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## RESEARCH ARTICLE

### THE CURRENT TRENDS OF AURICULAR ACUPUNCTURE RESEARCH IN THE UNITED STATES AND ITS FUTURE DIRECTION

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#### ABSTRACT

**Objective:** This review aimed to investigate the current trends of auricular acupuncture (AA) research in the U.S. and its future direction from recent journal publications. **Methods:** AA relevant articles published by authors from the U.S. were collected from PubMed database from 2014 to 2018. **Results:** The following categories were analyzed: 1) publication years, 2) AA topics, 3) article types, 4) research collaborators by country, 5) AA tools and combinations of other therapeutic methods with AA, 6) NADA protocol and BFA protocol, 7) p-values, 8) number of subjects, and 9) animal model experiments. Top four AA article topics in the U.S. were pain management, psychological disorders, addiction, and U.S. military health care. The journal article types were primarily clinical study, review, and research supported by the U.S. government. Other therapeutic methods combined with AA treatment were electroacupuncture, body acupuncture, guasha, tuina, relaxation technique, antiemetic medication, and botulinum toxin A injection. U.S. authors wrote articles in collaboration with authors mainly from China and Hong Kong. **Conclusions:** Recent AA research in the U.S. may underscore the current major health care needs and concerns in American society – pain management, psychological disorders, addiction, and military and veteran's health care. U.S. military department has supported AA research and clinical practice in order to respond to these health issues. Further AA research projects with international collaborators may advance in AA intervention.

#### INTRODUCTION

Within last five decades, the National Acupuncture Detoxification Association (NADA) protocol for drug addiction and Battlefield Acupuncture (BFA) protocol for the immediate pain relief are the most remarkable auricular acupuncture (AA) protocols developed in the U.S. [1,2]. The current opioid epidemic leads 115 Americans to opioid overdose deaths daily according to the Centers for Disease Control and Prevention [3]. To combat the worst drug crisis in U.S. history, U.S. government and health care system seeks non-pharmacological interventions for pain relief and substance use disorder (SUD) related to prescription and illicit opioids. Despite the historical presence of NADA and BFA protocols, AA has not been practiced in the public medical setting on a large scale yet. Extensive research on efficacies and mechanisms of AA can promote this integrative method of treatment on various ailments and disease prevention. This study aimed to investigate the current trends of AA research in the U.S. and its future direction from recent journal publications.

#### MATERIALS AND METHODS

**Data Sources and Searches:** The search was performed using PubMed (2013 - 2018) within two different periods of May 2018 and March 2019.

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The search keywords included *auricular AND acupuncture, ear AND acupuncture, and auriculotherapy.*

**Inclusion and Exclusion Criteria:** Total 2118 articles were collected through the keyword search on May 10, 2018. Exclusion criteria were duplicates ( $n=238$ ), irrelevant topics ( $n=46$ ), and non-U.S. and non-U.S. related authors ( $n=218$ ). Inclusion criteria were publication dated last five years ( $n=565$ ), original article ( $n=327$ ), relevant topics ( $n=281$ ), and U.S. and U.S. related authors ( $n=63$ ). In March 2019, the search procedure was conducted. Ninety-nine articles appeared in the search. Exclusion criteria were duplicates ( $n=26$ ), irrelevant topics ( $n=5$ ), and non-U.S. and non-U.S. related authors ( $n=54$ ). Inclusion criteria were publication dated between May 11, 2018 and December 31, 2018 ( $n=99$ ), original article ( $n=73$ ), relevant topics ( $n=68$ ), and U.S. and U.S. related authors ( $n=14$ ). Then four articles published in 2013 that were previously included in May 2018 were removed from the inclusion criteria in order to limit publication years to five years for the most recent investigation. Thus 74 articles were chosen for this study. All the articles were written in the English language.

**Data Synthesis and Analysis:** Data were collected from abstracts only, and all data were entered on Excel spreadsheets. PubMed search filters for *article types* and *Other Animals* under *species* were used to identify specific article types.

#### RESULTS

**Publication Years:** Publication dates ranged from 2014 to 2018. Table 1 demonstrates the citations of AA articles and

Table 1.

AA Articles	Publication year
Reilly, P. M., Buchanan, T. M., Vafides, C., Breakey, S., & Dykes, P. (2014). Auricular Acupuncture to Relieve Health Care Workers' Stress and Anxiety. <i>Dimensions of Critical Care Nursing</i> ,33(3), 151-159.	2014
Yeh, C. H., Chien, L., Huang, L. C., & Suen, L. K. (2014). Auricular Point Acupressure for Chronic Pain. <i>Holistic Nursing Practice</i> ,28(3), 184-194.	2014
Yeh, C. H., Chiang, Y. C., Hoffman, S. L., Liang, Z., & Klem, M. L. (2014). Efficacy of Auricular Therapy for Pain Management: A Systematic Review and Meta-Analysis. <i>Evidence-Based Complementary and Alternative Medicine</i> ,2014, 1-14.	2014
Leggit, J. C. (2014). Introduction of Integrative Health and Acupuncture to Pre-Clerkship Medical Students. <i>Medical Acupuncture</i> ,26(4), 226-229.	2014
Stuyt, E. B. (2014). Ear Acupuncture for Co-Occurring Substance Abuse and Borderline Personality Disorder: An Aid to Encourage Treatment Retention and Tobacco Cessation. <i>Acupuncture in Medicine</i> ,32(4), 318-324.	2014
Yin, J., Kuang, J., Chandalia, M., Tuvdendorj, D., & Tumurbaatar, B. (2014). Hypoglycemic effects and mechanisms of electroacupuncture on insulin resistance. <i>American Journal of Physiology-Regulatory, Integrative and Comparative Physiology</i> ,307(3).	2014
Sforzo, G. A., Kaye, M., Ayers, G. D., Talbert, B., & Hill, M. (2014). Effective Tobacco Cessation via Health Coaching: An Institutional Case Report. <i>Global Advances in Health and Medicine</i> ,3(5), 37-44.	2014
Li, S., Zhai, X., Rong, P., McCabe, M. F., & Zhao, J. (2014). Transcutaneous Auricular Vagus Nerve Stimulation Triggers Melatonin Secretion and Is Antidepressive in Zucker Diabetic Fatty Rats. <i>PLoS ONE</i> ,9(10).	2014
Carter K, &Olshan-Perlmutter M. (2014) NADA protocol: integrative acupuncture in addictions. <i>Journal of Addictions Nursing</i> ,25(4), 188-189	2014
Li, S., Zhai, X., Rong, P., McCabe, M. F., & Wang, X. (2014). Therapeutic Effect of Vagus Nerve Stimulation on Depressive-Like Behavior, Hyperglycemia and Insulin Receptor Expression in Zucker Fatty Rats. <i>PLoS ONE</i> ,9(11).	2014
Li, H., Hu, S., Zhang, J., Zhou, J., & Ran, H. (2014). Effects and Mechanisms of Auricular Electroacupuncture on Visceral Pain Induced by Colorectal Distension in Conscious Rats. <i>Acupuncture in Medicine</i> ,32(6), 472-477.	2014
Zhang, Z., Yin, J., & Chen, J. D. (2015). Ameliorating Effects of Auricular Electroacupuncture on Rectal Distention-Induced Gastric Dysrhythmias in Rats. <i>Plos One</i> ,10(2).	2015
Otjen, J. P., Mallon, K., & Brown, J. C. (2015). Acupressure magnets: A possible MRI hazard. <i>Journal of Magnetic Resonance Imaging</i> ,41(3), 858-860.	2015
King, H. C., Spence, D. L., Hickey, A. H., Sargent, P., & Elesh, R. (2015). Auricular Acupuncture for Sleep Disturbance in Veterans With Post-Traumatic Stress Disorder: A Feasibility Study. <i>Military Medicine</i> ,180(5), 582-590.	2015
Suen, L. K., Yeh, C. H., Lee, W. K., Chu, W. L., & Loo, J. F. (2015). Association of auricular reflective points and the status of lower urinary tract symptoms in aging males. <i>The Aging Male</i> ,18(3), 149-156.	2015
Yeh, C. H., Chien, L., Chiang, Y. C., Ren, D., & Suen, L. K. (2015). Auricular Point Acupressure as an Adjunct Analgesic Treatment for Cancer Patients: A Feasibility Study. <i>Pain Management Nursing</i> ,16(3), 285-293.	2015
Yeh, C. H., Suen, L. K., Chien, L., Margolis, L., & Liang, Z. (2015). Day-to-Day Changes of Auricular Point Acupressure to Manage Chronic Low Back Pain: A 29-day Randomized Controlled Study. <i>Pain Medicine</i> ,16(10), 1857-1869.	2015
Carter, K., & Olshan-Perlmutter, M. (2015). Impulsivity and Stillness: NADA, Pharmaceuticals, and Psychotherapy in Substance Use and Other DSM 5 Disorders. <i>Behavioral Sciences</i> ,5(4), 537-546.	2015
Hull A, Holliday SB, Eickhoff C, Rose-Boyce M, & Sullivan P. (2015). The Integrative Health and Wellness Program: Development and Use of a Complementary and Alternative Medicine Clinic for Veterans. <i>Alternative Therapies In Health And Medicine</i> ,21(6), 12-21.	2015
Moss, D. A., & Crawford, P. (2015). Ear Acupuncture for Acute Sore Throat: A Randomized Controlled Trial. <i>The Journal of the American Board of Family Medicine</i> ,28(6), 697-705.	2015
Li, H., Yin, J., Zhang, Z., Winston, J. H., & Shi, X. (2015). Auricular vagal nerve stimulation ameliorates burn-induced gastric dysmotility via sympathetic-COX-2 pathways in rats. <i>Neurogastroenterology &amp; Motility</i> ,28(1), 36-42.	2016
Fang, J., Rong, P., Hong, Y., Fan, Y., & Liu, J. (2016). Transcutaneous Vagus Nerve Stimulation Modulates Default Mode Network in Major Depressive Disorder. <i>Biological Psychiatry</i> , 79(4), 266-273.	2016
Guthrie RM, Chorba R. (2016). Physical Therapy Treatment Of Chronic Neck Pain A Discussion And Case Study: Using Dry Needling And Battlefield Acupuncture. <i>Journal of Special Operations Medicine</i> , 16(1), 1-5.	2016
Jonas, W. B., Bellanti, D. M., Paat, C. F., Boyd, C. C., & Duncan, A. (2016). A Randomized Exploratory Study to Evaluate Two Acupuncture Methods for the Treatment of Headaches Associated with Traumatic Brain Injury. <i>Medical Acupuncture</i> ,28(3), 113-130.	2016
Kattalai Kailasam V, Anand P, &Melyan Z. (2016) Establishing an animal model for National Acupuncture Detoxification Association (NADA) auricular acupuncture protocol. <i>Neuroscience Letters</i> ,624, 29-33.	2016
Suen, L. K., Yeh, C. H., & Yeung, S. K. (2016). Using auriculotherapy for osteoarthritic knee among elders: A double-blinded randomised feasibility study. <i>BMC Complementary and Alternative Medicine</i> ,16(1).	2016
Huang, W., Halpin, S., & Perkins, M. (2016). A case series of auricular acupuncture in a veteran's population using a revised auricular mapping-diagnostic paradigm (RAMP-uP). <i>Complementary Therapies in Medicine</i> , 27, 130-136.	2016
King, C. H., Moore, L. C., & Spence, C. D. (2016). Exploring Self-Reported Benefits of Auricular Acupuncture Among Veterans With Posttraumatic Stress Disorder. <i>Journal of Holistic Nursing</i> ,34(3), 291-299.	2016
Lapaglia, D., Bryant, K., & Serafini, K. (2016). Implementation of the National Acupuncture Detoxification Association Protocol in a Community Mental Health Setting. <i>The Journal of Alternative and Complementary Medicine</i> ,22(9), 729-731.	2016
Walker, P. H., Pock, A., Ling, C. G., Kwon, K. N., & Vaughan, M. (2016). Battlefield acupuncture: Opening the door for acupuncture in Department of Defense/Veterans Administration health care. <i>Nursing Outlook</i> ,64(5), 491-498.	2016
Yeh, C. H., Chien, L., Lin, W., Bovbjerg, D. H., & Londen, G. V. (2016). Pilot Randomized Controlled Trial of Auricular Point Acupressure to Manage Symptom Clusters of Pain, Fatigue, and Disturbed Sleep in Breast Cancer Patients. <i>Cancer Nursing</i> ,39(5), 402-410.	2016
Liu, J., Fang, J., Wang, Z., Rong, P., & Hong, Y. (2016). Transcutaneous vagus nerve stimulation modulates amygdala functional connectivity in patients with depression. <i>Journal of Affective Disorders</i> ,205, 319-326.	2016
Tsai, S., Fox, L. M., Murakami, M., & Tsung, J. W. (2016). Auricular Acupuncture in Emergency Department Treatment of Acute Pain. <i>Annals of Emergency Medicine</i> ,68(5), 583-585.	2016
Baker, T. E., & Chang, G. (2016). The use of auricular acupuncture in opioid use disorder: A systematic literature review. <i>The American Journal on Addictions</i> ,25(8), 592-602.	2016
Fang, J., Egorova, N., Rong, P., Liu, J., & Hong, Y. (2016). Early cortical biomarkers of longitudinal transcutaneous vagus nerve stimulation treatment success in depression. <i>NeuroImage: Clinical</i> ,14, 105-111.	2016
Stuyt, E. B., & Voyles, C. (2016). The National Acupuncture Detoxification Association protocol, auricular acupuncture to support patients with substance abuse and behavioral health disorders: Current perspectives. <i>Substance Abuse and Rehabilitation, Volume 7</i> , 169-180.	2016
Federman, D. G., & Gunderson, C. G. (2017). Battlefield Acupuncture: Is It Ready for Widespread Dissemination? <i>Southern Medical Journal</i> ,110(1), 55-57.	2017
Murakami, M., Fox, L., & Dijkers, M. P. (2017). Ear Acupuncture for Immediate Pain Relief—A Systematic Review and Meta-Analysis of Randomized Controlled Trials. <i>Pain Medicine</i> ,18(3), 551-564.	2017
Zhou, J., Li, S., Wang, Y., Lei, Y., & Foreman, R. D. (2017). Effects and mechanisms of auricular electroacupuncture on gastric hypersensitivity in a rodent model of functional dyspepsia. <i>Plos One</i> ,12(3).	2017

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- Madsen, C., Patel, A., Vaughan, M., & Koehlmoos, T. (2018). Use of Acupuncture in the United States Military Healthcare System. *Medical Acupuncture*,30(1), 33-38.
- Kong, J., Fang, J., Park, J., Li, S., & Rong, P. (2018). Treating Depression with Transcutaneous Auricular Vagus Nerve Stimulation: State of the Art and Future Perspectives. *Frontiers in Psychiatry*,9.
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- Niemtzow, R., Baxter, J., Gallagher, R. M., Pock, A., & Calabria, K. (2018). Building Capacity for Complementary and Integrative Medicine Through a Large, Cross-Agency, Acupuncture Training Program: Lessons Learned from a Military Health System and Veterans Health Administration Joint Initiative Project. *Military Medicine*,183(11-12).

years of publication. The number of publications was found:  $n=11$  in 2014,  $n=9$  in 2015,  $n=16$  in 2016,  $n=11$  in 2017,  $n=26$  in 2018.

**AA Topics:** Pain management was the largest AA topic category ( $n=27$ ) followed by psychological disorders ( $n=13$ ). Addiction category comprised substance/opioid use disorder ( $n=7$ ), smoking cessation ( $n=1$ ) and food ( $n=1$ ). Other topic categories were AA use in the U.S. military/veteran health care system ( $n=8$ ), AA theory ( $n=4$ ), AA education ( $n=4$ ), AA

mechanism ( $n=4$ ), postoperative care ( $n=3$ ), endocrinological disorders ( $n=3$ ), gastroenterological disorders ( $n=2$ ), dermatological disorders ( $n=2$ ), urological disorders ( $n=1$ ), neurological disorders ( $n=1$ ), AA magnet bead possible MRI hazard ( $n=1$ ). Meanwhile, seven articles contained two topics [4-10], and one articles had three topics [11]. See Figure 1.

**Article Types:** With the PubMed article type filter function, twenty-seven articles were classified into five following article types: 41% ( $n=11$ ) clinical studies, 22% ( $n=6$ ) reviews, 18%

( $n=5$ ) research supported by U.S. government, 15% ( $n=4$ ) case report, and 4% ( $n=1$ ) historical article. One article was a clinical study supported by the U.S. government [12].

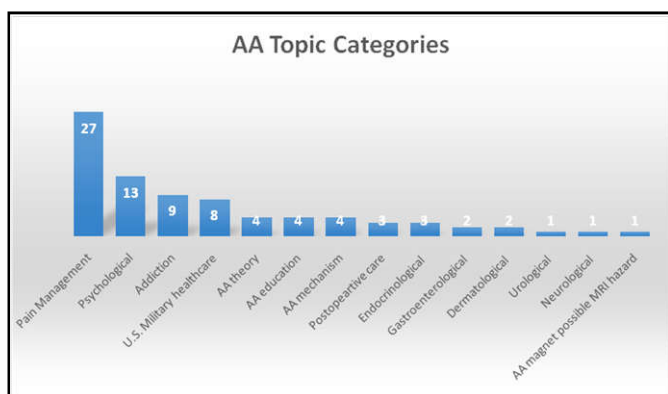


Figure 1.

**Research Collaborators by Country:** Seventy-one percent of the selected articles ( $n=52$ ) were written by authors from U.S. institutions. Subsequently, the remaining articles, 29% ( $n=21$ ), were jointly written by authors from one or more non-U.S. countries in addition to U.S. authors. Among these 21 articles, 62% ( $n=13$ ) included authors from institutions in China, 14% ( $n=3$ ) from Hong Kong, 5% ( $n=1$ ) from Australia, Austria, China, Canada and France, 5% ( $n=1$ ) from Australia, 5% ( $n=1$ ) from Germany, 5% ( $n=1$ ) from Hong Kong and Taiwan, and 5% ( $n=1$ ) from South Korea. See Figure 2.



Figure 2.

**AA Tools and Combinations of Other Therapeutic Methods with AA:** One study taped vaccaria seeds (wang bu liu xing in Chinese herbological term) on AA points. Golden needles were used for AA treatment on pediatric migraines. Six studies stated the use of electrical stimulator on auricular vagal nerve area while electric stimulation was applied to specific AA points in three studies. Five studies examined combinations of other therapeutic methods with AA: 1) body acupuncture, 2) relaxation technique combined with AA electric stimulation, 3) body acupuncture, guasha, and tuina, 4) Antiemetic medication for postoperative nausea and vomiting, and 5) Botulinum toxin A injection for pain relief.

**NADA Protocol and BFA Protocol:** Eleven studies analyzed the NADA protocol. Nineteen studies, including one on modified BFA protocol [13], evaluated the BFA protocol. These articles represented 41% ( $n=30$ ) of the entire selected articles.

**P-Value:** P-values were reported in 15 abstracts. One research study refuted the hypoglycemic effects of AA by elevating

postprandial glucose level ( $P < 0.03$ ) whereas body electroacupuncture significantly lowered glucose level ( $P < 0.01$ ) [14]. On the contrary, 14 research studies showed statistically significant findings which supported the hypotheses – positive therapeutic effects of AA.

**Number of Subjects:** Thirty-three studies mentioned numbers of research subjects that ranged from one to 753. Twenty-one studies had equal to and less than 50 subjects. The remaining 14 studies had over 50 subjects, including nine studies with equal to or more than 100.

**Animal Model Experiments:** Animal model experiments on AA were identified in nine articles. A mouse experiment was conducted in one study. A rat model was mentioned in seven studies. One article did not specify an animal used for research.

## DISCUSSION

The primary findings of this study revealed that the major AA article topics in the U.S. (pain management, psychological disorders, addiction, and the U.S. military health care), journal article types, adjunct therapies, and international researcher involvement, especially collaborators associated with academic institutions in China. In particular, the top AA topics must have reflected the current urgent health care needs and concerns in America. AA as a non-pharmacological intervention of pain relief and mental illnesses such as depression, anxiety, insomnia, and drug-induced psychiatric disorders might ease the widespread of prescription opioid use disorders. All these health issues could be applied to not only the general public but also active-duty military personnel and veterans. A current lack of mental health care for veterans suffering from posttraumatic stress disorders, SUD, and other mental disorders, led them to a high suicide rate and homelessness [15]. Conventional treatment approach has not been affordable and effective in the long run. Upon overwhelming treatment demands and rising numbers of veteran patients, the federal government has been progressively supporting AA research and treatment. AA training programs among U.S. military and veteran health care facilities became more available ( $n=7$ , U.S. military topics). BFA appeared disseminated due to the simple and easy treatment method and practice by the BFA developer, a former Air Force colonel and MD, Dr. Richard Niemtzw in 2001 [2]. Nonetheless, the content and quality of the training must be carefully evaluated to address any shortage and maximize the efficacy of AA. These findings suggested that AA also treat a broad range of pathological disorders that are endocrinological, gastroenterological, dermatological, urological, and neurological.

The evaluation of articles published between 2014 and 2018 highlighted the increasing number of AA publications. The recent year 2018's AA publications reached 26 more than double last year's. AA research has quickly gained much importance in the recent year and was observed to lean towards evidence-based medicine. Clinical study (41%) was a leading journal article type followed by review (22%). Fifteen studies showed statistical findings with p-values. The use of over 100 research subjects and animal models underlined the progress of AA clinical trials and lab experiments. In addition, 12 articles suggested that the combination of AA and other modalities such as body acupuncture and relaxation technique enhanced the efficacy of AA. Furthermore, the international

collaboration of AA research contributed to the publications remarkably. Sixty-two percent ( $n=13$ ) of international authors were from China followed by authors from Hong Kong (14%,  $n=3$ ). Both China and Hong Kong have a rich heritage of acupuncture and provide more acupuncture treatment for the general population than any other countries. Addiction treatment with AA was discovered by a neurosurgeon Dr. Hsiang Lai Wen of Hong Kong in 1972 [16]. China and Hong Kong may be able to offer the potential AA clinical research collaboration opportunity to explore AA field of medicine. Despite ongoing studies on NADA protocol and BFA protocol in the U.S., not all of NADA and BFA practitioners may be familiar with the traditional Chinese medicine (TCM) theory for their clinical application. Emerging two different medical theories in AA can benefit an individualized treatment approach for various pathological conditions [17]. China has established the integrative medicine model of AA since the inverted fetus auricular map was published by Dr. P. Nogier of France in 1957 [18,19]. Some pre-clerkship medical students in the U.S. had a privilege to be trained with integrative health and acupuncture education, including AA education, added to their curriculum [20]. This new educational movement implies that AA treatment becomes increasingly available to the general public near future. A correlation between AA points and auricular vagal nerve explained the AA mechanism; multiple research studies focused onelectroacupuncture on auricular vagal nerve area as a treatment approach. These investigations, however, were limited to PubMed search engine results and abstracts. It was difficult to identify potential biases and quality of studies by relying on abstracts only. P-value was statistically significant, but it was uncertain whether these selected studies were clinically significant. Further research is necessary to interpret the data with full articles for detailed descriptions. Although the number of publications on AA is smaller compared to other academic journal articles, it is expected to rise in the coming years. The efficacy of AA and cost-effective approach are known so that the expansion of AA training and care in the U.S. military and veteran health care facilities is extrapolated. Hopefully, such a pattern can be quickly replicated in private and public clinical settings to serve a large number of population suffering from emotional and physical pains as well as SUD.

## Conclusions

Recent AA research in the U.S. may underscore the current major health care needs and concerns in American society – pain management, psychological disorders, addiction, and military and veteran’s health care. U.S. military department has supported AA research and clinical practice in order to respond to these health issues. Further AA research projects with international collaborators may advance in AA intervention.

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