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Patient outcomes following lower leg major amputations for peripheral arterial disease: A series review

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Introduction: Despite improvements in revascularization, major amputation remains a significant part of the case-mix in vascular surgical units. These patients tend to be elderly with complex pathology, resulting in poor outcomes and longer lengths of stay (LOS).

Aim: This series review provides a description of the patient complexities and outcomes in an Australian cohort undergoing major lower limb amputation for peripheral arterial disease.

Method: Medical records coded for major amputation between July 2012 and June 2013 in an Australian government funded, tertiary hospital were retrospectively reviewed and descriptively analyzed.

Findings: Twenty-five patients had 29 major amputations including four conversions from below to above knee. Seventeen had multiple vascular procedures before amputation. The average LOS exceeded the national target, and there was substantial morbidity and 30-day mortality.

Conclusion: Major amputation continues to present challenges because of patient frailty and the high rate of complications. These issues need to be considered in a robust care planning framework that includes consideration of cognitive decline and other markers of frailty. Opportunities to optimize the physical condition of these patients and to reduce delays in proceeding to surgery require further investigation. (J Vasc Nurs 2017;35:49-56)

INTRODUCTION

Major amputation remains a substantial contributor to case mix in vascular surgical units despite improved options for revascularization resulting from a rapid expansion of endovascular interventions. The latest global estimate of major amputation related to peripheral arterial disease (PAD) is 500-1000 per 100,000 people.[1] It has also been conservatively estimated that the number of patients worldwide needing a major amputation due to "dysvascular disease" is likely to double by the year 2050.[2] Such predictions have important implications for health care economics and models of care in the acute care setting.

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Numerous publications have described surgical morbidity and mortality and protracted length of stay (LOS) after lower limb amputation during the acute and rehabilitation phases.[3–5] There is also considerable evidence of poor functional outcomes with the resulting loss of mobility, leading to decreased quality of life and a declining probability of the patients' previous home being the discharge destination after amputation.[6–8] Perhaps, not surprisingly given these reported outcomes, many patients delay proceeding to major amputation. Clinical observations would indicate that it is likely that such delays feed into a cycle of complications and delayed discharge after surgery.

Major amputation is defined as at a level above the ankle and further specified as below knee amputation (BKA), above-knee amputation (AKA), or hindquarter amputation. Early (30 day) surgical outcomes following major amputation have been reported internationally[1] as 60% achieving primary healing, 15% secondary healing, 15% conversion to AKA, and 10% mortality. However, the broader geriatric-related outcomes which include delirium, falls, and pressure injuries are not well described for patients undergoing major amputation. The REASON study,[9] which included vascular surgical patients but not specifically those with amputations, analyzed outcomes in a large sample (N = 4 158) of older surgical patients from Australia and New Zealand. The 30-day mortality rate was 5%, and those with acute renal impairment, unplanned admission to intensive care, and systemic inflammatory responses were 2-3 times more likely to die within 30 days of surgery. Findings indicated that age and baseline physical and cognitive function impacted on complication rate and mortality for this patient group, whereas those who died by day 30 had longer LOS.

Because of a lack of contemporary, amputation-specific Australian data, this study will explicate the characteristics of the amputation case-mix to appreciate the complexity of patients. In doing this, it may explain why these patients are perceived to be consuming significant health care resources and the difficulty in meeting LOS targets. Such information will also assist the vascular surgical team to better anticipate some of the unique requirements of this patient group and inform interdisciplinary workforce training aimed at risk identification and reduction.

The aim of this series review is therefore to provide a description of the complexities and outcomes of patients in an Australian cohort undergoing major lower limb amputation for PAD.

MATERIALS AND METHODS

A retrospective review, the medical records of separations from a government funded, urban, tertiary hospital coded for major amputation provides the data for this series review. The hospital has a designated vascular surgical unit and four vascular surgeons. The service includes a combined 24-bed vascular-cardiac stepdown ward. It provides separate accommodation for patients with multiresistant organisms or renal failure in a renal-vascular ward with a co-located dialysis unit with 20 beds and 16 dialysis chairs. This analysis will focus on patients with peripheral arterial disease who underwent major lower limb amputation performed within a 12-month period from July 2012 to June 2013. Separations for major amputation for PAD were extracted from the data set of all major amputations conducted at the hospital during the study period.

Ethical considerations

In line with ethical access and use of patient information, an "Application for access to health data" was submitted to the Performance Monitoring & Case-mix Unit of the Local Health District. Approval was given to access the medical records coded for major amputation. Data security arrangements at all times complied with conditions of the human ethics approval, state legislation, and health policies regarding privacy and data security.

Data extraction

A list of medical record numbers assigned to separations coded for major amputation in the 12-month study period were provided by the hospital's Performance Monitoring & Case-mix Unit. The diagnosis-related group (DRG) codes assigned to amputation cases including the occurrence of complications are listed in Table 1. Coding is delineated by whether the complications are "catastrophic" (disastrous) or "severe" (serious). All patient separations meeting selection criteria between 1 July 2012 and 30 June 2013 were included in this series of 29 consecutive separations for major amputation. A detailed review of the data uncovered two cases of conversion from BKA to AKA and three cases relating to a single patient having sequential BKAs and a subsequent simultaneous bilateral above knee conversion. These cases were combined resulting in a series of 25 patients.

Each patient's paper and electronic medical record were reviewed to capture data for the first seven of the following eight data categories. Details of common complications and those of specific interest for this analysis were then extracted from a secondary report detailing all complications coded for the separation to form category eight.

TABLE 1

DRG CODINGS ASSIGNED

DRG	*Description*	*Number MA coded*
I072	Amputation	3
Y012	Ventilation for burns & severe full-thickness burns	1*
K01A	OR Procedures for diabetic complications W catastrophic CC	6
F11A	Amputation for circulatory system except upper limb and toe W catastrophic CC	11
F11B	Amputation for circulatory system except upper limb and toe W/O catastrophic CC	5
X04A	Other procedures for injuries to lower limb W catastrophic or severe CC	1
F08A	Major reconstruct vascular procedure W/O CPB pump W catastrophic CC	1
F08B	Major reconstruct vascular procedure W/O CPB pump W/O catastrophic CC	1
J112	Other skin, subcutaneous tissue and breast procedure	1

W = with; W/O = without; CC = complications; CPB = cardiopulmonary bypass.
*excluded.

1. Patient demographics
2. Previous vascular interventions
3. Indication for major amputation
4. Level of major amputation
5. Length of stay
6. Co-morbid conditions
7. Preoperative function and three physical markers (albumin, white cell count and hemoglobin)
8. Postoperative complications

RESULTS

Patient demographics

Table 2 provides a summary of patient characteristics. The series was of advanced age; the mean was 78.3 years (range, 57-92 years). Amputation was more common in males with a ratio of males to females of 1.5:1. Home was the place of preoperative

TABLE 2

SERIES DEMOGRAPHIC CHARACTERISTICS AND DISCHARGE DESTINATIONS

Demographic characteristics	*n*	*%*
Gender		
Male	15	60
Female	10	40
Level of amputation		
BKA	12	42
AKA	17	58
Conversion BKA to AKA	4	16
Admission residence		
Home	16	64
RACF	9	36
Pre-op. narcotic use		
Yes	24	96
No	1	4
Discharge destination		
Home	1	4
RACF	12	48
Rehabilitation	9	36
Deaths	3	12

residence for 16 patients and Residential Aged Care Facilities (RACF) for a further nine patients. Only one patient was able to be discharged directly to their home, with nine transitioning to inpatient rehabilitation with plans of returning home as the eventual discharge destination. In-hospital deaths included patients from both preoperative residence groups: home (n = 2) and RACF (n = 1). An additional four patients were discharged to RACFs resulting in 12 of 22 (54%) live separations requiring institutional care on a permanent basis following amputation.

Previous vascular interventions

A summary of health care resource utilization for vascular indications before amputation including LOS and previous procedures arising from PAD is provided in Table 3. Eleven patients had presented to the Emergency department (ED) a total of 21 times (range, 1-4 occasions each). For 17 patients (68%), there were 42 previous procedures with a mean of 2.8 (range, 1-11) on the ipsilateral leg and in nine patients (36%) underwent 19 procedures with a mean of 1.6 on the contralateral limb. Among patients who had previously been admitted for ipsilateral limb interventions, the average LOS for the previous admission was 21.5 days (range, 10-65 days), which reflects the high use of acute care services as these patients approach major amputation (MA).

Indication for major amputation

Table 4 provides indications for major amputation with 86% of operations performed for tissue breakdown. There was a range

TABLE 3

SUMMARY OF HEALTH CARE RESOURCE UTILIZATION

Characteristic	*Mean*	*Range*
Hospital length of stay (d) for MA	35.1	7-101
Time between admission and MA (d)	11	0-44
Emergency department presentations	1.9	1-4
LOS of previous admission for PAD (Days)	21.5	10-65
Previous ipsilateral procedures	2.8	1-11
Previous procedures on contralateral limb	1.6	1-9
Pre amputation interventions	Ipsilateral	Contralateral
Debridement	1	2
Toe amputation	4	4
Major amputation	4	4
Stump revision	2	
Stent	8	6
Bypass	8	3
Extra-anatomic bypass	3	
Endarterectomy	1	
Graft thrombectomy/revision	11	
Total	42	19

in characteristics of the tissue loss related to arterial insufficiency in terms of tissue type, surface area and depth, and location. Of the 25 initial amputations, 14 (56%) were for gangrene, an indicator of advanced tissue loss and only three (12%) proceeded to major amputation solely with ischemic rest pain. As expected, all four conversion amputations were for nonhealing stump wounds. A further three amputations involved patients with infected synthetic bypasses that required explantation of the graft rendering the limb critically ischemic.

Level of major amputation

The initial amputation levels were 12 BKA versus 13 AKA, a ratio of 1:1. Four of 12 (33%) below-knee stumps required revision to above knee for three patients with cognitive impairment.

Hospital length of stay for major amputation

Mean LOS for this series was 35.1 days (range, 7-101 days; Table 3). The time between admission and major amputation varied between 0 and 44 days with an average delay of 11 days

TABLE 4

MAJOR AMPUTATION SEPARATIONS CODED FOR INDICATION

Disease	*n*	*%*
Atherosclerosis of arteries of extremities with	25	86
Intermittent claudication	2	7
Rest pain	1	4
Ulceration	4	14
Gangrene	15	52
Unspecified	3	10
Type 2 diabetes mellitus with foot ulcer due to multiple causes	2	7
Leg wounds	1	4
Gangrene not classified elsewhere	2	7

between admission and surgery. The average time between admission and major amputation for patients admitted from home and discharged to RACFs was 15.8 days (range, 1-44 days) and the average LOS was 55.4 days (range, 21-100 days).

Co-morbid conditions

In keeping with the growing prevalence of diabetes and cardiovascular disease, the following co-morbity data were recorded: diabetes mellitus (type II) (40%), known coronary artery disease (32%), heart failure (28%), and chronic kidney disease (32%, of which about half were on renal replacement therapy). Twenty-eight percent of patients were current smokers, and all remaining patients had a documented history of tobacco use. One patient had active lung carcinoma. Cognitive impairment was documented in 40% of cases although the severity of the impairment was not specified, and few patients had it formal measurement using a recognized tool.

Preoperative function and physical markers

The patients' preoperative functional level was assessed and recorded on admission and is summarized in Table 5. Only seven patients (28%) were documented as achieving "mobility at baseline," and three of these were previous amputees and mobilized using prostheses. Ten were below their baseline; two were chairbound, and three were bed bound (Note, all but one of these patients were receiving narcotics pre-operatively).

TABLE 5

LEVEL OF MOBILITY AT MA

Mobility level	*Number*
Mobility at baseline	7
Mobility at below baseline	10
Prosthetic mobility	3
Wheelchair mobility	2
Bed bound	3

Table 6 contains mean levels for three biomarkers (routinely assessed in the surgical workup), measured on the day of amputation, that are known to be useful in the evaluation of fitness and have potential for risk prediction.[10] In this series, the average serum albumin was 31.7 g/L (3.17 g/dL); just under the lower limit of normal. However, albumin was 20.5 and 22 g/L (2.05 and 2.2 g/dL) in two of the three patients who subsequently died. The average hemoglobin level of 107.5 g/L (10.75 g/dL) for the series was well below the lower limit of normal. However, in the patients who died, the documented hemoglobin level was above the series average and almost within the normal range which may relate to transfusion (transfusion history was not investigated). The average white cell count for the 29 cases was well above the upper limit of the normal range, including marked elevation in two patients who died.

Postoperative complications

Nineteen of the 29 (76%) episodes were coded as having either severe or catastrophic complications after major amputation. A summary of complications that were prevalent and those of interest in this review are provided in Table 7. Procedure-related complications include bleeding or hematoma. Amputation-specific surgical outcomes for this series were 38% primary wound healing, 15% secondary wound healing, 30% conversion from BKA to AKA, and 10% early mortality.

DISCUSSION

This series review demonstrates the complexities of patients undergoing major lower limb amputation for PAD. Patients were advanced in age and had high levels of cardiovascular and other co-morbidities, and in the year preceding, amputation had experienced multiple presentations to ED, in-hospital stays, and numerous vascular interventions. A high number of interventions on both the ipsilateral and contralateral limbs were also documented, particularly given that this series reviews only reported procedures performed within this vascular unit.

The surgical outcomes reported for this series compares reasonably well to the available international collaboration group (ICG) series review data with 20% compared to 15% (ICG) secondary healing and 12% compared to 10% (ICG) early mortality. The series rate of conversion was twice that of the ICG (30% compared to 15%[1]) and primary healing close to half the ICG rate (38% vs 60%). Three patients had synthetic bypass graft infections that are associated with high morbidity and mortality.[11] Two of the three patients who died in this series had graft infections and died from sepsis and multiorgan failure despite explantation of the graft and major amputation. The importance of identifying patients at increased risk of developing surgical site infection[12] (i.e., patients with immunocompromise, active ulceration or infection) which may lead to graft infection and providing antibiotic prophylaxis for this high-risk group is paramount. If a graft infection develops, then early and aggressive management is vital as once infected graft material requires

TABLE 6

SUMMARY OF FITNESS MARKERS AT TIME OF SURGERY

Marker	*Mean*	*Series range*	*Normal range values*
Albumin	31.7 g/L (3.17 g/dL)	20-50 g/L (2.0-5.0 g/dL)	35-50 g/L (3.5-5.0 g/dL)
Hemoglobin	107.5 g/L	76-136 g/L	Female 123-157 g/L (12.3-15.7 g/dL), Male 140-174 g/L (14-17.4 g/dL)
White cell count	15.2×10^9/L	$8.7\text{-}26.4 \times 10^9$/L	$4.0\text{-}10.0 \times 10^9$/L

explantation and the subsequent risk of major amputation is extremely high.[13]

The length of stay (LOS) for major amputation as defined within the activity-based funding model is currently 24.5 days.[14] At 35.1 days (range, 7-101 days; Table 3), the mean LOS for this series exceeded the national benchmark by more than 10 days. This may in part be explained by the prolonged preoperative hospitalization period, ranging from 0 to 44 days between admission and amputation. The mean preoperative time for this series was 11 days which is the same as the 11 days for a national series of over 14,000 amputations in the United Kingdom. In their group that received no revascularization attempt, the median delay to amputation was reduced to 7 days.[15]

It may be that such variations in the preoperative LOS (time to amputation) reflect the need for surgical work-ups to optimize preoperative fitness, attempts to revascularize or allow demarcation of dead tissue or treat infection[15] and/or health system–related waiting lists. However, anecdotal evidence suggests that an extended (often in-patient) preoperative period frequently relates to the difficulty patients (and their families) often have in reaching a decision about amputation. The cognitive impairment reported as co-morbidity in 40% of this series also requires further consideration as a potential contributing factor to delayed amputation as it is may underlie both the patient's own difficulty in reaching a decision and/or the need for family or guardian(s) involvement in making such decisions by proxy. Irrespective of the reason for the extended preoperative LOS, patients decondition very quickly in this state, which increases the risk of postoperative problems and delays the transition to rehabilitation[16]

The high incidence of postoperative complications (Table 7) also contributes to extended LOS. This is because patients then require additional time to address these wide-ranging set-backs. Postoperative complications increase hospital costs and may contribute to delayed rehabilitation and return to optimal function. A second reason for extended postoperative LOS is delayed discharge, which is often due to system-related difficulties in accessing rehabilitation or RACF beds. Although this was not tracked specifically in this series, two patients admitted from RACFs for a second major amputation were discharged back to the RACF at postoperative day 7 and 10, respectively: a LOS well below the series average, which was the result of the patients RACF preadmission location and family agreement for their return to the original facility when stable.

The cases identified within this series as having extended LOS (frequently well above the series and national average) support the argument for an increased focus on strategies to reduce the time between admission and amputation and further attention to discharge processes as these necessary reductions in LOS would both decrease resource utilization and also the risks associated with hospitalization of a frail elderly person.

TABLE 7

SUMMARY OF POSTOPERATIVE COMPLICATION

Complication	*Number of cases*	*% Of cases*
Procedure-related complication	8	27
Post hemorrhagic anemia	6	20
Anemia not specified	21	72
Wound infection	4	14
Multiresistant organism colonization	16 (16 MRSA + 3 VRE)	55
Delirium	10	35
Pressure injury	18	62
Fall	8	27
Urinary tract infection	10	35
Acute myocardial infarction	6	20
Acute renal impairment	8	27
Respiratory failure	5	17
Adverse effects of opioids	3	10

MRSA = multiresistant staphylococcus aureus; VRE = vancomycin resistant enterococcus.

Frailty and the vascular patient

Patients requiring major amputation for PAD tend to be elderly, frail and exhibiting multiple co-morbid conditions. Patients in this series had an average age of 78.3 years and exhibited a number of markers of frailty, flagging this issue as worthy of further discussion. Frailty is an emerging concept in surgical practice[17] and is pertinent to understanding and planning optimal care for vascular patients. Fried defines frailty as: "a physiologic state of increased vulnerability to stressors that results from decreased physiologic reserves, and even dysregulation, of multiple physiologic systems."[18] Frailty renders patients clinically vulnerable in the perioperative setting due to a diminished capacity to compensate effectively for external stressors. Frailty places patients at greater risk of adverse outcomes, including increased hospital stay, institutionalization, worsening disability, and death.[19]

Conceptualizing a frail older person as a complex system on the threshold of failure facilitates assessment for potential geriatric syndromes.[17] The impact of geriatric syndromes on perioperative experience and poor outcomes is demonstrated in a useful conceptual model inclusive of incontinence, falls, pressure injuries, delirium, and functional decline (see Figure 1).[20] Risk factors that may lead to such geriatric syndromes include older age, baseline cognitive impairment, baseline functional impairment, and impaired mobility—all of which are evident in this series review. Additionally, cognitive impairment is likely to further compound some risk factors[21] with patients unable to engage in all aspects of their care plan[22] as observed in practice decisions about amputation.

The complex interplay between surgical and geriatric outcomes will be examined with reference to the patients is this series. Albumin and hemoglobin levels, two of the three physical markers of fitness for surgery reported in our series review (Table 7) are accepted characteristics of frailty and indicators of potential mortality (low albumin <30 g/L [3 g/dL] and low hemoglobin < 119 g/L [11.9 g/dL]).[9] The series mean albumin level approached 30 g/L (3 g/dL) and was well below this level in two of the patients who died. The series mean hemoglobin level of 107.5 g/L (10.75 g/dL) was also well below the lower limit of normal suggesting that many of the patients in this series may have had anemia of chronic disease, which is related to ongoing inflammation associated with chronic ulceration and low-grade infection.[23] Finally, although not a marker of frailty but related to the issue of infection and inflammation, the series mean for white cell count was 15.2×10^9/L which was well above the upper limit of normal (Table 7). Although studies report the link between frailty and specific inflammatory biomarkers including C-reactive protein, albumin, interleukin-6, and tumor necrosis factor-α,[19] the relationship between white cell count (WCC) can only be generally linked to infection in this series as we did not specifically extract data for these inflammatory markers. The high mean WCC and a marked elevation of the WCC in the two patients who died do, however, support the potential usefulness of WCC as an inflammatory marker of frailty and of increased risk of poor postoperative outcomes.

Falls, pressure injuries, delirium, and functional decline as components of "geriatric syndromes" (Figure 1) are targeted for prediction/identification and early intervention through focused assessments at admission and regularly thereafter. These three frailty indicators are interrelated and contribute to death, discharge to aged care facility, and nonambulatory status.[24] Despite baseline risk assessments for delirium, falls, and pressure injuries, these factors continue to be a common problem in vascular surgical patients, particularly those having a major amputation.

Within our series, eight patients experienced falls (Table 7), two of which resulted in trauma to their stump and suture line breakdown. Both of these patients also had documented delirium and despite close nurse observation, their unpredictable behavior clearly remained a challenge in a busy surgical unit. The implications of falls are far reaching for both patients and the service as significant injuries are associated with falls including those to soft tissue, head, and bone, which may lead to further hospitalization, disability, and increased risk of institutionalization and death.[23]

Amputees are at high risk for pressure injuries.[3] Among the 18 patients in our series, a total of 27 pressure injuries (Table 7) of varying severity were documented: four stage 1, 15 stage 2, two stage 3, three stage 4, and three unstageable. Only three pressure injuries were present on admission resulting in the hospital-acquired incidence rate of 72%. Although there is no doubt that this is cause for concern, there are a number of factors that may have contributed to the high incidence. First, as a

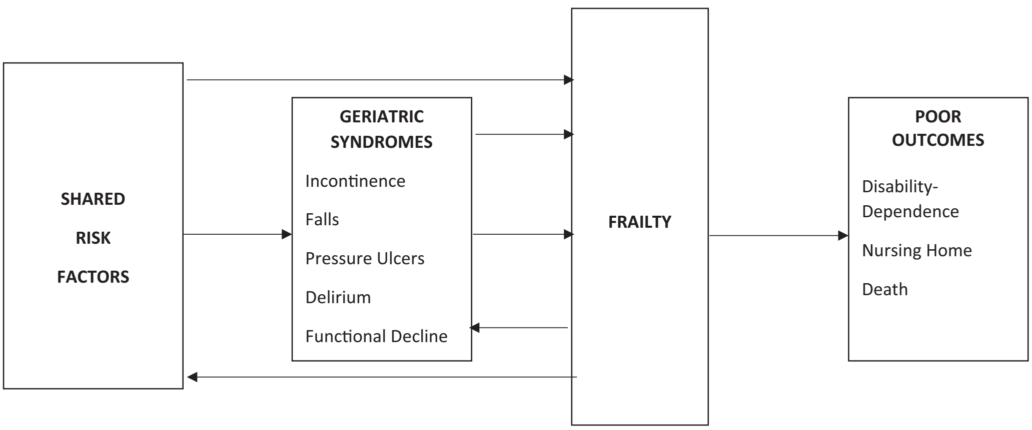

Figure 1. *Conceptual model of geriatric syndromes.[20] Reproduced with permission.*

consequence of their increasing immobility (due to their ischemia and wound pain), many of these patients were present at admission with undetectable or undetected pressure-related skin injury that only manifests later. Although this delay in manifestation may inflate the hospital-acquired rate of pressure injuries, it also highlights the importance of skin assessment and aggressive risk reduction interventions on admission to hospital.

Delirium, a further component of geriatric syndromes, also contributes to the difficulty of implementing effective pressure injury risk reduction strategies in this patient group. In this series, 35% of patients had a documented delirium of varying severity and duration. In reality, it is likely that an additional number may have had either mild delirium or a hypo delirium postoperatively which may not have been detected and documented.[25] If the care environment is not suitable to nurse a patient with a delirium, there is often a need for 1:1 specialling to reduce the risk of harm, and this is an additional cost to the episode of care.[26] It may not be unusual for a patient with a persistent delirium to need high-level observation for a number of days, adding to both the cost and length of stay. Delirium then feeds into the cycle of other geriatric issues delaying recovery and transition to rehabilitation.[27]

Patients approaching major amputation usually have some degree of walking impairment due to ischemic pain that then contributes to functional decline. Kane et al [23] highlight the issues related to immobility in the geriatric population and the multiple subsequent diseases and problems that induce further pain, disability, and impaired quality of life. In this series, only a quarter of patients were assessed as having "baseline mobility" on admission but in reality, this "baseline" was likely to be a reflection of the gradual deterioration in walking capacity they had been experiencing due to their ischemia. This is, therefore, the documented beginnings of the functional decline that is then compounded when the patient undergoes major amputation; the capacity for bipedal ambulation is interrupted until and if the patient begins prosthetic ambulation. Combining abrupt loss of mobility with their other conditions and the impact of anesthesia and surgery further impair an elderly person's physical and cognitive function. Many of these elderly patients are challenged in improving their functional capacity[22] and the contribution this makes to their frail state are clear.

Approaches to vascular surgery for PAD need to address the complexities of this patient group so that the economic model that mandates a defined LOS is achievable or explainable when LOS variances occur. The "clock" is ticking from the time of the patient's admission and if the preoperative period is extended for any of the many reasons demonstrated within this series it makes LOS targets difficult to achieve. Hence, it may be necessary to reset LOS benchmarks for this cohort of largely geriatric surgical patients. The difficulty optimizing the condition of these patients, and the decision to opt for either a surgical versus a conservative approach needs to be incorporated into a patient's care plan. Consideration needs to be given to preoperative time needed to assist the team to work sensitively with the patient and family to make timely and appropriate decisions.

Amputation earlier and at the optimal level may have the potential to improve patient and family outcomes by reducing the range and severity of complications. In this series, the level of the initial amputation was 12 BKA versus 13 AKA, which is consistent with other centers who reported ratios of 1:1.[1] Four of the 12 (33%) below-knee stumps required revision to above-knee stumps, which exceeded the 12% reported in the IGS[1] and requires further explanation and monitoring. Attempts to preserve as much of the limb as possible need to be balanced with the degree of cognitive impairment and its impact on the patient's ability to maintain knee extension. In cognitively impaired patients, conversion is necessitated by severe stump breakdown from fixed-flexion contractures of the knee contributing to poor positioning and a compromised suture line.

With the significant mortality rate in mind, it is also an opportunity for the commencement or adjustment of an advanced care plan. The benefits of an advanced care plan include planning patient-centered care and an opportunity to open-up discussions about end-of-life care. This task may not fit well with the surgical focus of the team and the often tight timelines mandated, but these must be considered.

This series review has demonstrated both considerable consistence with the findings of the IGS[1] but also important differences in outcome from the international data which were collected nearly 10 years ago. Most importantly though, it illustrates how major amputation for PAD continues to present challenges to the vascular team and the importance of considerations of frailty within this largely geriatric surgical population.

Limitations

Activity outside the service could not be included due to lack of access to medical records outside the organization resulting in noncapture of possible outlying interventions and ED presentations. Data were reported by means and percentages which do not support the conclusions as well as a higher level statistical analysis. Albumin levels correlate with inflammatory response and are useful to demonstrate depletion but may not necessarily indicate poor nutritional levels. A superior marker for nutritional fitness would have provided a stronger predictor of nutritional status.

CONCLUSION

Major amputation for PAD continues to present challenges for LOS determinations because of the complexity of the preoperative preparation required, patient frailty, and the high rate of reported complications. These issues need to be included when discussing options for treatment with patients and families. The difficulty optimizing the condition, the potential for and use of markers for frailty in these patients and delays in proceeding to surgery require further investigation, including research to further clarify the links between frailty, delays to major amputation, and poorer outcomes. Qualitative research that seeks to interpret the patient and family decision-making processes for major amputation would also assist here.

This series has demonstrated that the care of patients preparing and recovering from major amputation requires skills beyond general surgical practice. Broad ranging risk identification and reduction via the interdisciplinary team and the engagement of the patient and family will hopefully contribute to better patient and family outcomes and for the health service, optimal patient flow and resource utilization. Models of service delivery such as a collaborative Vascular-Geriatric Team would likely be of value in achieving a more patient-centered approach to this complex clinical scenario. Not only do clinicians working with these patients have to be concerned with surgical management, but we also need to interface more effectively with services such as geriatric and rehabilitation medicine so that patients preparing and recovering from amputation get the best possible care and support.

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