeting. May 2014, Volterra, Italy.

25. Merriman M, **Truitt JM**, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Horani S, Lasek AW, Harris RA, Mayfield RD. The role of IKKβ in the central amygdala in voluntary ethanol drinking. Longhorn Research Bazaar. April 2014, Austin, TX.

26. Horani S, **Truitt JM** , Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Merriman M, Lasek AW, Harris RA, Mayfield RD. The role of TLR4 signaling in the nucleus accumbens in voluntary ethanol drinking. College of Natural Sciences Undergraduate Research Forum. April 2014, Austin, TX.

27. Horani S, **Truitt JM** , Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Merriman M, Lasek AW, Harris RA, Mayfield RD. The role of TLR4 signaling in the nucleus accumbens in voluntary ethanol drinking. 2nd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2014, Austin, TX.

28. Merriman M, **Truitt JM**, Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Horani S, Lasek AW, Harris RA, Mayfield RD. The role of IKKβ in the central amygdala in voluntary ethanol drinking. 2nd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2014, Austin, TX.

29. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Horani S, Merriman M, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. 2nd Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2014, Austin, TX.

30. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Horani S, Merriman M, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. Texas Research Society on Alcoholism Annual Meeting. February 2014. San Antonio, TX.

31. Horani S, **Truitt JM** , Blednov YA, Benavidez J, Black M, Ponomareva O, Law J, Merriman M, Lasek AW, Harris RA, Mayfield RD. The role of TLR4 signaling in the nucleus accumbens in voluntary ethanol drinking. Texas Research Society on Alcoholism Annual Meeting. February 2014. San Antonio, TX.

32. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. University of Texas System MD/PhD Retreat. September 2013. Austin, TX.

33. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Merriman M, Horani S, Jameson K, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. 36th Research Society on Alcoholism Annual Meeting. June 2013. Orlando, FL.

34. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. 1st Annual Waggoner Center for Alcohol and Addiction Research Advance. March 2013, Austin, TX.

35. **Truitt, JM**, Blednov, YA, Benavidez, JM, Black, M, Ponomareva O, Law J, Lasek AW, Harris RA, Mayfield RD. Inhibition of IKKβ reduces ethanol consumption in C57BL/6J mice. Texas Research Society on Alcoholism Annual Meeting. February 2013. Austin, TX.

36. Nunez Y., **Truitt JM**., Ponomareva O., Gorini G, Tiwari G., Blednov Y., Harris R., Mayfield R. Identification of alcohol-induced mirnomes in distinct areas of the mouse brain. 35th Research Society on Alcoholism Annual Meeting. June 2012. San Francisco, CA.

37. Nunez Y., **Truitt JM**., Blednov Y., Harris R., Mayfield R. Brain microRNA expression profiling in mouse model of high ethanol consumption. 34th Research Society on Alcoholism Annual Meeting. June 2011. Atlanta, GA.

38. **Truitt J**., Jost D., Barrows L., Leedy G. Social stress as an inducer of depressive-type behaviors in female rats. Society for Neuroscience Annual Meeting. November 2007. San Diego, CA.

39. **Truitt J**., Barrows L., Leedy G. Neurobiological Aspects of Postpartum Depression in Rats. Wyoming Undergraduate Research Day. April 2007. Laramie, WY.

40. **Truitt J**., Passmore M. Examination of Natural Microbial Control Agents for use in Medical Infections. Biofilm Undergraduate Research Day. August 2000.Bozeman, MT.

41. **Truitt J**., Woody R. Circular Dichroism and Fluorescence Studies of the Pectate Lyase C Mutant G280N. Colorado State University Undergraduate Research Day. August 1999. Fort Collins, CO.

42. **Truitt J**., Hutcheson J., Black W. Restriction enzyme patterns of the rDNA ITS are homogeneous among populations and mitochondrial haplotypes of *Ixodes scapularis*. McNair Conference. August 1998. Fort Collins, CO.

Permanent address: 4911 14th Street Lubbock, TX 79416

This dissertation was typed by Jay Michael Truitt.