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Prevention of osteoporotic refractures in regional Australia

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Abstract

Objective: Clinical guidelines recommend that patients who sustain a minimal trauma fracture (MTF) should receive a bone mineral density (BMD) scan and bisphosphonate (or equivalent) therapy if diagnosed with osteoporosis. A pilot fracture liaison service (FLS) was implemented in regional NSW to improve adherence to the guidelines.

Design: prospective cohort study with an historical control

Setting: primary care

Participants: Control (n=47) and cohort (n=93) groups comprised patients consenting to interview who presented with a MTF to the major referral hospital four months before and twelve months after FLS implementation, respectively.

Main outcome measures: Primary outcome measures were the rates of BMD scans and anti-osteoporotic medication initiation/review after MTF. Hospital admission data were also examined to determine death and refracture rates for all patients presenting during the study period with a primary diagnosis of MTF within three years of their initial fracture.

Results: Although there was no improvement in BMD scanning rates, the reported rate of medication initiation/review after fracture was significantly higher ($p<0.05$) in the FLS cohort. However, once adjusted for age, this association was not significant ($p=0.086$). There was a lower refracture rate during the cohort period ($p=0.013$), however there were significantly more deaths ($p=0.035$) within three years of initial fracture. When deaths were taken into account via competing risk regression, patients in the cohort period were significantly less likely to refracture than those in the control period (Hazard ratio = 0.576, $p=0.032$).

Conclusions: A rurally-based nurse-led FLS was associated with modest improvement after MTF. Consideration should be given to ways to strengthen the model of care to improve outcomes.

Keywords: Bisphosphonates, Bone mineral density, Fracture liaison service, Minimal trauma fracture, Refracture

What is already known on this subject?

● Despite a significant proportion of the Australian population being affected by osteoporosis, a large gap exists between the recommended guidelines and current practice for MTF, and this is often greater in rural and remote areas.

● Specialised osteoporosis fracture liaison services (FLS) can be effective in identifying and guiding patients to appropriate services for osteoporosis management

● Rural communities may have limited access to specialist outpatient services, which are a feature of successful metropolitan-based FLS

What does this study add?

A nurse-led FLS without an associated specialist outpatient clinic:

- can be implemented in a rural location,
- was associated with a modest improvement in medication initiation/review after MTF and significantly lower refracture rates,
- requires strengthening to achieve optimal treatment after MTF.

Introduction

It has been estimated that more than 2.2 million Australians are affected by an osteoporosis-related condition[1]. However, due to the silent nature of the disease, in 2011-2012 only 3.3% of the Australian population were diagnosed with osteoporosis[2]. One of the consequences of osteoporosis is the occurrence of minimal trauma fractures (MTF), a fracture resulting from a fall from a standing height or less. In 2009, there were almost 87,000 hospital admissions for MTF in Australia[3]. Mortality rates significantly increase after sustaining a MTF. In the first five years after a MTF, increases in absolute mortality above expected have been estimated at 1.3-13.2 and 2.7-22.3 per 100 person years in females and males respectively[4]. Sustaining a MTF also carries significant morbidity with a reduction in quality of life and loss of independence[5].

Effective strategies for reducing the risk of refracture in MTF patients focus on identifying patients at risk, diagnosing osteoporosis, and implementing treatment[5]. Australian clinical guidelines currently recommend that MTF patients should receive assessment of their bone mineral density (BMD) with dual-energy x-ray absorptiometry (DXA) scanning[6]. The guidelines also recommend bisphosphonate or equivalent therapy for all MTF patients diagnosed with osteoporosis or osteopenia[6] as these agents are effective in reducing refractures in high-risk patients[7]. Supplemental medications such as vitamin D and calcium alone have a minimal effect on reducing fracture risk in patients with osteoporosis[8].

Despite the significant proportion of the Australian population affected by osteoporosis, a large gap exists between the recommended guidelines and current practice for MTF patients[3-13]. Furthermore, BMD scanning rates after MTF have been found to be lower in rural and remote populations[14]. Specialised osteoporosis fracture liaison services (FLS) can be effective at identifying and guiding patients to appropriate services for osteoporosis management[15-18]. However, the majority of this research is conducted in metropolitan centres and does not address rural challenges.

A recent study has described a rural intervention for osteoporotic fracture prevention. The Coffs Fracture Prevention Clinic was established in NSW in response to a proposed model of care developed by the NSW Agency for Clinical Innovation (ACI)[19]. This intervention involved a fracture liaison coordinator (FLC) in combination with a specialist clinic for osteoporosis management after MTF.

Around the same time, an FLS was also developed in the Murrumbidgee Local Health District (MLHD) located in the rural south west of NSW[20] in response to the ACI model of care. The service employed a part-time FLC who identified patients during their hospital admission to the Wagga Wagga Rural Referral Hospital (WWRRH) and contacted them to provide information on

osteoporosis and falls prevention strategies. The FLC also communicated with the patient's general practitioner to indicate that the patient would benefit from osteoporosis-specific investigations and management if appropriate. In this region, a specialist clinic was not available and was not included in the intervention.

This study was undertaken to evaluate the effectiveness of this nurse-led FLS. It was hypothesised that the implementation of the FLS would lead to an increased rate of BMD scanning after MTF and higher rates of appropriate pharmacotherapy for osteoporosis when diagnosed.

Method

All patients aged over 45 years who were admitted with a MTF to the WWRRH during the first 12 months after the implementation of the FLS in September 2011 (FLS cohort group) or during the four months preceding the FLS (control period) were eligible for participation. Minimal trauma (fall from a standing height or less) was verified from the description of the injury in the electronic records. Specific fractures included in the search were: femur (*condyle, shaft, neck, subtrochanteric, intertrochanteric and subcapital fractures*), tibia and fibula, ankle, pelvis, humerus and wrist. Patients were excluded if they had a pathological fracture (*vertebral, clavicle and rib*) or if they were deceased. Prior to the implementation of the FLS, patients would be discharged from hospital for follow up in orthopaedic specialist rooms, registrar outpatient clinics or by general practitioners and no specific advice was routinely provided in relation to further investigation for osteoporosis.

Study participants were recruited initially by mail. A second round of letters was sent to increase participation, followed by a round of questionnaires asking the same questions. A telephone interview or postal survey was carried out for willing participants. All patients were contacted within a year of their initial MTF and their post-fracture osteoporosis management was assessed. In the interview (or questionnaire), patients were asked whether they had received a BMD scan, and whether appropriate anti-osteoporosis pharmacotherapy (bisphosphonate or equivalent therapy) had been reviewed or initiated. These outcomes were compared between recruited patients in the control and cohort groups.

De-identified interview and survey data were collected and analysed using SPSS Version 20 (SPSS Inc, Chicago, USA) and OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version 2.3.1 (Atlanta, USA) (www.OpenEpi.com). Two tailed *p*-values were used and a value of <0.05 was considered significant. Confidence intervals were set at 95%. Patient demographics were analysed using frequency distribution, Pearson Chi-square tests (or

Fishers' exact test) and independent samples t-tests. Binary logistic regression was used to adjust for differences in age between the control and cohort survey groups.

In addition, to further assess the possible effectiveness of the FLS, it was decided to determine the rates of refracture and death (within three years of initial fracture) for all patients with MTF before and after the implementation of the FLS using hospital admissions data. All patients who sustain fractures within the catchment area who need to be admitted are received by this regional referral hospital. Patients suffering major trauma, or with secondary diagnoses of fracture and patients who suffered multiple fractures were excluded from the analyses. In line with the rest of this study, pathological fractures were excluded. Differences in refracture and death between control and cohort periods were determined using Pearson's Chi-Square test. Competing risks regression (via STATA v14, StataCorp LP, College Station, Texas USA www.stata.com) was used to determine if there was a difference in refracture rate (within three years of initial fracture) between groups while taking deaths into account.

Ethics approval was granted by The University of Notre Dame Australia Human Research Ethics Committee (HREC) and the Greater Western HREC. The research was conducted in accordance with the ethical standards of the Declaration of Helsinki.

Results

Patients (n=483) were identified from medical records as having met the inclusion criteria. Of these, 10 were identified as having suffered a major trauma, 12 fractures were secondary diagnoses and a further 42 died before recruitment. Therefore, there were 419 eligible survey participants; these were contacted irrespective of whether or not they had been contacted by the FLS. Data were obtained from 140 patients, a 33.4% response rate. The fracture type characteristics of patients who were eligible for inclusion were similar to those of recruited participants, with a predominance of female patients (~75%). However, patients recruited to this study were significantly younger than the non-recruited patients (p=0.003), with an average of 72.8 years (SD 11.8). Non-recruited participants were older, with an average of 76.7 years (SD 12.9).

The characteristics of eligible and recruited patients are presented in Table 1. Although there was no difference in mean age between eligible patients in the control group and eligible patients in the cohort group, the recruited control group was significantly older than the recruited cohort group (p=0.034, t(138)=2.142). Femoral fractures were the most common fracture type identified. There were no significant differences in gender or fracture types between the groups.

There were no differences between recruited patients in the control and cohort groups in terms of the level of BMD scanning conducted nor the type of medication taken for their bones (Table 2). Overall, 41% of patients had received a BMD scan after their MTF and 78% had ever had a BMD scan. Just over 30% of recruited patients reported being on no medications for osteoporosis, while 33% reported being on supplements (Ca^{2+} and/or vitamin D) and the remaining 37% on bisphosphonates or equivalent. Patients in the FLS cohort group were more likely to have had their medications initiated or reviewed following fracture [$X^2(1)=3.900$, $p=0.048$] than patients in the control group. However, once age was adjusted for, this association was no longer significant ($p=0.086$). Almost 43% of patients in the cohort group had their medications reviewed versus 25% of patients in the control group.

From the hospital admissions data, it was found that within three years of their initial fracture, 59/456 (12.9%) patients had refractured the same or a different bone, with significantly fewer refractures overall during the FLS cohort period [$X^2(1)=6.162$, $p=0.013$] (Table 3). Fewer of those patients presenting with femur fracture during the cohort period refractured within three years ($p=0.002$) than patients presenting during the control period. There were no differences for the other fracture types.

However, there were more deaths during the cohort period [$X^2(1)=4.427$, $p=0.035$) (Table 4). Overall, 18% of patients died within three years of their initial fracture. There were no differences in deaths when comparing individual fractures. Mean age (obtained from hospital admissions data) in the two groups were similar [77.1 (SD 13.1) in the control period and 75.9 (SD 12.5) in the cohort period]. When deaths were taken into account via competing risk regression, patients in the cohort period were significantly less likely to refracture than patients in the control period (Hazard ratio = 0.576, 95%CI 0.348-0.953, $p=0.032$) (Figure 1). The probability of refracture within three years was around 11% in the cohort group versus almost 20% in the control group.

Discussion

Recently, Fraser and Wong (2016)[19] reported the effectiveness of a regional osteoporosis model of care involving an FLC and a specialist clinic. One quarter (25.4%) of eligible patients attended and 88% of these patients commenced bone protective therapy. In our nurse-led model of care, without the support of a specialist clinic, only a modest improvement was observed. This study complements the Coffs Harbour study[19] as it evaluated a different model in the rural setting wherein 33.4% of eligible patients were surveyed and it was found that medication initiation or review was increased from 25.5% in the control period to 42.6% in the cohort period.

The association towards improved management in FLS cohort patients in this study is consistent with a meta-analysis by Ganda *et al.*[21] which reviewed the evidence relating to different models of care available for osteoporosis in order to assess their effectiveness at increasing BMD scans and bisphosphonate treatment rates in post MTF patients.

The rate of BMD testing in our control group (40%) was much higher than reported in similar studies. One study based in a northern NSW regional hospital reported that 22% of patients received a BMD scan after their MTF[11]. The rates of BMD scanning for control groups in the Ganda *et al*. meta-analysis were between 9.2% and 23.8%[20]. The average bisphosphonate initiation rates for control groups in previously reported studies are around 7.5%[21]. The baseline management rates of the control group within this study were higher than what were expected based on studies with similar patient demographics and models of care[11,12,21]. This demonstrates the importance of using a control group to evaluate the outcome of service interventions. Without the presence of the control group, the success of the model may have been overestimated as it would have been judged against similar studies with lower rates in their control or intervention groups.

There was a modest improvement in the level of medication initiation or review following MTF in the FLS cohort, however, there was no difference in the type of medication being taken for their bones. Although Australian guidelines recommend the use of bisphosphonate or equivalent therapy for all MTF patients diagnosed with osteoporosis[6], the use of supplements alone for the treatment of osteoporosis in patients after a MTF was found to be high in both the control and cohort groups. Nearly a third of the patients were receiving calcium or vitamin D supplements as the only form of medication even though supplementation therapy alone has been shown to have minimal effect in preventing refractures[22-24].

The pilot FLS program was implemented in this region due to the high public health promotion and support for osteoporosis management by a group of local health care providers[20]. However, this service did not involve medical specialist outpatient clinics. Ganda *et al*.[21] reports that such limited interventions results in modest improvements in clinical outcomes if any and that more funding and a more intensive intervention would result in greater improvements in clinical outcomes. However, as this study only examined the pilot FLS during the first 12 months of implementation, the skill and confidence of the FLC and the acceptance of the intervention among primary care providers may take some time to reach full effect. In addition, it appears that the FLS was only able to contact less than half of the patients who had fractures during the FLS cohort period.

In addition to data from the telephone survey, refracture and death rates were also determined using hospital admissions data for all patients who sustained a MTF during the control and

cohort periods. This was done to address some of the issues of recall bias, non-randomisation of groups and inherent differences in patients who opt to participate. Patients in the cohort period had a lower refracture rate than patients in the control period. However, there were more deaths in the cohort period despite the fact that there was no difference in age between groups nor a difference in the proportion of femur fractures, known to have increased mortality. Due to this increased death rate in the cohort period, competing risks regression was used to determine if there was a difference in refracture rates after deaths were taken into account. Controlling for death, the cohort period had a significantly lower refracture rate than the control period.

This study showed that a part-time nurse-led model of care for osteoporosis without a specialist clinic was associated with only a modest impact on outcomes after MTF. The reality is that many regional and rural areas do not have specialist clinics, so other means to strengthen the FLS are needed. One area for future research involves better co-ordination of discharge care follow-up between hospitals, orthopaedic surgeons and general practitioners.

References

1. Osteoporosis Australia. The burden of brittle bones: epidemiology, costs and burden of osteoporosis in Australia -2007. Sydney (NSW): Osteoporosis Australia and International Osteoporosis Foundation, 2008.
2. Australian Bureau of Statistics. Australian Health Survey: First Results. Australian Bureau of Statistics, 2012. [cited Sept 2012]. Available from: http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4364.0.55.001main+features12011-12
3. Australian Institute of Health and Welfare. Australia's Health 2012. Australia's health no. 13. Cat. no. AUS 156 Canberra:AIHW, 2012.
4. Bliuc D, Nguyen ND, Milch VE, Nguyen TV, Eisman JA, Center JR. Mortality risk associated with low-trauma osteoporotic fracture and subsequent fracture in men and women. JAMA 2009; **301**(5): 513-521.
5. Australian Institute of Health and Welfare. A Snapshot of Osteoporosis in Australia 2011. Arthritis series no. 15. Cat. no. PHE 137 Canberra:AIHW, 2011.
6. The Royal Australian College of General Practitioners. Clinical guideline for the prevention and treatment of osteoporosis in postmenopausal women and older men. The Royal Australian College of General Practitioners, 2010 [cited September 2012]. Available from : http://www.racgp.org.au/your-practice/guidelines/musculoskeletal/osteoporosis/
7. Jansen JP, Bergman GJ, Huels J, Olson M. The efficacy of bisphosphonates in the prevention of vertebral, hip, and nonvertebral-nonhip fractures in osteoporosis: a network meta-analysis. Semin Arthritis Rheu 2011; **40**(4): 275-284.
8. Sambrook P, Cooper C. Osteoporosis. Lancet 2006; **367**(9527): 2010-2018.
9. Kelly AM, Clooney M, Kerr D, Ebeling PR. When continuity of care breaks down: a systems failure in identification of osteoporosis risk in older patients treated for minimal trauma fractures. Med J Aust 2008; **188**(7): 389-391.
10. Teede HJ, Jayasuriya IA, Gilfillan CP. Fracture prevention strategies in patients presenting to Australian hospitals with minimal-trauma fractures: a major treatment gap. Intern Med J 2007; **37**(10): 674-679.
11. Barrack CM, McGirr EE, Fuller JD, Foster NM, Ewald DP. Secondary prevention of osteoporosis post minimal trauma fracture in an Australian regional and rural population. Aust J Rural Health 2009; **17**(6): 310-315.
12. Vaile J, Sullivan L, Bennett C, Bleasel J. First Fracture Project: addressing the osteoporosis care gap. Intern Med J 2007; **37**(10): 717-720.

13. Port L, Center J, Briffa NK, Nguyen T, Cumming R, Eisman J. Osteoporotic fracture: missed opportunity for intervention. Osteoporosis Int 2003; **14**(9): 780-784.

14. Ewald DP, Eisman JA, Ewald BD *et al*. Population rates of bone densitometry use in Australia, 2001-2005, by sex and rural versus urban location. Med J Aust 2009; **190**(3): 126-8.

15. Gallacher SJ. Setting up an osteoporosis fracture liaison service: background and potential outcomes. Best Practice & Research: Clin Rheumatol 2005; **19**(6): 1081-1094.

16. Giles M, Van Der Kallen J, Parker V *et al*. A team approach: implementing a model of care for preventing osteoporosis related fractures. Osteoporosis Int 2011; **22**(8): 2321-2328.

17. Marsh D, Akesson K, Beaton DE *et al*. Coordinator-based systems for secondary prevention in fragility fracture patients. Osteoporosis Int 2011; **22(**7): 2051-2065.

18. Sander B, Elliot-Gibson V, Beaton DE, Bogoch ER, Maetzel A. A coordinator program in post-fracture osteoporosis management improves outcomes and saves costs. J Bone Joint Surg American 2008; **90**(6): 1197-1205.

19. Fraser S, Wong PKK. Secondary fracture prevention needs to happen in the country too: the first two and a half years of the Coffs Fracture Prevention Clinic. Aust J Rural Health 2016; online first

20. Agency for Clinical Innovation. NSW Model of Care for Osteoporosis Refracture Prevention. Agency for Clinical Innovation: Musculoskeletal Network, Sydney, 2011 [cited Sept 2012]. Available from: http://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0003/153543/aci_osteoporotic_refractu.pdf

21. Ganda K, Puech M, Chen JS *et al*. Models of care for the secondary prevention of osteoporotic fractures: a systematic review and meta-analysis. Osteoporosis Int 2013; **24**(2): 393-406. doi: 10.1007/s00198-012-2090-y. Epub 2012 Jul 25.

22. Bergman GJ, Fan T, McFetridge JT, Sen SS. Efficacy of vitamin D3 supplementation in preventing fractures in elderly women: a meta-analysis. Cur Med Res Opin 2010; **26**(5): 1193-1201.

23. Prince RL, Devine A, Dhaliwal SS, Dick IM. Effects of calcium supplementation on clinical fracture and bone structure: results of a 5-year, double-blind, placebo-controlled trial in elderly women. Arch Intern Med 2006; **166**(8): 869-875.

24. Porthouse J, Cockayne S, King C *et al*. Randomised controlled trial of calcium and supplementation with cholecalciferol (vitamin D3) for prevention of fractures in primary care. BMJ 2005; **330**(7498): 1003.

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Table 1: Characteristics of eligible and recruited participants

	Eligible			Recruited		
	Control (n=131)	Cohort (n=328)	All† (n=461)	Control (n=47)	Cohort (n=93)	All (n=140)
Female (%)	75.6	74.2	74.6	80.9	75.3	77.1
Age [mean (SD)]	77.1 (13.1)	76.1 (12.5)	76.4 (12.7)	75.8 (11.8)	71.3 (11.5)	72.8 (11.8)
Fracture Type (%)‡						
femur	52.7	47.6	49.0	39.8	41.4	41.3
wrist	18.3	20.3	19.7	22.6	22.1	21.7
pelvis	4.6	6.4	5.9	5.4	5.7	5.8
tibia/fibula	9.9	3.9	5.6	3.2	5.7	5.8
ankle	5.3	10.3	8.9	17.2	14.3	14.5
humerus	9.2	10.0	9.8	11.8	10.7	10.9
>1 fracture	0	1.5	1.1	0	0	0

* significant difference between control and cohort groups at $p<0.05$

† includes 42 patients who died prior to recruitment

‡ Values may not equal 100% due to rounding

Table 2: Percentages[†] of patients who received BMD scans, medication type and treatment after minimal trauma fracture in recruited control and cohort groups according to self-report

	Control (n=47)	Cohort (n=93)	All patients (n=140)
BMD scan (%)			
after fracture	40.9	40.5	40.6
ever had one	79.4	76.6	77.5
Medications (%)			
none	27.7	31.9	30.5
supplements	27.7	35.1	32.6
bisphosphonates or equivalent[‡]	44.7	33.0	36.9
Treatment initiated or reviewed after fracture (%)			
No/unchanged after fracture	74.5	57.4	63.1
Yes	25.5	42.6	36.9

[†] Values may not equal 100% due to rounding

[‡] equivalent medications such as denosumab or strontium

Table 3: Refracture (same or different bone) within three years in the control and cohort groups for eligible patients

Initial fracture type	Refracture [n(%)]		
	Control	Cohort	All patients
Femur**	16 (23.2)	13 (8.3)	29 (12.8)
wrist	5 (20.8)	9 (13.4)	14 (15.4)
pelvis	0	3 (14.3)	3 (11.1)
tibia/fibula	0	2 (15.4)	2 (7.7)
ankle	2 (28.6)	4 (11.8)	6 (14.6)
humerus	2 (16.7)	3 (9.1)	5 (11.1)
Total*	25 (19.1)	34 (10.5)	59 (12.9)

* significant difference between control and cohort groups at $p<0.05$

** significant difference between control and cohort groups at $p<0.01$

Table 4: Death within three years in the control and cohort groups for eligible patients

Initial fracture type	Death [n(%)]		
	Control	Cohort	All patients
Femur	13 (18.8)	47 (29.9)	60 (26.5)
wrist	1(4.2)	0 (13.4)	10 (11.0)
pelvis	0	6 (28.6)	6 (22.2)
tibia/fibula	0	4 (30.8)	4 (25.4)
ankle	0	0	0
humerus	2 (16.7)	1 (3.0)	3 (6.7)
Total*	16 (12.2)	67 (20.6)	83 (18.2)

* significant difference between control and cohort groups at $p<0.05$

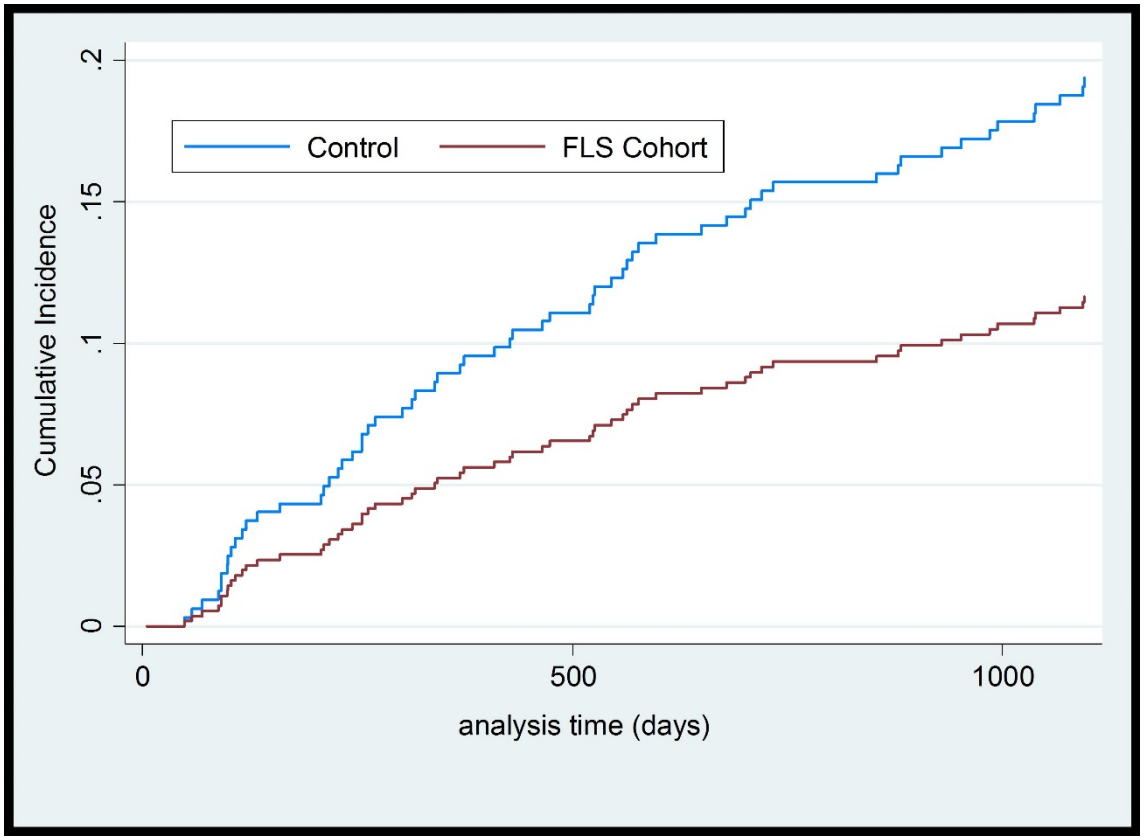
Control
FLS Cohort
Cumulative Incidence
0
.05
.1
.15
.2
0
500
1000
analysis time (days)

Figure 1