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ORIGINAL ARTICLE

Lower extremity amputations in Ireland: a registry-based study

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Abstract

Objective To analyse the current provision of lower extremity amputations (LEA) in Irish public hospitals by patient characteristics and assess the potential savings for reducing numbers if a national multi-disciplinary foot protection clinic (MDFPC) was established nation-wide.

Design and data sources Patient characteristics of LEA conducted during 2016–2019 were analysed based on discharge data from the national hospital inpatient enquiry system. Reported consequences from existing literature were used to extrapolate national consequences.

Results Public hospitals registered 3104 hospital admissions with LEA during 2016–2019. 68% ($n = 2099$) of these were minor amputations. About 76% ($n = 1592$) of minor amputations and 52% ($n = 525$) of major amputations were performed on patients with a diagnosis of diabetes. If the implementation of a national MDFPC programmed could reduce the number of diabetic amputations by 20%, 80 minor and 26 major amputations could be avoided annually. This would avoid nearly 3000 hospital bed days and correspond to a potential annual saving of €3 M.

Conclusion LEA has severe impact on patients' lives and hospital resources. Potential savings from effective prevention strategies may offer both health improvements and cost-savings.

Keywords Ireland · Lower extremity amputations · Registry-based study

Introduction

Although amputations of lower extremities may save the life of patients, they have severe consequences for surviving patients' health-related quality of life including mobility and functional levels, in particular in reference to major lower extremity amputations (LEA) [1–3]. LEA are also related to substantial use of hospital resources as patients with LEA tend to stay for a long time and require both intensive rehabilitation and expensive fitting and use of protheses [4, 5].

LEA is a common procedure in patients with non-healing diabetic ulcers that arise due to autonomic neuropathy, sensory, and motor dysfunction. Patients with diabetes and foot disease have elevated risk of requiring lower limb amputation with risk ratios exceeding 7 in comparison with non-diabetic populations [6].

The clinical prognosis of patients with diabetes who undergo LEA is poor with 9–20% of patients requiring a further amputation within the year and 28–51% requiring a further amputation within 5 years. The 2-year survival rates after major limb amputation has been estimated at 50% and 5-year survival rates at 29% [7].

Several studies have recommended dedicated diabetic foot teams as cost-effective means to improve patient care and reduce the need for amputations. Diabetic foot teams include podiatrists, specialist nurses, endocrinologists, and surgeons that are the mainstay of diabetic foot care [8, 9]. An Irish study from 2012 identified potential national annual savings of €114,000 from implementation of a multi-disciplinary foot protection clinic (MDFPC) [10], which was a consultant led team including Vascular Surgery, Endocrinology, Orthopaedic Surgery, Podiatry, Orthotics and Tissue Viability. The study documented a reduced need for amputations, less need for rehabilitation, and shorter length of stay.

Despite their advantages and a HSE model of care supporting their development [11], MDFPCs have not yet been

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established in Ireland nationwide though the model of care is currently under review. However, this may soon change as there is clear support of Foot Protection Teams and Multidisciplinary Foot Teams in the soon to be published "Diabetic Foot Model of Care" 2020.

The foot protection team is a community-based team involved in the care of the person with the "at-risk foot." It consists of a general practitioner, clinical specialist podiatrist (diabetes), diabetes nurse specialist, senior podiatrist, staff grade podiatrist, administrative staff, orthotist, and clinical specialist podiatrist (musculoskeletal). The document advocates for better foot management in the community which would reduce the number of patients being to referred to secondary care. Better diabetes control, earlier identification of the risk, and appropriate intervention could prevent ulceration and reduce the risk of LEA in this population.

The multidisciplinary foot team, based in secondary care, will lead the assessment and management of active disease with appropriate input from senior clinical expertise in diabetes, podiatry, wound care, vascular surgery, orthopaedics, infectious diseases and microbiology, orthotics, and prosthetics psychology and nutrition.

This paper examines the current situation in terms of the incidence of LEA among patients with diabetes and the implications in terms of healthcare costs in Ireland. The objective was to analyse the current provision of LEA in Irish public hospitals between 2016 and 2019, to assess the potential for reducing the volume of procedures and the associated cost, and the scope for an effective preventative strategy to save limbs and money, if an effective prevention strategy as described in the Model of Care was in place.

Materials and methods

All patients who have undergone LEA in public hospitals in Ireland are registered in the national Hospital Inpatient Enquiry (HIPE) system. This system uses the International Classification of Disease-10th Revision, Australian Modification (ICD-10AM) to describe the diagnosis and the Australian Classification of Health Interventions, 8th Edition (ACHI) to describe procedures. The National Quality Assurance Improvement System Surgery (NQAIS) is a software system [12] for extracting HIPE discharge data [13] into useful clinical information.

From NQAIS data was obtained for inpatient episodes for patients aged 16 years and older where amputation of the lower limb was coded as the primary procedure. We categorised amputations below and above the knee (ACHI codes: 4433800, 4435800) as major amputations, and amputations of a toe, metatarsal, and transmetatarsal (ACHI codes: 4,436,401, 4,436,700, 4,437,600) as minor amputations. Based on all available diagnostic codes (primary and secondary diagnoses), we identified episodes with a diabetic diagnostic code (ICD-10AM codes: E10-E13) as patients with diabetes and all other episodes as non-diabetic.

Based on these four categories of patients with diabetes/without diabetes and major/minor amputations, descriptive analysis was conducted of the categorical variables related to sex, age, ASA-score [14], Charlson Comorbidity Index [15], mean length of stay, mean length of pre- and post-operative stay, length of intensive care stay, readmissions within 7 and 30 days, and hospital death within 7 and 30 days post-operatively. Graphical presentations were used to illustrate variation by sex and age for the four categories of amputations by number of episodes and mean length of stay.

As expression of the hospital costs, we used the available codes for diagnostic related groups (DRG) and obtained the national tariff for these codes from the Healthcare Pricing Office (HPO)[16]. For the four categories of amputations, we presented the accumulated DRG-cost by sex and age.

To express the potential savings from better prevention of amputations, we examined the assumption that an effective multi-disciplinary team approach might reduce the current level of amputations conducted on patients with diabetes by 20%.

Results

Between 2016 and 2019 public hospitals in Ireland conducted a total of 3104 LEAs. The annual number of procedures varied between 700 (2016) and 848 (2018). Of these procedures, 68% ($n = 2099$) were minor amputations and 32% ($n = 1005$) were major amputations. About 76% ($n = 1592$) of the minor amputations and 52% ($n = 525$) of the major amputations were performed on patients with a diagnosis of diabetes.

The number of hospital admissions by sex and 10-year age groups is shown in Fig. 1. Patients with diabetes undergoing a minor amputation clearly make up the most hospital admissions, with a plateau between age groups 60–79.

Table 1 provides descriptive analyses of the four categories of amputations in terms of comorbidity scores (ASA and Charlson Comorbidity Index), length of stay, readmission, and mortality rates for the different patient groups. The breakdown of length of stay for the different procedures and patient categories shows that the mean LOS for major LEA was 52.2 days, patients with diabetes staying approximately 3.5 days longer than patients without diabetes. The mean LOS for minor LEA was 17.5 days with patients with diabetes staying for 4.2 days longer than patients without diabetes. Although there was 3.4 times as many male as female patients, there was no statistically significant difference in mean length of stay ($p = 0.601$).

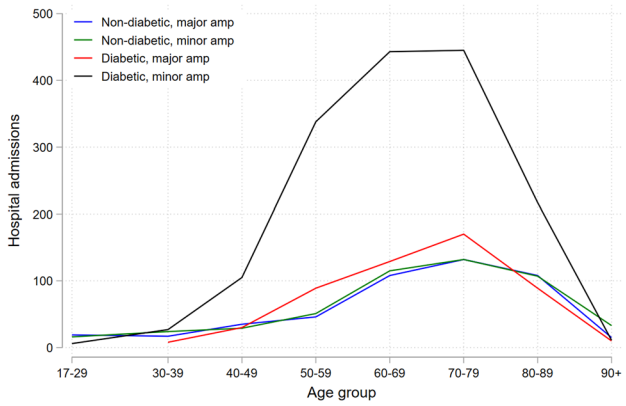

Fig. 1 Hospital admissions by LEA type and 10-year age group

Figure 2 shows the variation in length of stay for different patient categories by sex and age group. Patients aged 40–49 year with diabetes stay the longest time in hospital with an average length of stay of 70 days. This age group has the longest pre-op LOS of 20 days. The average pre-op LOS for a patient with diabetes undergoing a major LEA was 14.7 days and 12.7 days for a patient without diabetes. The average LOS for minor LEAs was considerably shorter as can be seen on Fig. 2. The total LOS was higher for each age category except 50–59 years and 80–89 years when comparing patients with and without diabetes.

The accumulated hospital bed days and DRG costs between 2016 and 2019 are visualised in Fig. 3 for patients categorised into 10-year age groups. Patients with diabetes undergoing minor LEAs between ages 70–79 took up more than 10,000 bed days during the 4-year period. Patients with diabetes undergoing major LEAs between the ages 60–69 and 70–79 took up approximately 9000 bed days for each age group over the 4-year period.

The total hospital cost for all amputations during 2016–2019 was estimated at €90.4 M. 52% of the costs (€47.3 M) relate to minor amputations, and 67% of the cost (€60.6 M) relate to patients with diabetes. The mean

Table 1 Descriptive analysis of hospital inpatient episodes with LEA conducted at Irish public hospitals 2016–2019

Type of pt	Non-diabetic, major	Non-diabetic, minor	Diabetic, major	Diabetic, minor	Total
n (%)	480(15.5)	507(16.3)	525(16.9)	1592(51.3)	3104(100)
ASA score, *n* (%)					
1, *n* (%)	10(2.1)	26(5.1)	3(0.6)	25(1.6)	64(2.1)
2, *n* (%)	79 (16.5)	127 (25.0)	46 (8.8)	328 (20.6)	580 (18.7)
3, *n* (%)	270 (56.3)	255 (50.3)	337 (64.2)	907 (57.0)	1769 (57.0)
4, *n* (%)	76 (15.8)	24 (4.7)	91 (17.3)	102 (6.4)	293 (9.4)
5, (%)	7 (1.5)	0(0)	6 (1.1)	2 (0.1)	15 (0.5)
Missing, *n* (%)	38 (7.9)	75 (14.8)	42 (8.0)	228 (14.3)	383 (12.3)
Charlson Comorbidity Index, *n* (%)					
0–3, n (%)	267 (55.6)	364 (71.8)	202 (38.5)	735 (46.2)	1568 (50.5)
4–6, n (%)	61 (12.7)	52 (10.3)	18 (3.4)	43 (2.7)	174 (5.6)
7–9, n (%)	22 (4.6)	4 (0.8)	64 (12.2)	228 (14.3)	318 (10.2)
10+ , *n* (%)	130 (27.1)	87 (17.2)	203 (38.7)	359 (22.6)	779 (25.1)
Missing, *n* (%)	0 (0.0)	0 (0.0)	38 (7.2)	227 (14.3)	265 (8.5)
Proc 1 ACHI name, *n* (%)					
Amputation above knee, n (%)	344 (71.7)	0 (0.0)	247 (47.0)	0 (0.0)	591 (19.0)
Amputation below knee, n (%)	136 (28.3)	0 (0.0)	278 (53.0)	0 (0.0)	414 (13.3)
Amputation of toe, n (%)	0 (0.0)	243 (47.9)	0 (0.0)	658 (41.3)	901 (29.0)
Amputation toe including metatarsal bone, *n* (%)	0 (0.0)	197 (38.9)	0 (0.0)	692 (43.5)	889 (28.6)
Transmetatarsal amputation, *n* (%)	0 (0.0)	67 (13.2)	0 (0.0)	242 (15.2)	309 (10.0)
LOS total, mean (sd)	50.4 (59.3)	15.4 (21.3)	53.9 (63.5)	19.6 (25.9)	29.5 (43.5)
LOS pre-op, mean (sd)	12.7 (27.3)	4.7 (8.0)	14.7 (24.3)	5.6 (11.9)	8.1 (17.7)
LOS post-op, mean (sd)	37.7 (48.4)	10.6 (17.7)	39.2 (53.6)	14.0 (20.8)	21.4 (35.5)
ICU/CCU bed days, mean (sd)	2.0 (8.9)	0.2 (1.6)	1.1 (4.0)	0.2 (1.7)	0.6 (4.1)
Readmission after 7 days, mean (sd)	0.01 (0.10)	0.03 (0.18)	0.02 (0.14)	0.04 (0.19)	0.03 (0.17)
Readmission after 30 days, mean (sd)	0.06 (0.23)	0.10 (0.30)	0.07 (0.25)	0.16 (0.37)	0.12 (0.32)
Death 7-day post-OP, mean (sd)	0.03 (0.17)	0.00 (0.06)	0.02 (0.14)	0.00 (0.05)	0.01 (0.10)
Death 30-day post-OP, mean (sd)	0.07 (0.26)	0.02 (0.13)	0.06 (0.23)	0.01 (0.10)	0.03 (0.17)

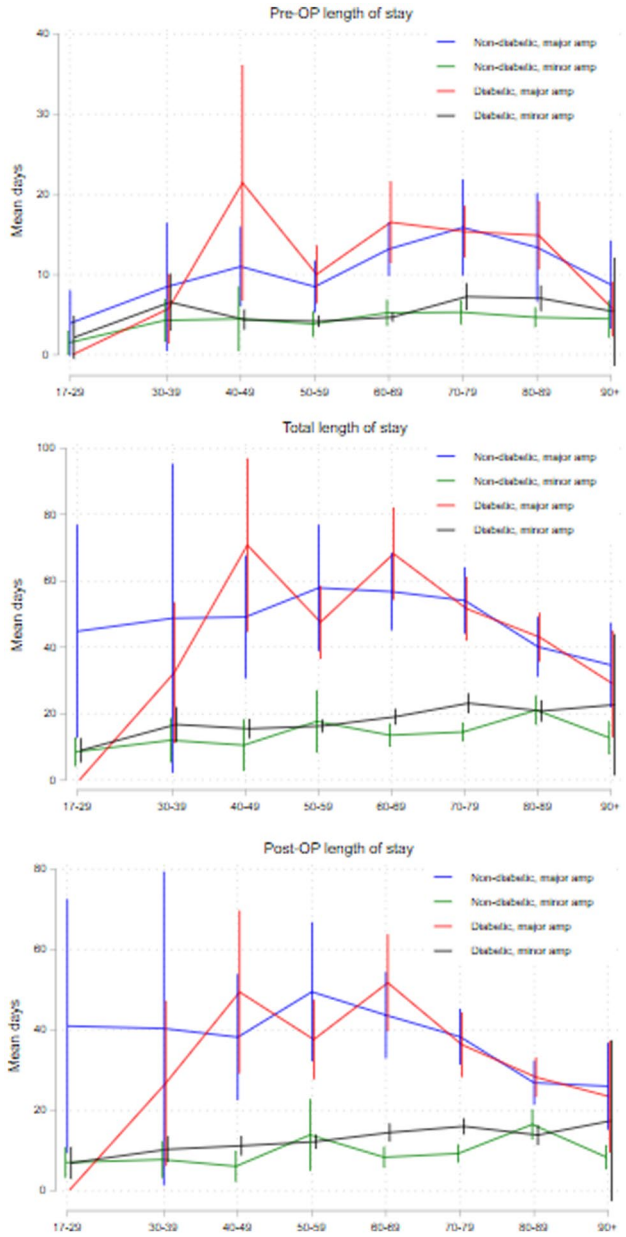

Fig. 2 Mean length of stay (total, pre-OP, and post-OP) by LEA type and 10-year age group

cost of a major LEA was €42,814 for a patient diagnosed with diabetes and €42,746 for a patient without diabetes. The similar mean cost for patients with minor LEA was €23,940 for a patient diagnosed with diabetes and € 19,244 for a patient without diabetes.

If the implementation of a model of care including the deployment of multidisciplinary foot protection clinics could reduce the number of diabetic amputations by 20%, 80 minor and 26 major amputations could be avoided annually eliminating 2975 bed days and yielding a potential saving of €3 M.

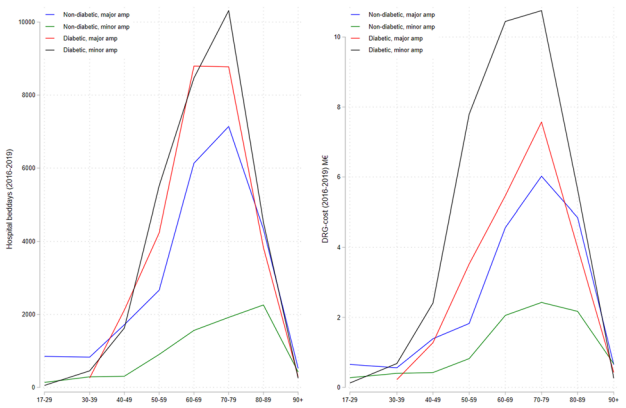

Fig. 3 Accumulated hospital bed days and DRG-cost by LEA type and 10-year age group

Discussion

Public hospitals in Ireland conducted a total of 3104 amputations between 2016 and 2019. Two thirds of these were minor amputations, and the majority of these procedures occurred in patients with a diagnosis of diabetes. It has been established that the prevalence of diabetes is rising in Ireland [17]. A systematic review of fifteen studies in 2016 identified that the national prevalence of doctor diagnosed diabetes significantly increased from 2.2% in 1998 to 5.2% in 2015. A study in primary care identified incidence rates for leg amputations were 1.7% in the West of Ireland in 2013 [18]. There is no reliable data comparing the quality of diabetes management in the Irish population with other jurisdictions [17]. While there is debate on whether amputation rates should be used as a marker of both prevalence and quality of diabetes management [8, 19], they clearly have obvious negative implications for patients' mobility and functional level, and long-term implications for their health-related quality of life and survival [2, 3].

Approximately 68% of all amputations were conducted on patients with a diagnosis of diabetes, and 75% of amputations on patients with a diagnosis of diabetes were minor amputations. Certainly, data from the USA suggest that more than 80% of all vascular-related LEA are associated with diabetes [9]. There may be some element of under-reporting of co-morbidities in HIPE, particularly where this has no impact on the calculation of DRGs, the primary indicator of complexity used by the HPO.

This study clearly demonstrates the extended LOS that is associated with these procedures and the consequent huge costs. Patients with diabetes stay approximately 3.5 days longer than patients without diabetes for major LEAs and 4.2 days longer for minor LEAs. The difference in pre-op LOS between patients with a diabetic diagnosis and without

may be due to the fact that patients with diabetes may need treatment before amputation such as antibiotic treatment or revascularisation [10]. It is clear that great savings could be made by reducing these long LOS. Other contributors to the extended LOS for major LEAs are likely to be social reasons (home modifications etc.), and discharge destinations are linked to LEAs more so than most other procedures. A study in Canada found 36% of patients were discharged to a rehabilitation centre post LEA [20], while an American study found that only 40.6% of patients were discharged directly home post LEA [21].

Analysis of the existing literature found that implementation of comprehensive footcare programmes could reduce amputation rates between 37.5 and 50% [10, 22, 23]. A modest reduction in the Irish setting of 20% in the numbers of amputations for patients with diabetes could avoid 80 minor and 26 major amputations among patients with diabetes on a yearly basis. This would yield considerable savings (3000 bed day's equivalent to €3 M) and free-up resources for other uses including the funding of the community prevention programme. In addition, there would be a significant impact on patient quality of life and allow for resources to be redistributed to rehabilitation and support for patients after amputation.

Investment in both better diabetes control and preventative foot care would be required to realise these gains. In the short to medium term, given the lag between the diagnosis and diabetes and the presentation with advanced diabetic foot disease, it is likely that the need for amputations will continue to grow and short-term investment aimed at accelerating hospital discharge will be required to prevent a substantial impact on hospital resources. A key factor that is beyond the scope of this paper is that the number of people with diabetes is expected to continue to rise. It has been predicted that 530 million people worldwide will be diagnosed with diabetes by 2030 [24], an increase from 463 million today [25]. This rise will increase the demand for LEAs unless investment is made in the prevention, early detection, and management of diabetes and diabetic foot care. Early detection of diabetes is another key aspect of addressing the rise of LEAs as many patients with a type-2 diabetes may have the disease for 7 years before a diagnosis[26]. The current study has provided detailed baseline data about the current use of amputation that could enable healthcare planners and clinical researchers to develop and assess implementation plans to support services for patients with diabetes in avoiding the need for amputations.

Strength and weakness

The availability of up-to-date national data about amputations in Irish public hospital is a major strength of this study. Although the data set does not include amputations conducted at private hospitals, it is believed that private hospitals conduct only few amputations. The analysis of patient characteristics in terms of diabetic diagnosis and other comorbidities is reasonably accurate.

A major weakness of the study is that the unit of analysis is hospital episodes. In the current hospital information system, it is not possible to reliably match different episodes across different hospitals to individual patients. In the current dataset, we have observed repeat hospital admissions with the same medical record number. This indicates that the same individual has had more than one hospital episode with amputations. During the 4-year period, more than 20% of the episodes were repeat admission. We have abstained from reporting this analysis as the 4-year period is unlikely to provide a reliable impression of the longer-term risk of amputation. This would be important for an analysis of the population health impacts of amputations. Instead, we have provided an analysis that is focused on hospital provision of amputations. This is a relevant approach for discussions about how hospitals potentially can adapt their services to improve the health of patients.

A limitation of HIPE data is that a specific reason for the amputation is not given, e.g., osteomyelitis, ischemia, and soft tissue sepsis.

Conclusion

This study has identified that more than 3000 hospital episodes have had LEA and have described the characteristics of patients and process outcomes from care. The analysis provides relevant information for discussing preventative interventions for patients with diabetes that will support behavioural and clinical changes that may prevent the need for LEA.

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Availability of data and material The data applied in this study are available from NQAIS but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data used and analysed during the current study are available from the corresponding author on reasonable request subject to permission from NQAIS.

Declarations

Ethics approval and consent to participate This study analysed anonymised data, and therefore, formal patient consent was not required.

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