Title: Lower-limb amputee rehabilitation outcomes in Australia: analysis of a national data set 2004-2010
Key Question Summary

What is known about the topic?
Literature reporting on the rehabilitation outcomes of cohorts of lower limb amputees in Australia is limited to individual sites. No previous literature was identified which reported national data.

What does this paper add?
This study investigates amputee rehabilitation at a national level over a seven year observation period (2004 to 2010) and comprises 6,588 episodes. It reports the national demographics, clinical characteristics and rehabilitation outcomes, with the aim of identifying findings that have implications for practitioners.

What are the implications for practitioners?
Although only a small proportion of all episodes in the AROC database, this subset of lower-limb amputee episodes has provided a useful snapshot of the current state of amputee rehabilitation in Australia. We believe these findings have significant implications for practitioners in delivery of amputee rehabilitation services across Australia. Practitioners may benefit from adjusting service delivery based upon the decreasing age of lower limb amputees. Findings from this study also indicate that AN-SNAP classifications are effective in discriminating amputee rehabilitation outcomes and may be used to streamline rehabilitation services and provide a more efficient and effective rehabilitation service.
Abstract

Objective: Examine demographics, clinical characteristics and rehabilitation outcomes of lower-limb amputees using the Australasian Rehabilitation Outcomes Centre (AROC) database.

Methods: Lower-limb amputee rehabilitation episodes completed between 2004 and 2010 were identified from the AROC database using AROC impairment codes 5.3-5.7. Analysis was conducted by year, impairment code, Australian National Sub-acute and Non-Acute Patient (AN-SNAP) classification (S2-224, FIM™ motor score 72-91; S2-225, FIM™ motor score 14-71) and States of Australia.

Results: Mean length of stay (LOS) for all lower-limb amputee episodes was 36.1 days (95% CI: 35.4-36.9). Majority of episodes were unilateral below knee (63.6%), males (71.8%) with a mean age of 67.9 years (95% CI: 67.6-68.3). Year-on-year analysis revealed that LOS was not decreasing. Analysis by impairment code demonstrated no significant difference in rehabilitation outcomes. Analysis by AN-SNAP found that LOS was 16.2 days longer for S2-225 than S2-224 (95% CI: 14.7-17.8, p<0.001), whilst FIM™ (mot) change was 12.0 points higher for S2-225 than S2-224 (95% CI: 11.5-12.6, p<0.001). Analysis by states revealed significant variation in LOS, FIM™ (Mot) change and FIM™ (Mot) efficiency which were associated with variations in organisation of rehabilitation services across States.

Conclusion: Whilst amputees represented a comparatively small proportion of all rehabilitation episodes in Australia, their LOS was significant. Unlike many other rehabilitation conditions, there was no evidence of decreasing LOS over time. AN-SNAP classes were effective in distinguishing rehabilitation outcomes, and could potentially be used more effectively in planning rehabilitation programs.

Key words: Amputees, Functional Independence Measure, FIM Motor, Rehabilitation, Rehabilitation Centres, Rehabilitation Outcome, AN-SNAP class.
Introduction

Worldwide incidence of lower-limb amputation is highly variable with incidence rates ranging from 5.8 to 31 per 100,000.² Most lower-limb amputees in the developed world are elderly dysvascular patients often presenting with diabetes mellitus.³⁻⁵ It is estimated that 700,000 Australians (3.6% population) were diagnosed with diabetes mellitus, and 3,394 diabetic related lower-limb amputations were performed in Australia in 2004-05.⁶

Amputees are a core group in Australian rehabilitation units who have a long index length of stay (LOS). The long LOS associated with the index admission is justified by clinicians as important because restoring independent mobility and community integration reduces the larger social and health service costs associated with disability.⁷ It is widely believed that growth of interventional vascular surgery has helped reduce or postpone lower-limb amputation numbers in dysvascular patients.⁸⁻⁹ However, it is unknown whether amputees entering rehabilitation units now present with different demographics than previously. This may result in a change in the outcomes achieved, time taken to achieve these outcomes or in the nature of the clinical programs provided. National outcome data collected by the Australasian Rehabilitation Outcomes Centre (AROC) will allow further investigation into the demographics, clinical characteristics and rehabilitation outcomes across Australia.

AROC collects standardized data for each and every episode of inpatient rehabilitation care from rehabilitation services in Australia (private and public). It provides a national benchmarking service, as well as providing information to improve understanding of factors that influence rehabilitation outcomes and costs. The objective of this study was to examine the AROC database for IP lower-limb amputee rehabilitation episodes to understand the demographics, clinical characteristics, and rehabilitation outcomes. Service implications for lower-limb amputees in Australia will be drawn from these findings. The primary outcomes of interest will include improvement in patient functional
status, hospital LOS, clinical characteristics and discharge destination. In addition, the yearly trends in episodes outcomes and service efficiency will be examined, as well as comparison of outcomes for service provision between impairment codes, Australian National Sub-Acute and Non-Acute Patient (AN-SNAP) classifications, and States of Australia.

Methods

Design

This study was a retrospective analysis of lower-limb amputee rehabilitation outcomes for episodes discharged between 2004 and 2010 using the AROC database. Lower-limb amputee data were identified using AROC impairment codes 5.3 to 5.7\(^1\) (definitions of impairment codes in table 1). All data were de-identified prior to data extraction and analysis. Ethical approval for this study was provided by the Southern Adelaide Clinical Human Research Ethics Committee.

AROC dataset

AROC was established in July 2002 as a joint initiative of the Australasian Rehabilitation sector and is funded by contributions from all stakeholders, including facilities, health funds, Department of Veterans’ Affairs, health departments (state and commonwealth), some general insurers and the Australasian Faculty of Rehabilitation Medicine (AFRM). AROC receives quarterly episodic data from private and public rehabilitation facilities across Australia. Thirty facilities were submitting data to AROC in 2002. However AROC coverage grew steadily with 109 facilities submitting by 2004, and 180 facilities submitting by 2011, representing more than 95% of Australian rehabilitation facilities and inpatient episodes. Of the rehabilitation facilities submitting data to AROC, 21 units specialize in lower-limb amputee rehabilitation and contributed the majority of amputee episode data (59.3%). The AROC data set includes 42 items: sociodemographic, funding and employment details, episode items (admission and discharge), medical (impairment codes, comorbidities, complications), and outcome data (patient level of function at admission and discharge).\(^{10,11}\)
Data within the AROC database are classified under the AN-SNAP casemix classification system which was developed at the University of Wollongong in 1997. The purpose of AN-SNAP was to provide a casemix classification system for sub and non-acute care provided in a number of treatment settings. It was borne out of growing recognition patients should be classified by functional ability, rather than diagnosis and procedure codes as in the acute sector. AN-SNAP subdivides case episodes according to both diagnosis and functional level, using the Functional Independence Measure (FIM™). Version 2 AN-SNAP classification became operational in 2007 and includes 45 inpatient rehabilitation classes. For amputees, AN-SNAP version 2 contains two functional levels based on the FIM™ motor score. The two functional classes are S2-224 (FIM™ Mot 72-91) and S2-225 (FIM™ Mot 14-71). FIM™ is an internationally recognised and reliable functional status instrument that is widely used with rehabilitation inpatients. It contains 18 items, 13 of which relate to motor function, and 5 to cognition. Total FIM™ scores including both motor and cognitive aspects range from 18 to 126, with higher scores representing greater functionality. FIM™ scores relating to motor assessments range from 13 to 91. AROC holds a territory license for use of the FIM™ in Australia and New Zealand, and is responsible for the national certification and training for all accredited rehabilitation clinicians. Clinical staff are required to be recredentialed in the FIM™ every two years to maximize the quality of data. All data received by AROC are screened for errors and missing data prior to adding the episodes to the database. If necessary, AROC will request that the submitting facility review and correct any inconsistencies.

Analysis
Deidentified data for lower-limb amputees admitted for inpatient rehabilitation between 2004 and 2010 were extracted from the main AROC database using AROC impairment codes 5.3-5.7. Data were then transferred to SPSS version 19.0 for analysis. Descriptive analysis was conducted on demographics, FIM™ (Mot) (admission score, discharge score, change and efficiency), LOS, clinical
characteristics and discharge destination collated by year, AN-SNAP class, impairment code and States of Australia. FIM™ (Mot) change is the difference between admission and discharge FIM™ (Mot) scores, and is an indicator of change in functional status during rehabilitation stay. FIM™ (Mot) efficiency is the FIM™ (Mot) change achieved per day of LOS. Significant differences were analysed by independent sample t-tests and between subjects analysis of variance (ANOVA) with post-hoc pairwise comparisons using Tukey adjustments for significant results. Results of descriptive analysis are presented as a mean and 95% confidence interval (95% CI). Results of independent sample t-test and ANOVA are presented as mean difference and 95% CI.

Results

Episodes

A total of 6,588 lower-limb amputee episodes were submitted to the AROC database between 2004 and 2010. However only 4,864 (73.8%) of episodes could be analysed for rehabilitation outcomes which requires valid LOS and valid FIM™ scores. Of all rehabilitation episodes submitted to the AROC database between 2004 and 2010, lower limb amputees contributed only 1.7% of episodes (see table 2). Of all submitted amputee episode data, NSW was the largest contributing state (48.5%), whilst the majority of episodes were submitted from public facilities (83.4%). The number of lower-limb amputee episodes submitted to the AROC database grew steadily each year as did the number of facilities submitting lower-limb amputee episodes data, reaching 99 by 2010.

Demographics

The majority of lower-limb amputee episodes were male (71.8%), with mean age of all episodes being 67.9 years (95% CI: 67.6–68.3). Episodes in the private sector had a mean age 6.1 years lower than those in the public sector (95% CI: 5.1–7.0, \( P < 0.01 \)). Episodes categorised to the higher functioning AN-SNAP class (S2-224) had a lower mean age by 10.0 years in comparison to those in S2-225 (95% CI: 9.2–10.8, \( P < 0.001 \)). Year-on-year analysis revealed a trend for decreasing age with
the mean age in 2004 being 70.2 years (95% CI: 69.1–71.3), dropping in 2010 to 67.1 years (95% CI: 66.2–68.0).

Clinical Characteristics

Majority (63.6%) of episodes within the AROC database were unilateral below knee amputees with most episodes being characterised into the lower functioning AN-SNAP class, S2-225 (71.8%). Table 3 demonstrates the breakdown of lower-limb amputee impairment codes and AN-SNAP classifications across Australian states. The majority of episodes were admitted from private residence (89.5%), with 87.1% of those admitted from private residence also returning there upon completion of rehabilitation.

Complications and comorbidities occurring during rehabilitation were not well recorded in the dataset prior to 2007. In 2004 94.7% of episodes did not record complications during rehabilitation. This figure dropped to 51.1% in 2007, and by 2010 there were only 2.7% of episodes with missing data for complications during rehabilitation. Of submitted data where complications were recorded from 2007 to 2010, 44.2% reported at least one complication, commonly being a wound infection (33.3%) or a fall (12.5%). Of submitted comorbidities data between 2007 and 2010, 67.4% had at least one comorbidity, with 43.4% having multiple comorbidities. The most commonly reported comorbidity was diabetes mellitus (43.4%). Comorbidities and complications did not vary by year or impairment code. However, analysis by AN-SNAP classification revealed that episodes in S2-225 were significantly more likely to have at least one complication (45.8%) compared to those in S2-224 (31.2%) ($\chi^2(1) = 49.9, P<0.001$). Episodes in S2-225 were also significantly more likely to have multiple comorbidities (36.2%) compared to those in S2-224 (27.4%) ($\chi^2(1) = 40.6, P<0.001$).

Program suspension recording changed in 2007 to enable reporting of the number of suspensions, total number of days of the suspension period, and if the suspension was planned or not. Since 2007
38.1% of episodes reported a suspension to treatment during inpatient rehabilitation. Of those, only 17.1% reported the number of suspensions, 21.1% the length, and all reported if the suspension was planned. Of those episodes with only one suspension (75.4%), the mean length of suspension was 4.7 days (95% CI: 3.8 – 5.6). The program suspension was a planned occurrence in 49.1% of episodes.

Rehabilitation Outcomes

Mean LOS for all lower-limb amputee episodes was 36.1 days (95% CI: 35.4–36.9). FIM™ (Mot) change was 13.5 (95% CI: 13.2–13.8) and FIM™ (Mot) efficiency was 0.5 (95% CI: 0.5–0.5). Year-on-year analysis (see table 4) revealed a trend for increasing LOS and FIM™ (Mot) change, however this did not reach significance. Table 5 provides results of rehabilitation outcomes from submitted episode data for lower-limb amputee impairment codes. Post-hoc analysis revealed that impairment code 5.5 had a significantly lower admission FIM™ (Mot) than all other impairment codes. Impairment code 5.5 also had significantly lower discharge FIM™ (Mot) scores than all other impairment codes, while impairment code 5.4 had significantly higher discharge FIM™ (Mot) scores compared to all other impairment codes. Analysis by AN-SNAP classification revealed that LOS was longer for S2-225 at 40.6 days (95% CI: 39.8-41.5) compared to S2-224 at 24.4 days (95%CI: 23.4-25.4), with a significant difference of 16.2 days (95% CI: 14.7-17.8, P<0.001). FIM™ (mot) differences were also found between AN-SNAP classifications with S2-225 achieving a higher FIM™ (mot) change of 16.8 (95%CI: 16.5-17.2) compared to 4.8 (95%CI: 4.5-5.0) for S2-224, with the mean difference of 12.0 reaching significance (95% CI: 11.5-12.6, P<0.001). FIM™ (mot) efficiency was also found to be different between AN-SNAP classifications with S2-225 being 0.6 (95%CI: 0.5-0.6) compared to 0.3 (95%CI: 0.3-0.3) for S2-224, with the mean difference of 0.3 reaching significance (95% CI: 0.2-0.3, P<0.001). Analysis by States (see table 6) revealed significant variations in LOS, FIM™ (Mot) change and FIM™ (Mot) efficiency. Post-hoc analysis revealed New South Wales (NSW) had shorter LOS compared to South Australia (SA) by 3.7 days (95% CI: 0.6-6.8, P<0.01) and Victoria (Vic) by 6.3 days (95% CI: 3.7-9.0, P<0.001), whilst Queensland (Qld) had significantly shorter LOS.
compared to Vic by 4.4 days (95% CI: 0.9-7.9, P<0.01). Vic achieved a significantly greater FIM™ (Mot) change than Qld by 1.6 points (95% CI: 0.1-3.1, P<0.05). FIM™ (Mot) efficiency was significantly greater for NSW in comparison to SA by 0.1 (95% CI: 0.0-0.2, P<0.05) and Vic by 0.1 (95% CI: 0.0-0.1, P<0.05). Caution however should be taken when considering these results due to variations in organisation of rehabilitation and prosthetic services across States.

Discussion:
The AROC dataset proved useful for providing a snap-shot of lower-limb amputee rehabilitation nationally. Since inception of the database, a number of modifications and improvements have been implemented to ensure that data recorded is done so correctly, accurately and provides a realistic picture of the current state of rehabilitation. For lower-limb amputees, an adjunct dataset was introduced to specifically target outcomes related to amputees. Once sufficient data has been collected, the addition of this adjunct dataset should allow a more complete analysis of amputee rehabilitation. In the meantime, results from the current version of the AROC database indicate that the majority of cases were managed by the public sector, overall LOS can be considered to be quite long compared to other patient populations including stroke (27 days) and orthopaedic fractures (23 days)\(^19,20\). The significant LOS may be attributed to a number of factors such as waiting for suitable wound healing to occur before prosthetic casting, waiting for adequate home modifications to be made so that the amputee may safely return home, or the earlier arrival of amputees from acute setting to rehabilitation facilities. Data also indicates that the amputee population entering rehabilitation is old. Age was also found to be lower in the higher functioning AN-SNAP classification (S2-224) which is not surprising given that age is often considered a factor that impacts functional abilities in amputees.\(^16-18\)

Year on year analysis revealed a trend for increasing LOS, FIM™ (Mot) change and decreasing age. As discharge to private residence has remained relatively steady over the observation period, it appears
that the lower admission FIM\textsuperscript{TM} (Mot) scores entering rehabilitation may contribute to the longer LOS to achieve a greater FIM\textsuperscript{TM} (Mot) change and ensure similar discharge FIM\textsuperscript{TM} (Mot) scores. Increasing LOS in this population appears to be contradictory to other rehabilitation patient populations who are typically experiencing decreasing rehabilitation LOS.\textsuperscript{19,20} The decreasing age observed may be related to the increasing prevalence of diabetes mellitus in younger adults due to the increasing incidence of obesity and physical inactivity.\textsuperscript{21-23} However a number of other factors may contribute to the observed decreasing age such as rehabilitation facilities admitting older amputees for transfer training only under reconditioning, rather than rehabilitation. There may also be an increasing trend of facilities not admitting older amputees from care facilities for rehabilitation as their care is already maximal. It is important that clinicians provide suitable rehabilitation programs based on the decreasing age of lower limb amputees entering rehabilitation.

The findings around increasing LOS and decreasing age should raise concerns within the wider amputee rehabilitation community. Clinicians and public health physicians need to ensure active data collection of all items within the AROC amputee adjunct data set to provide a comprehensive overview of lower-limb amputee rehabilitation in Australia. It does appear that the decreasing age and increasing LOS will require amputee rehabilitation units to overview current practice and provide a more efficient and better targeted service. The amputee rehabilitation community should consider research into interventions aimed at decreasing LOS. Such interventions may include techniques to better target the motor learning process involved in learning to ambulate with a prosthesis. Therapies to complement physiotherapy provided should also be considered, and may include the use of video game therapy or virtual reality. Earlier access to amputee patients following may allow the rehabilitation process to begin earlier. The multidisciplinary unit involved in amputee rehabilitation should ensure early identification of home modifications required and ensure that this factor does not delay discharge from the rehabilitation unit, and may allow amputees to continue rehabilitation as out-patients rather than inpatients.
Analysis by impairment code found that single below knee episodes were the most common in this database, which is commonly the case in amputee rehabilitation facilities.\textsuperscript{24,25} Differences in admission and discharge FIM\textsuperscript{TM} scores were found between bilateral above or through knee amputees and all other impairment codes. This is not surprising given that more proximal and bilateral amputations result in lower functional abilities.\textsuperscript{26} Despite this, differences in LOS, FIM\textsuperscript{TM} (Mot) change and FIM\textsuperscript{TM} efficiency were found to be not significant between impairment codes, however fewer episodes from impairment code 5.5 discharged to private residence indicating that the decreased function affects ability to discharge home.

Discrimination of episodes by AN-SNAP classification through use of the FIM\textsuperscript{TM} appears to be an effective method of distinguishing functional abilities and rehabilitation outcomes of lower-limb amputees. Significant differences were found in LOS, FIM\textsuperscript{TM} (Mot) change and efficiency between classifications. Potential exists for AN-SNAP classes to be used more effectively in planning and targeting rehabilitation programs for the lower-limb amputee population. Although the FIM itself is not an amputee specific tool, it is a widely used and useful tool for obtaining a broad snap shot of a patients potential and allows comparison of amputees with other patient populations. AROC has recently introduced an amputee adjunct dataset which will provide more specific amputee related rehabilitation outcomes. Although insufficient data is currently available for analysis, we believe the addition of this adjunct dataset will prove useful for investigating amputee rehabilitation nationally.

Limitations
A limitation typical of retrospective studies is a result of reliance upon quality of data recorded within the database. Data within this database is recorded at various rehabilitation facilities by a wide variety of clinical staff throughout Australia. To help ensure quality of data submitted to the AROC database clinical staff undergo regular training. Data submitted to AROC is checked for validity and returned for correction if required.
Not all Australian rehabilitation facilities submit episode data to the AROC database. Currently 180 facilities submit data to AROC which represents more than 95% of rehabilitation facilities in Australia. However, that number has not remained constant over the observation period with the number of submitting facilities growing over time.

Although interesting, there are limitations in reporting outcomes by States of Australia. Whilst there were variations in rehabilitation outcomes across Australia, results also indicated variations in episodes discriminated by AN-SNAP and impairment codes exist which may have contributed to this (see table 3). However, there may be other factors influencing the variation in rehabilitation outcomes across Australia. Other factors may include the variation in funding structures and organisations of rehabilitation and prosthetic facilities across Australia. This study also lacks detail regarding the variation in amputee clinical practice across Australia which would impact rehabilitation outcomes.

Finally, some amputee specific items should be addressed to provide a clearer picture of the state of amputee rehabilitation. Although admission and discharge FIM™ scores are provided, information regarding level of function prior to amputation is lacking. Factors such as mobility prior to amputation are known to affect the ability of amputees to achieve successful rehabilitation with a prosthesis. Inclusion of additional outcomes may prove useful in describing rehabilitation and functional outcomes of amputees.

Conclusion:

Although only a small proportion of all episodes in the AROC database, this subset of lower-limb amputee episodes has provided a useful snapshot of the current state of amputee rehabilitation in Australia. Mean age of amputees was 67.9 years with a trend for decreasing age over the
observation period. Overall LOS of this amputee subset was considered high in comparison to other patient populations. However unlike other patient populations there does not appear to be a trend for LOS to decrease. AN-SNAP classes appear effective in distinguishing rehabilitation outcomes, and could potentially be used more effectively in planning rehabilitation programs.
References:


