FIFTEEN-YEAR HEALTH OUTCOMES FOLLOWING UPPER LIMB AMPUTATION AND SERIOUS EXTREMITY INJURY IN OPERATIONS ENDURING AND IRAQI FREEDOM: A RETROSPECTIVE ANALYSIS

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NAVY MEDICINE RESEARCH & DEVELOPMENT

Background

Traumatic lower limb amputation has been associated with earlier postinjury rehabilitation and fewer adverse outcomes compared with delayed amputation.

For upper limb injuries, the frequency of traumatic and delayed amputations and long-term outcomes among Operations Iraqi and Enduring Freedom (OIF/OEF) combatants remains unclear.

Objectives

The objectives were to:

1) Analyze the longitudinal course of outcomes diagnoses (dx) during the first 10–15 years after serious upper limb injury, including amputation.
2) Compare outcomes of patients who sustained traumatic and delayed upper limb amputations.

Methods

Study Design

Retrospective analysis of existing Department of War (DoW) and Veterans Administration (VA) health data—dx 15 years following combat-related upper limb injury in OIF/OEF, 2001–2017.

Patients

- 963 U.S. service members (SMs) who sustained:
  - **Traumatic amputation** (n = 149): single upper limb (≤24 hours postinjury) or
  - **Delayed amputation** (n = 49): single upper limb (>24 hours postinjury) or
  - **Limb injury** (n = 763): serious-to-severe lower limb injury (Abbreviated Injury Scale [AIS] score ≥ 3) without amputation
- *The 963 SMs are virtually all who sustained these injuries in OIF/OEF*

Data Sources

- Expeditionary Medical Encounter Database (EMED)
- Clinicians reviewed casualty records to code injury-specific data (limb amputation or injury, AIS, Injury Severity Score (ISS)
- Military Health System Data Repository (MDR) and VA Corporate Data Warehouse (CDW; *International Classification of Diseases*, 9th and 10th Revisions [ICD-9/10] diagnostic codes [dx] for health disorders)

Measures

- Independent variables and covariates:
  - Traumatic or delayed amputation vs. limb injury, age, injury years (2001–2008 vs. 2009–2017), blast injury, ISS, traumatic brain injury, health care use years (up to 15)
  - Postinjury year 1–15
- Outcomes dx (comorbidities–**30 total**), only selected dxs are shown:
  - Pain-related: chronic pain, back pain, any pain disorders
  - Behavioral health: adjustment, posttraumatic stress disorder (PTSD), substance abuse disorders (SUD)
  - Cardiovascular (CVD): hypertension, obesity, diabetes, hyperlipidemia
  - Total comorbidities are the sum of all dx up to 30

Data Analysis

- Description of overall (15 years) and year-by-year prevalence of outcomes dxs
- Multivariable analysis, including repeated measures tested for:
  - Main effects of injury group (traumatic **or** delayed amputation vs. limb injury)
  - Interactions: injury group x postinjury year on outcomes after adjusting for covariates

Results

Table. Patient characteristics of the three study groups **(n = 963)**

Variables	Traumatic amputation n = 149	Delayed amputation n = 49	Limb injury (AIS ≥ 3) n = 765	*p value*
Age (mean [SD])	26.4	25.8	26.2	*0.872*
ISS (mean [SD])	**18.8 / 17**	**18.8 / 14**	14.0 / 10	*0.001*
Traumatic brain injury severity (%)				*0.250*
None	79	78	83	
Mild	21	22	16	
Health care use, years (of 15, mean/median)	**13.5 / 15**	**13.3 / 14**	11.5 / 13	*0.001*
Mean comorbidities (of 30 dxs)	11.6/ 12	**13.5/13**	10.4/11	*0.001*

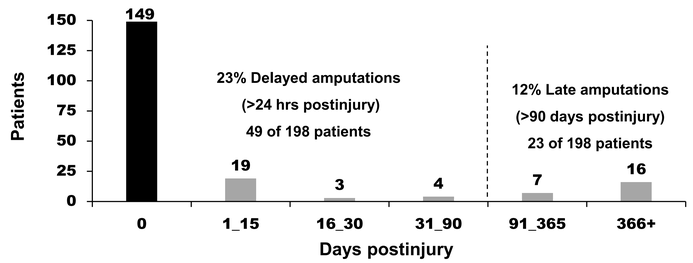
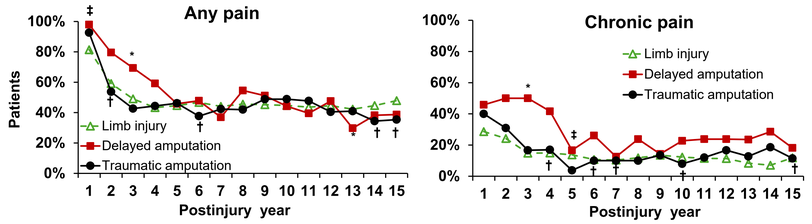
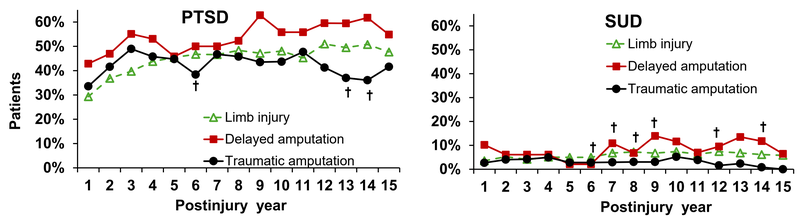


Figure 1. Postinjury timing of upper limb amputations.

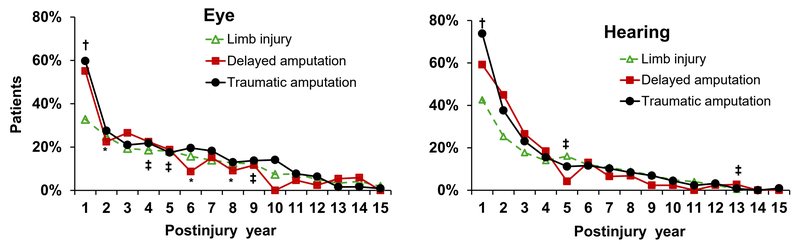


Figures 2 and 3. Prevalence for diagnoses of pain disorders by postinjury years.

**Delayed amputation, †traumatic amputation, ‡traumatic and delayed amputation. Adjusted odds ratio vs. limb injury reference group: ps < .05.*



Figures 3 and 4. Prevalence for diagnoses of pain disorders by postinjury years.



Figures 5 and 6. Prevalence for diagnoses of eye and hearing disorders by postinjury years.

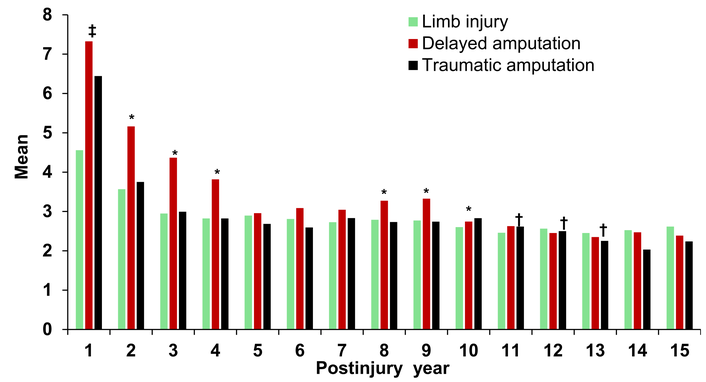


Figure 5. Longitudinal changes in total comorbidities (of 30 dx) by postinjury years.

Conclusions

- **Traumatic and delayed upper limb amputation groups had different long-term patterns of diagnoses (comorbidities), including pain and behavioral disorders**
- A substantial number of patients had delayed (23%) or late (12%) postinjury amputations
- Regression models showed significant:
  - Associations between amputation and total comorbidities (of 30)
  - Interactions between amputation and postinjury years for behavioral and pain disorders
- During early postinjury years, the traumatic and particularly the delayed amputation group had significantly:
  - More total comorbidities
  - Higher rates of dx within multiple categories (pain, behavioral health, eye/hearing)
- During later postinjury years:
  - Traumatic amputation group had significantly fewer total comorbidities, including pain, PTSD, and substance abuse disorders (SUD)
  - Delayed amputation group had significantly more total dx, including PTSD
- Longitudinal analyses showed significant declines in rates of diagnoses, with exceptions:
  - Some persisted, including pain (and chronic insomnia, depressive disorders, not shown)
  - Some increased during later postinjury years, including PTSD (and cardiovascular disorders, not shown)
- Overall CVD dx were not significantly associated with traumatic or delayed amputation (not shown).
- Integrated DoW and VA health data produced high rates of long-term follow-up
- The results support prolonged multidisciplinary rehabilitation care for many years after serious combat-related upper limb injury
- The results can inform clinical guidelines to improve existing treatment pathways for patients who sustain traumatic or delayed upper limb amputation

Partners/Collaborators

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