

# *Tennessee emergency hand care distributions and disparities*

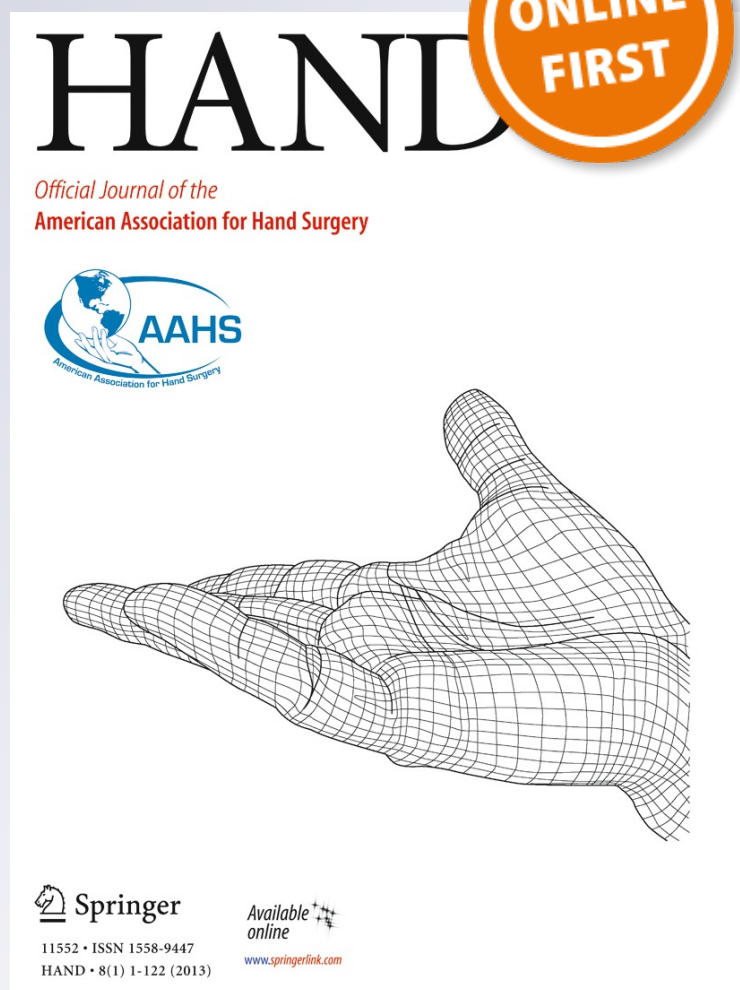
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**HAND**

ISSN 1558-9447

**HAND**

DOI 10.1007/s11552-013-9503-z



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# Tennessee emergency hand care distributions and disparities

## Emergent hand care disparities

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### Abstract

**Background** Hand trauma is the most frequently treated injury in emergency departments, but presently there is a crisis of insufficient emergency coverage. This study evaluates the discrepancy of emergent and elective hand care trends based on socioeconomic factors in the state of Tennessee.

**Methods** We identified 119 hospitals in Tennessee that contained operating and emergency room facilities. Of these, 111 hospitals participated in a survey to determine the availability of elective and emergency hand surgery. Wilcoxon rank-sum test or permutation chi-square test and logistic regression were used to analyze reported measures.

**Results** Our results revealed that hospitals in counties with the lowest per capita income and median household income are less likely to have hand specialists or offer hand call. There are also significantly fewer hospitals that have hand specialists and offer hand call that are located in medically underserved areas. In the state of TN, level 1 trauma facilities are required by the Tennessee Department of Health to have staffed hand specialists and 24/7 hand call. Our study revealed that while 7/8 (87.5 %) level 1 trauma facilities have hand specialists, only 2/8 (25 %) provide 24/7 hand specialist call.

**Conclusion** Our results strongly suggest the presence of a health care disparity for hand trauma in counties with a low income and in medically underserved areas.

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**Keywords** Tennessee · Hand surgery · Disparity ·  
Disparities · Income · Medically underserved area · Rural ·  
Metropolitan · Elective · EMTALA · Trauma · Emergency ·  
Distributions · Hand call · Hand specialist · Hand surgeon

### Introduction

Hand trauma has been reported as the most frequently treated nonlethal injury in emergency departments (ED) throughout the USA. Wrist, hand, and finger injuries represent 11.6 % of all traumatic injuries treated in the ED, totaling 4.6 million visits in 2007 [12]. Of all nonfatal, work-related electrical injuries, 34.9 % involve the hands, fingers, or wrist [7]. In 2010, 29 % percent of work-related injuries resulting from contact with objects or equipment consisted of cuts, lacerations, or punctures. Of all work-related contact injuries, 26 % involved damage to a finger or fingernail; 15 % involved the head; and 10 % involved the hands (excluding fingers) and feet (including toes) [5].

Despite the demand for emergency hand care around the country, many regions are left with insufficient coverage

centering on the limited availability of on-call hand specialists. Hand specialists have received specialized additional training in the treatment of hand problems beyond their board-certified specialty training in orthopedic surgery, plastic surgery, or general surgery and are offered a Certificate in the Subspecialty of Surgery of the Hand [4, 18]. Nationally, 73 % of emergency departments report inadequate on-call coverage by specialist physicians across all fields [2]. According to hospital executives, orthopedic surgeons, plastic surgeons, and hand surgeons are particularly difficult to secure for on-call coverage [6]. According to a national hospital survey, 80 % of respondent hospitals reported inadequate hand surgery coverage [14]. A survey study conducted across three major cities in North Florida found discrepancies between availability of trained hand surgeons and emergency hand surgery. This study suggests that the majority of hand surgeons from North Florida are reducing their involvement in emergency care and shifting their practices to elective ambulatory centers [6]. This shift to elective ambulatory centers allows increased control of scheduling without the responsibility of on-call availability. The state of Tennessee is not immune to this situation either. Our previous study showed that while elective hand care is widely available in Tennessee, there are large gaps for emergency hand care availability. We also found a correlation between insurance payer charges and hand specialist availability [11]. However, there may be other factors such as hospital structure and the socioeconomic area surrounding the hospital that contribute to the absence of hand specialist emergency care over large geographical areas in Tennessee.

Decreased access to on-call specialists can compromise the quality of emergency care for patients. This has contributed to increased wait times and increased transfer rates for distant care of urgent or emergent intervention [10, 14]. It has been reported that over half of all hospital sentinel events involving death or permanent disability are due to delays in treatment in EDs with 21 % of these cases directly attributable to shortages of specialist physicians [2]. More than half of all incoming patient transfers to level I trauma centers, the highest level of acute trauma management, are due to the lack of on-call specialist coverage at the referring hospital [14]. Although the health care system does not require every specialty to be present at every hospital, patients do need timely access to treatment [2]. Any transfer could potentially incur a delay in treatment, either while attempts are made to arrange the transfer or during the travel to the accepting hospital. In addition, any significant distance between a patient's home and hospital of treatment could potentially disrupt and stifle follow-up care and hand therapy.

Types of hand injuries that require immediate diagnosis include: vascular injuries that cause hemorrhage, vascular injuries that compromise perfusion, compartment syndromes, traumatic amputations with potential for reimplantation, burns, high-pressure injuries, and self-inflicted injuries [15].

Failure to diagnose, manage, and rehabilitate hand injuries has the potential to result in permanent disability in patients suffering from these injuries [20].

Our previous study found a discrepancy between elective and emergency hand care across Tennessee. While elective hand care was available at most of the hospitals (75 %), only 58 % of hospitals offered basic emergency hand services [11]. Additionally, types of insurance payer charges were correlated with the presence of hand specialists for a given hospital. Based on these findings, the purpose of the current study is to investigate other factors that may influence the presence and discrepancies of hand specialist-derived emergency and elective hand care in Tennessee. The factors chosen for comparison of hand care were: hospital ownership, teaching status, trauma level designation, county per capita income (PCI), county median household income (MHI), county demographic, hospital location in a rural or metropolitan area, and hospital location in a medically underserved area (MUA). These factors were chosen because they directly affect the services typically offered and the population generally served by a hospital [14]. Our goal was to determine if these factors correlated with emergency hand care availability. We hypothesize that medically underserved areas and areas with low income will have a lower percentage of hand specialists and available hand call.

## Methods

In our previous study (2010), all hospitals in Tennessee capable of accommodating hand trauma (those with both emergency department and operating room facilities) were surveyed ( $n=119$ ). The patient capacity of these 119 hospitals ranged from 12 to 927 licensed beds. One hundred eleven (111 hospitals, 93 % of total contacted) participated in the survey. Using hand specialist presence, hand call availability, and elective surgery availability hospital data from this study, we assessed availability based on our new data for hospital ownership, teaching status, trauma level designation, per capita income, median household income, hospital location in a medically underserved area, and hospital location in a rural or metropolitan area. To simplify data collection, we accepted the surveyed hospital personnel's impression of their surgeon to delineate whether or not they are hand specialists.

Patient demographics, county median household income, county per capita income, and hospital geographic data were gathered from the 2010 Census taken from the U.S. Census Bureau website [19]. Hospital teaching and ownership statuses were obtained from the American Hospitals Directory and American Association of Medical Colleges websites [1, 3]. Trauma level hospital designations were obtained from the Tennessee Department of Health Trauma Care Advisory Council [16]. Medically underserved area information for

**Table 1** Comparison of hand specialist versus No hand specialist

	<i>N</i>	Hand specialist <i>N</i> =41	No hand specialist <i>N</i> =70	<i>p</i> value
Teaching hospital	111			<0.001 <sup>a</sup>
Yes		24 % $\frac{10}{41}$	0 % $\frac{0}{70}$	
No		76 % $\frac{31}{41}$	100 % $\frac{70}{70}$	
Trauma facilities level	111			0.006 <sup>a</sup>
Level 1		17 % $\frac{7}{41}$	1 % $\frac{1}{70}$	
Levels 2–4		83 % $\frac{34}{41}$	99 % $\frac{69}{70}$	
Medically underserved area	111			<0.001 <sup>a</sup>
No		66 % $\frac{27}{41}$	26 % $\frac{18}{70}$	
Yes		34 % $\frac{14}{41}$	74 % $\frac{52}{70}$	
Area	111			<0.001 <sup>a</sup>
Metropolitan area		89 % $\frac{33}{41}$	31 % $\frac{22}{70}$	
Rural area		20 % $\frac{8}{41}$	69 % $\frac{48}{70}$	
White population	111			<0.001 <sup>a</sup>
>50 %		29 % $\frac{12}{41}$	64 % $\frac{45}{70}$	
<50 %		71 % $\frac{29}{41}$	36 % $\frac{25}{70}$	
Ownership	111			0.21 <sup>a</sup>
Government		15 % $\frac{6}{41}$	24 % $\frac{17}{70}$	
Proprietary		32 % $\frac{13}{41}$	39 % $\frac{27}{70}$	
Voluntary		54 % $\frac{22}{41}$	37 % $\frac{26}{70}$	
Per capita income	111			<0.001 <sup>a</sup>
<\$20K		7 % $\frac{3}{41}$	51 % $\frac{36}{70}$	
Between \$20K and \$25K		29 % $\frac{12}{41}$	34 % $\frac{24}{70}$	
>\$25K		63 % $\frac{26}{41}$	14 % $\frac{10}{70}$	
Median household income	111			<0.001 <sup>a</sup>
<\$37K		7 % $\frac{3}{41}$	49 % $\frac{34}{70}$	
Between \$37K and \$44.75K		39 % $\frac{16}{41}$	37 % $\frac{26}{70}$	
>\$44.75K		54 % $\frac{22}{41}$	14 % $\frac{10}{70}$	
Per capita income	111	24,114 25,002 27,349 (25,408±3,664)	18,183 19,892 21,932 (20,464±2,920)	<0.001 <sup>b</sup>
Median household income	111	41,256 45,408 46,278 (45,591±8,319)	33,972 37,503 42,896 (38,807±6,663)	<0.001 <sup>b</sup>
White population	111	58 75 87 (71±19)	79 90 94 (82±19)	<0.001 <sup>b</sup>

Note: *a*, *b*, *c* represent the lower quartile *a*, the median *b*, and the upper quartile *c* for continuous variables.  $x \pm s$  represents  $X \pm 1$  SD  
*N* is the number of non-missing values

<sup>a</sup>Permutation chi-square test

<sup>b</sup>Wilcoxon test

participating hospitals was collected via the Health Resource Services Administration (HRSA) website [9]. According to the HRSA, a MUA may refer to a whole county or a group of contiguous counties, a group of county or civil divisions, or a group of urban census tracts in which residents have a shortage of personal health services [9].

Descriptive statistics were calculated as median with interquartile range (or mean with standard deviation) for continuous variables. For categorical variables, frequencies and percentages were computed. Wilcoxon rank-sum or chi-square tests were used to compare between groups for continuous and categorical variables, when appropriate. Logistic regression was utilized to assess the associations of hand specialist and hand call with clinical factors: per capita income, median household income, white population, medically underserved area, and rural/metropolitan hospital locations. The term “hand call” was used to refer to any occasional (at least once per month) or 24/7 on-call services

offered specifically by a hospital's hand specialists and does not include any emergency hand care services that may be provided by orthopedic or plastic surgeons. All tests were two tailed, with a significance level of 0.05. All statistical analyses were performed using R statistical software (version 2.15.1, Vienna, Austria).

## Results

### Hand Specialist Presence

Out of 111 hospitals that participated in our survey, 37 % (41/111) have hand specialists. The distribution of these hospitals with hand specialists for Tennessee (TN) is shown in Table 1. Hospitals with lower PCI were less likely to have hand specialists than hospitals with higher PCI ( $p < 0.001$ ). Comparison with hospitals of 1,000



**Table 2** Logistic regression to model the probability of no hand specialist

	Odds ratio	Lower 0.95	Upper 0.95	<i>p</i> value
Per capita income (19,142:25,002)	24.97	5.01	124.51	0.000
Medically underserved area (yes/no)	4.20	1.39	12.70	0.011
Area (metropolitan/rural)	1.64	0.31	8.62	0.556
White population (92.4:72)	0.79	0.43	1.44	0.442

higher PCI yielded an odds ratio of 1.73 (95 % confidence interval, 1.32 to 2.28), indicating that every 1,000 lower PCI was associated with a 73 % decreased odds of having hand specialists. Hospitals in medically underserved area were also less likely to have hand specialists than hospitals not in medically underserved areas ( $p=0.011$ ). Comparison of hospitals in medically underserved areas with hospitals not in medically underserved areas yielded an odds ratio of 4.2 (95 % confidence interval, 1.39 to 12.7) (Table 2).

#### Hand Call Availability

Out of 111 hospitals that participated in our survey, 24 % (27/111) offer hand specialist call. The distribution of these hospitals with hand specialists is of particular interest in identifying the current trends of hand care delivery in TN. Table 3 illustrates the comparison of hospitals with hand specialists versus those without based on various clinical factors. Low per capita income is associated with high probability of no hand calls. Hospitals with lower PCI were

**Table 3** Comparison of hand call versus no hand call

	<i>N</i>	Hand call, <i>N</i> =27	No hand call, <i>N</i> =84	<i>p</i> value
Teaching hospital	111	19 % $\frac{5}{27}$	6 % $\frac{5}{84}$	0.06 <sup>a</sup>
Yes		81 % $\frac{22}{27}$	94 % $\frac{79}{84}$	
No				
Trauma facilities level	111	7 % $\frac{2}{27}$	7 % $\frac{6}{84}$	1 <sup>a</sup>
Level 1		93 % $\frac{25}{27}$	93 % $\frac{78}{84}$	
Levels 2–4				
Medically underserved area	111	63 % $\frac{17}{27}$	33 % $\frac{28}{84}$	0.008 <sup>a</sup>
No		37 % $\frac{10}{27}$	67 % $\frac{56}{84}$	
Yes				
Area	111	74 % $\frac{20}{27}$	42 % $\frac{35}{84}$	0.008 <sup>a</sup>
Metropolitan area		26 % $\frac{7}{27}$	58 % $\frac{49}{84}$	
Rural area				
White population	111	30 % $\frac{8}{27}$	58 % $\frac{49}{84}$	0.018 <sup>a</sup>
>50 %		70 % $\frac{19}{27}$	42 % $\frac{35}{84}$	
<50 %				
Ownership	111	15 % $\frac{4}{27}$	23 % $\frac{19}{84}$	0.57 <sup>a</sup>
Government		33 % $\frac{9}{27}$	37 % $\frac{31}{84}$	
Proprietary		52 % $\frac{14}{27}$	40 % $\frac{34}{84}$	
Voluntary				
Per capita income	111	11 % $\frac{3}{27}$	43 % $\frac{36}{84}$	<0.001 <sup>a</sup>
<\$20K		22 % $\frac{6}{27}$	36 % $\frac{30}{84}$	
Between \$20K and \$25K		67 % $\frac{18}{27}$	21 % $\frac{18}{84}$	
>\$25K				
Median household income	111	7 % $\frac{2}{27}$	42 % $\frac{35}{84}$	<0.001 <sup>a</sup>
<\$37K		26 % $\frac{7}{27}$	42 % $\frac{35}{84}$	
Between \$37K and \$44.75K		67 % $\frac{18}{27}$	17 % $\frac{14}{84}$	
>\$44.75K				
Per capita income	111	23,752 26,588 27,780 (25,827±4,220)	18,499 20,616 24,114 (21,153±3,197)	<0.001 <sup>b</sup>
Median household income	111	44,678 45,668 46,518 (46,551±9,670)	34,744 39,215 44,705 (39,629±6,596)	<0.001 <sup>b</sup>
White population	111	58 75 87 (73±16)	76 88 94 (79±21)	0.006 <sup>b</sup>

Note: *a*, *b*, *c* represent the lower quartile *a*, the median *b*, and the upper quartile *c* for continuous variables.  $\bar{x} \pm s$  represents  $\bar{X} \pm 1$  SD

*N* number of non-missing values

<sup>a</sup>Permutation chi-square test

<sup>b</sup>Wilcoxon test

**Table 4** Logistic regression to model the probability of no hand call

	Odds ratio	Lower 0.95	Upper 0.95	<i>p</i> value
Per capita income (19,142:25,002)	50.16	7.44	338.09	0.000
Medically underserved area (yes/no)	3.28	1.01	10.66	0.048
Area (metropolitan/rural)	7.18	0.92	56.06	0.060
White population (92.4:72)	0.69	0.35	1.33	0.265

less likely to have hand call availability than hospitals with higher PCI ( $p < 0.001$ ). Comparison with hospitals of 1,000 higher PCI yielded an odds ratio of 1.95 (95 % confidence interval, 1.41 to 2.7), indicating that every 1,000 lower PCI was associated with a 95 % decreased odds of having hand call availability. Hospitals in medically underserved areas were also less likely to have hand calls than hospitals not in medically underserved areas ( $p = 0.048$ ). Comparison of hospitals in medically underserved areas with hospitals not in medically underserved areas yielded an odds ratio of 3.28 (95 % confidence interval, 1.01 to 10.66) (Table 4).

#### Trauma Level Designation Effect

Tennessee has six level 1 adult trauma hospitals, with four state-designated level 1 children's hospitals for a total of ten level 1 trauma facilities. Eight of these facilities participated in our survey. In the state of Tennessee, these level 1 trauma facilities are required by the Tennessee Department of Health to have staffed hand specialists who take hand call or a current signed transfer agreement with an institution having a hand surgery service [17]. Our study revealed that while 7/8 (87.5 %) level 1 trauma facilities have hand specialists, only 2/8 (25 %) provide hand specialist call.

#### Emergency Versus Elective Hand Care

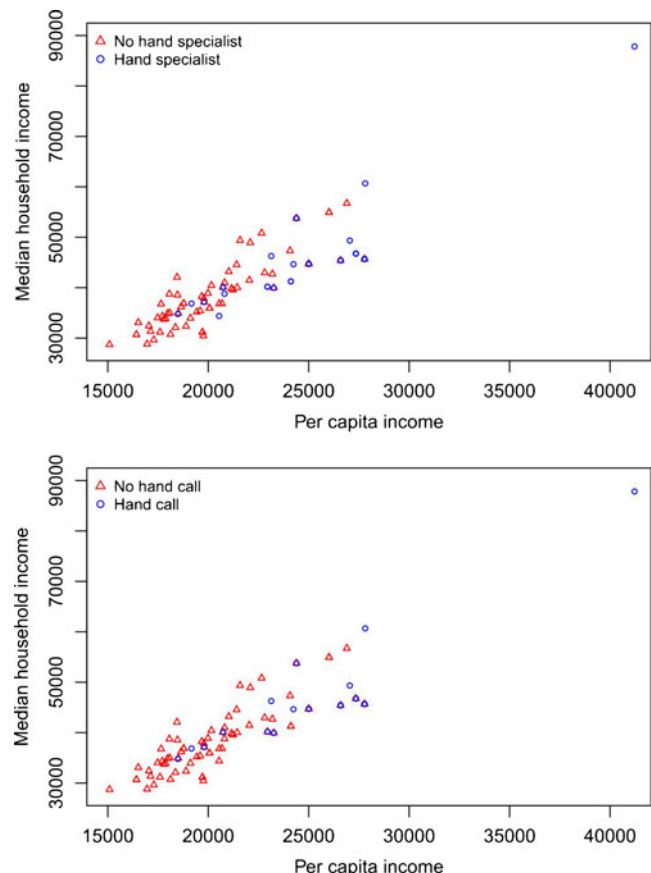
Emergency hand care availability is defined as emergency hand care offered by a hand specialist at least one night per month. Elective hand surgery capability was identified by hospitals offering both carpal tunnel release and finger fracture reduction. Of the hospitals with hand specialists, 95 % (39/41) offer elective surgery. These figures can be directly compared to those of hospitals offering emergency hand care. Of the hospitals with hand specialists, 66 % (27/41) offer hand specialist call. One hundred percent of level 1 trauma facilities offer elective hand surgery while only 25 % offer emergency hand care services provided by hand care specialists.

#### Discussion

This is a retrospective study of the on-call availability of hand surgeons in the state of Tennessee. This study shows

that hand specialist presence within an institution does not guarantee hand specialist call availability in emergency situations. In fact, many hospitals within the state that are staffed with hand specialists do not offer any emergency hand specialist call at all. If a hospital does not offer hand call, even if it has a staffed hand specialist, it is unlikely that a patient with a hand-related emergency will be treated for their injury at that institution [8]. Our previous study revealed a shortage of emergency hand care for the state of Tennessee. This study contributes to our understanding of the availability and distribution of hand care services.

Currently, a significant volume of hand surgeries performed in the Tennessee is performed by physicians who are not hand specialists such as plastic surgeons or orthopedists on call [11]. Because of this, all hospitals that



**Fig. 1** Plot of median household versus per capita income stratified by hand specialists and hand call

do not offer hand specialist delivered hand care were included with the hospitals without hand call. For this study, we differentiate between situations where hand call is offered by a surgeon who is regarded as either being a hand specialist or not. However, we did not specify that the hand specialists have been fellowship-trained hand surgeons or hold a Certificate of Added Qualification (CAQ) in surgery of the hand because of study design. Also, a significant number of surgeons who are CAQ in hand surgery did not complete a hand surgery fellowship year, but were grandfathered into CAQ eligibility based on their practice volumes. Our data collection approach allowed us to include recent hand fellowship graduates who may not have received their CAQ yet, but probably take significant hand call, while excluding hand fellowship-trained surgeons who no longer operate on the hand.

We ranked the five clinical factors (PCI, MHI, MUA, white population, and rural/metropolitan area) for the counties where a hospital is located and the likely patient demographic treated by the hospital, using a logistic regression model. There is a correlation between county income and emergency hand care services (Fig. 1). As county per capita income and median household income increases, so does the number of hospitals that have hand specialists and offer hand call. Likewise, medically underserved areas have shown a general lack of hospitals with hand specialists or hand call offerings. Our results suggest that within the sparse distribution of emergency hand care services in Tennessee, there appears to be socioeconomic disparities that exist.

The most surprising finding in this study is the lack of hand specialist emergent hand services offered by the majority of Tennessee's level 1 trauma facilities. These medical centers are required by state law to have a full range of medical specialists and equipment available 24 h a day. According to the Rules of the Tennessee Department of Health Division of Health Care Facilities, level 1 trauma centers must have hand surgeons staffed and available for 24 h call or a current signed transfer agreement with an institution having a hand surgery service [17]. This discrepancy raises questions and concern about the delivery of hand care at hospitals tertiary referral hospitals. Is there a shortage of hand surgeons in TN preventing hospitals from meeting this demand? Is there a financial disincentive for hand surgeons to offer emergent hand care? Should hospitals coordinate call schedules in order to improve hand call coverage?

While this study characterizes the lack of emergency hand specialist coverage in lower socioeconomic areas,

it does not assess the relationship between emergent hand coverage and number of hand transfers or patient outcomes. However, it is unlikely that TN is meeting demand, considering the national data on frequency of hand emergencies and difficulties in obtaining hand call coverage [13]. Future research will examine the impact of these discrepancies on patient outcomes in the state of Tennessee.

**Acknowledgments** This work was supported by an institutional grant from Meharry Medical College and an institutional grant (VICTR) from Vanderbilt University Medical Center.

**Conflict of Interest** The authors declare that they have no conflict of interest.

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