

# Effect of Hospital Volume on Success of Thumb Replantation

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**Purpose** Hospital volume—outcome association has been examined for many high-risk surgical procedures. Little is known about this association for thumb replantation, a complex but essential surgical procedure to restore hand function. We aimed to determine patient and hospital characteristics that are associated with increased probability of replanted thumb survival and to examine volume—outcome association among hospitals that performed thumb replantation.

**Methods** We used data from 2008 to 2012 from the National Trauma Data Bank. Our sample included 773 patients who underwent thumb replantation procedures in 1 of 180 hospitals during the study period. We used patient-level logistic models to examine the association between a hospital's annual thumb replantation volume and the probability of survival for the replanted thumb.

**Results** Patients with drug/alcohol abuse record, and higher numbers of comorbid conditions had lower odds of replant success. Treatment in teaching hospitals and hospitals with a higher volume of thumb replantation increased the odds of replant survival. The risk-adjusted replantation success rate in high-volume hospitals was 12% higher than in low-volume hospitals.

**Conclusions** Regionalization of digit replantation procedures to high-volume centers can achieve the highest rate of successful revascularization. (*J Hand Surg Am.* 2016; ■(■): ■—■. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)

**Type of study/level of evidence** Economic/Decision Analysis II.

**Key words** Volume—outcome, thumb, replantation, success rate.



ACCORDING TO 2014 DATA FROM THE National Electronic Injury Surveillance System, more than 730,000 people sustain hand injuries each year.<sup>1</sup> Hand injuries may have severe and long-term consequences for one's ability to work and live

independently.<sup>2,3</sup> Traumatic thumb amputations are a common hand injury. The thumb contributes to about 40% of hand function and has an essential role in activities of daily living.<sup>3</sup> Thus, when clinically possible, replantation of the thumb is the recommended treatment.<sup>3,4</sup> Despite microsurgical advancements in the past few decades<sup>5</sup> and substantial improvements in the survival rate of thumb replantation,<sup>3,6,7</sup> attempts to replant the thumb after amputation injuries have been declining steadily in the United States (US).<sup>4</sup> Delivery of replantation surgery of the thumb is a resource-intensive procedure. For example, hospitals that routinely perform upper-extremity replantation surgeries are required to have a team of on-call hand surgeons with microsurgical expertise, specialized equipment, and experienced personnel available for the surgery and for postoperative

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care.<sup>8</sup> Although these resources should be available at all level I trauma hospitals, many of these regional trauma centers do not have on-call hand surgeons available on a 24/7 basis.<sup>9,10</sup> Based on the Department of Health and Human Service's 2003 statement, the decision to provide adequate number of specialist coverage at all times is up to each individual hospital.<sup>10</sup>

Despite data revealing a higher rate of digit replantation in centers of excellence,<sup>8,11</sup> digit replantation procedures in the US have not been regionalized.<sup>12</sup> Although there has been an ongoing debate over the benefits of regionalization of care,<sup>13–15</sup> an overwhelming amount of evidence indicates that in general, treatment in regionalized centers of excellence leads to lower mortality,<sup>15</sup> better health outcomes,<sup>12</sup> and a more effective system of care.<sup>16</sup> For example, over the past 20 years, burn care in the US has gradually been regionalized. Although many challenges remain,<sup>17</sup> regionalized burn centers have been successful in providing consistent, optimal burn care based on published criteria.<sup>18,19</sup> Research shows a lower rate of transfer of care for severe upper-extremity trauma cases and a higher rate of attempted replantation for all traumatic digit amputation among high-volume hospitals.<sup>9,11,20</sup> However, little is known about the association between hospital volume and survival of the replanted thumb.

The main purpose of this study was to examine variations in survival rate for attempted thumb replantations. Our 3 specific aims for this study were to: (1) examine the trends in survival of thumb replantation, (2) examine patient factors associated with survival of thumb replantation, and (3) examine hospital characteristics that are associated with survival of thumb replantation. Our main hypothesis was that the survival rate of thumb replantation is higher among hospitals with a higher volume of attempted replantations.

## MATERIALS AND METHODS

### Data source

We used 2008 to 2012 data from the National Trauma Data Bank (NTDB)<sup>21</sup> administered by the American College of Surgeons.<sup>22</sup> The NTDB is the largest collection of trauma data reported by hospitals across the US and has been used extensively in trauma research.<sup>23,24</sup> The NTDB contains files documenting patient demographics, trauma characteristics, diagnosis and procedure codes, and hospital characteristics.

In this study, we examined survival of the replanted thumb. First, we used *International Classification of Diseases, Ninth Revision (ICD-9-CM)* codes 885.0 and 885.1 to identify traumatic thumb amputation

patients. Second, we used ICD-9 procedure code 84.21 to select patients who underwent thumb replantation surgery.

### Cohort selection

All traumatic thumb amputation patients who underwent replantation after a thumb amputation injury at a participating institution were included in our sample. Between 2008 and 2012, we identified 773 cases of thumb replantation. After excluding patients with missing values, the final sample used in our regression models included 755 thumb replantation cases treated at 1 of 178 hospitals over the study period. A schematic flow diagram of our study population is presented in **Figure A1** (available on the *Journal's* Web site at [www.handsurg.org](http://www.handsurg.org)).

State officials designate the level of hospitals certified as trauma centers. Trauma centers can be categorized into regional (Level I), community (Level II), or rural (Level III) hospitals. The American College of Surgeons is responsible for verifying and approving the trauma designation. Furthermore, noncertified trauma hospitals may also report their trauma data to the NTDB. Although these hospitals are not officially trauma centers and are not assigned a trauma level, many are teaching hospitals with full capacity to treat a variety of trauma patients.

### Explanatory and Outcome Variables

The main outcome of interest in this study was the survival of the replanted thumb. For all patients who underwent thumb replantation, we looked for a subsequent ICD-9 code for revision thumb amputation (84.02) or debridement (86.22) before the patient was discharged from the hospital. If a revision thumb amputation or debridement was not reported, we considered the replanted thumb to have survived (success); otherwise we assumed that replantation failed. The NTDB does not follow patients longitudinally. Thus, we were unable to capture revision amputations that happened after patients were discharged from the hospital. Because the NTDB data are linked to a hospital's reimbursement records, we assume that all major procedures should be captured and reported by the hospitals to this dataset. Using NTDB, this approach was used by previous research to identify the survival or success of a surgical procedure after a traumatic event.<sup>25–27</sup>

At the patient level, our model included age, sex, race, injury severity score, number of certain chronic conditions (including hypertension, diabetes, respiratory condition, obesity, blood disorder, and heart disease), smoking status, a record of drug or alcohol

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