**Article Title: Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review**

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# Abstract

**Introduction:** There is lack of evidence about ankle sprain patients presenting to emergency department (ED) in the UK. The study aim was to determine prevalence, demographic and clinical characteristics of patients attending to one ED. Knowing those characteristics may help setting prevention strategies and inform effective clinical practice

**Methods:** A retrospective review of records from patients’ database system was conducted between May and November 2015 (inclusive).

**Results:** 909 new patients with ankle sprain were recorded during the study period. Patients had a median age of 27 years (IQR 20). Men aged between 14-37 years had higher percentage of injuries compared to women of a similar age. Overall prevalence of injury was equally distributed between men and women. Most patients were sent to radiography department for ankle/ foot x-ray (89%). Over half of patients (58%) were sent home with no follow-up treatment. A subsample (n=106) from the original sample (n=909) showed a variety of causes of injury such as tripping (29%), non-specific injury (26.4%), sports (26%), walking (12.2%) and other accidental causes (6%). Football was the most prevalent sport (13%).

**Conclusions:** Prevention strategies, appropriate assessment tools and tailored rehabilitation programs are warranted to reduce number of patients and potential chronic symptoms.

Key words

epidemiology; ankle sprain; prevalence; cause of injury; sport type; injury prevention; emergency department

# Introduction

Acute ankle sprain is an injury affecting the capsular ligament complex of the ankle joint within 72 hours of occurrence (Kerkhoffs et al. 2007). A systematic review and meta-analysis of prospective epidemiological studies found ankle sprain a very common injury among sport and general populations with a pooled cumulative incidence rate of 11.55 per 1,000 exposures (Doherty et al. 2014). They also calculated a higher incidence of ankle sprain in women compared with men (13.6 vs 6.94 per 1,000 exposures), in children compared with adolescents (2.85 vs 1.94 per 1,000 exposures), adolescents compared with adults (1.94 vs 0.72 per 1,000 exposures) and indoor/court sports (7 per 1,000 exposures). However, the impact and burden of this injury on the emergency department and emergency care is not thoroughly addressed.

In the US, epidemiological studies that investigated prevalence of ankle sprain in ED calculated a national incidence rate of 2.15 per 1000 person-years (Waterman et al. 2010) and 3.29 per 1000 person-years (Shah et al. 2016). A population based, of 1.1 million people, epidemiological study estimated the incidence rate in emergency departments to be 52.7 per 10,000 in four emergency departments in West Midlands of England, UK (Bridgman et al. 2003; Waterman et al. 2010; Shah et al. 2016). The main difference in methods of those epidemiological studies is that the UK study was conducted on 4 local EDs whereas the US studies were national reports.

The two national statistical reports from emergency departments across England do not provide specific information about ankle sprain injury admissions (Carl 2015; Hospital Episode Statistics Analysis 2015). As such, it is difficult to appropriately determine the epidemiology of this injury and estimate related health care expenditures. Providing information about patients’ demographic and clinical characteristics might be helpful for future research that is concerned with planning of prevention and intervention strategies. In addition, high incidence of ankle sprains demands thorough understanding of patients’ characteristics and injury/activity related factors that might affect the recovery following conservative management. In order to prevent further injury, it is very important to identify factors that are associated with that injury (Meeuwisse 1994).

The increased prevalence of ankle sprain exerts a large burden on the national economy; an estimated €187.2 million per year spent on the management of sport-related ankle sprains in the Netherlands (Verhagen et al. 2005). Some of these costs cover patients’ assessment procedures including ankle and foot x-rays. A multicentre trial in the US estimated a mean of 70.20 US dollars (SD 52.1) in medical charges for patients who had their ankle and foot x-rays taken in the emergency department. In the UK, it was hypothesized that annual costs for providing external supports for severe ankle sprain is £3 million for boots, £1.5 million for braces and £0.1 million for tubigrip (Bridgman et al. 2003). In the UK, there is a lack of evidence on the demographic and clinical characteristics of patients with ankle sprains, which once determined may inform the economic impact of this injury.

Therefore, the aim of this study was to determine prevalence, demographic and clinical characteristics of patients attending to a UK emergency department. In addition, it aimed to characterize those patients by their common causes of injury and sport type.

# Methods

## Design

A retrospective review of patients’ records from the electronic patient database was conducted between May and November 2015. This method is commonly used for large samples of patients in the emergency department (Gilbert et al. 1996). The study was approved byThe University of Southampton (ref:18515) as well as from Health Research Authority (HRA) (ref: 202053) and it complied with STROBE guidelines (Vol Elm et al. 2007).

## Setting

The study was conducted in an emergency department in a large industrial and coastal city in the South of England. This department provides assessment and treatment for patients with serious injuries. It manages in excess of 100,000 patients a year, serving a population of approximately 1.9 million in which 42% of them aged 20-44 years (2011 Census Information 2013). The department consists of a number of discrete areas: Majors (where patients who have presented with significant illness or injury are assessed), a resuscitation room, a Minor injury/illness receiving area, two clinical decision units and a paediatric emergency department within the overall unit.

## Sample

The sample consisted of the medical records of patients that attended the emergency department with acute ankle sprain. Both men and women aged 14 and above were included in the review as the incidence of ankle sprain increases remarkably between the ages of 14 and 19 years (Bridgman et al. 2003; Waterman et al. 2010; Shah et al. 2016). Patients with injuries/ diseases other than acute ankle sprain were immediately excluded.

## Data collection

Patient records were obtained from the electronic patient database. Patient records were identified by combining the diagnostic codes: “lower limb-ankle” and “sprain” in the electronic database (Phase 1). At this stage, all eligible records that met the inclusion criteria were identified within the electronic database (Figure 1).



Figure 1 Process of screening and inclusion of patient records

Then, relevant information of study variables were only selected: age, sex, attendance outcome, arrival date and time and radiography referrals. Then anonymity coding for each record was assigned to maintain confidentiality and privacy of patients’ records and to comply with ethics requirements. A random number was allocated to each individual record. All these steps including identifying eligible records and specification of study variables were conducted electronically. Then the anonymised data was transferred into an Excel database (Microsoft Office Excel 2013; Microsoft Corporation, Redmond, WA, USA).

From the total number of patient records that was identified in phase 1, a subsample was randomly selected to determine common causes of injury and sport type (Phase 2). The selected records were printed and manually reviewed in order to obtain information about common causes of injury and sport type. Details on cause of injury and sport type could not be collected directly from the electronic patient database as they can not be identified through the automated search. These two variables could only be identified by conducting a manual search of each individual patient record.

A stratified random sampling method was used to select the subsample. Firstly, the total number of patient records was divided into 4 separate age groups: teenagers (14-17 years), young adulthood (18-35 years), middle age (36-55 years) and older adulthood (56 years and over). This age clustering was reported in literature to ensure that the analysis includes all age ranges in the study population (Petry 2002).

The sample size of the subsample was determined based on the practicalities of conducting a manual review. It was calculated based on restricting the width of an exact binomial confidence interval for a proportion to be no wider than 20% (i.e., ±10%) (Morisette and Khorram 1998). Therefore, a number of 106 patient records were found adequate and selected for manual review.

## Statistical analysis

Data was analysed by Microsoft Excel (2013) and SPSS statistical package software (version 21; SPSS Incorporation). For phase 1, descriptive statistics were used to summarise prevalence, age, sex, attendance outcome, arrival date and time, and radiography referrals; for phase 2, descriptive statistics were used to summarise cause of injury and sport type. Means and standard deviations (SD) were presented for continuous variables, and frequencies and percentages were presented for categorical variables. For non-normally distributed data, median and interquartile range (IQR) were used.

# Results

During study period, 55,891 patients attended the emergency department. Out of those patients, a total of 909 new cases of ankle sprain (original sample) were identified. Prevalence of injury was equally distributed between men and women (49.6% and 50.3% respectively). Patients had a median of 27 years (IQR 20) and a peak at 19-23 years old (Figure 2).

Figure 2 Age-sex specific rates of ankle sprain patients

Men aged between 14-37 years accounted for a higher percentage of injuries (56%) compared to women of a similar age (44%), whereas women accounted for a higher percentage of injuries in those over 35 years as compared to their counterparts (59% and 41% respectively). Most patients were sent to radiography department for ankle and foot x-ray (89%). Over half of patients (58%) were sent home with no follow-up treatment. Twenty two percent (n=200) were referred to the emergency department review or physiotherapy clinic, 15% (n=132) were discharged with GP follow up , 2% (n=20) were admitted to the hospital, 2% (n=17) referred to fracture clinic, 1% (n=7) were referred to other out-patient clinic, 0.3% (n=3) were referred to other health care professional and 0.2% (n=2) left the department before being treated. The busiest day was Sunday with a peak at 157 patients. The lowest number of patients (n=95) attended on Saturday (Figure 3).

Figure 3 Attendances of ankle sprain patients per hour and days

In terms of monthly attendances, the number of patients per month was higher in May n=141), July (n=157) and September (n=152)

The subsample (n=106) that was selected from the original sample (n=909) showed a variety of causes of injury such as tripping (29%), non-specific injury (26.4%), playing sports (26%), walking (12.2%) and other accidental causes (6%) (Figure 4). Football was the most prevalent sport (Figure 5).

Figure 4 Common cause of inversion injury (n=106)

Figure 5 Sport type of patients who reported sport as cause of injury (n=106)

# Discussion

To our knowledge, this is the first study in a decade and the first in the south of England (UK) that illustrates both demographic and clinical characteristics of patients reporting to an emergency department with acute ankle sprain.

## Prevalence

This study identified 909 cases of ankle sprain attending an emergency department between May and November 2015. There was no definite increasing or decreasing trend in number of patients from May (end of spring) to November (end of autumn). In the UK, two statistical reports the first by Health and Social Care Information Centre (Hospital Episode Statistics Analysis 2015) and the second report presented by House of Commons Library (Carl 2015) provided detailed statistics about patient admissions to emergency departments across England. Across the financial year 2014/15 (April 2014-March 2015), they documented 367,093 patients presented with sport injuries (Hospital Episode Statistics Analysis 2015) and 688,000 with ligament injury/ sprain (Carl 2015). This study focused on investigating the epidemiology specific to acute ankle sprain whereas they presented data for a whole set of injuries such as “sport injuries” and “ligament injury/ sprain”.

## Age

This study included a wide age range from 14 to 92 years. Over half of ankle sprain injuries (65%) occurred in young patients aged between 14 and 35 years. The peak prevalence of ankle sprains was found to be between 19-23 years old (22%). Similar results were seen in patients who had attended emergency departments in the US (Waterman et al. 2010) and in the UK (Bridgman et al. 2003; Cloke et al. 2009; Cloke et al. 2011).

In our study, we observed that prevalence of ankle sprain increased with age in patients between 14 to 23 years old. Similarly in the UK, studies showed an increase in incidence of ankle injuries, including ankle sprain, with age in football academies players aged between 9 and 18 years old (Cloke et al. 2011) and 9 to 16 years old (Cloke et al. 2009). Perhaps the distinguishable proportional increase in incidence of injury in relation with age in young players can be explained by older boys having more speed, strength and may generate more tackling force during sport activities (Caine et al. 2008). It could be also due to the fact that a large percentage (42%) of the population where the ED is located are between 20 and 44 years (2011 Census Information 2013). The increase in incidence of ankle sprains in younger populations suggests that those who set training programs, schools’ administration, sport medical teams and sport academies should take precautionary measures to reduce the occurrence of this injury.

## Sex

Prevalence of ankle sprain for men and women in this study was relatively equal (49.6% and 50.3% respectively). Similar percentages (men, 50.3% and women, 49.7%) were noted in patients attending emergency department in the US (Waterman et al. 2010). Current literature is divided on the role of sex on sport injuries including ankle sprains. Some studies indicated that women had more prevalence of sport injuries including ankle sprain (Beynnon et al. 2005; Leininger et al. 2007). Others found no significant differences between men and women (Bridgman et al. 2003).

In this study, younger men (14-37 years old) accounted for a higher number of injuries (n=324) compared to women of the same age (n=269). In contrast, in older ages (38-92), the number of women with ankle sprain was higher (n=189) compared to men (n=127). Previous studies showed similar age-sex trends between men and women (Bridgman et al. 2003). It might be that men at younger ages generate more tackling force especially in contact sports and cause more sport injuries (Caine et al. 2008). Furthermore, a fluctuating hormonal cycle in women at older ages may be associated with joint laxity thus their ligaments more susceptible to injury (Heitz et al. 1999). Across all England, about 56% of people aged between 16 and 25 years take part in sports at least once a week (Sport England 2016). In addition, younger men are much more likely to participate in sports than women are (41% and 32% respectively); however, this difference declines with age. Potentially that may explain the increased prevalence of acute ankle sprain in younger men as compared to women. More research focused on determining the association between age and sex in individuals with ankle sprain in order to develop appropriate prevention programs tailored to individual age and sex groups would be useful.

## Attendance outcome

We recorded a total number of 528 (58%) patients that were sent home with no follow-up appointments. This percentage is relatively similar to that observed by Chorley (Chorley 2005) as 50% of their patients were sent home with “as needed” follow up referrals. As a routine practice in the emergency settings and at the time of discharge, patients are given discharge written instruction sheet that covers self-management care following ankle sprain (Chorley 2005). This instruction sheet includes information about patient-oriented care such as rest, ice, compression, elevation (RICE), range of motion exercises, strengthening exercises, proprioception exercises and/ or medication. However, it did not provide clear clinical guidelines for recovery threshold and return to work and sporting activity, leaving patients potentially susceptible to recurrent injuries and chronic symptoms. Inclusion of such information is very important as there is no guaranteed contact with those patients once they are discharged from the ED. Some patients may resume their normal sport/ work/ daily living activities without being fully recovered.

## Attendance month, day and time

Most patients in the current study attended the emergency department during May, July and September. Other studies have shown mixed results on monthly rates of ankle sprain injuries. An epidemiological study reported that ankle sprain injuries in English football leagues increase in July, August and September and decline in following months (Woods et al. 2004). Others showed higher number of ankle sprain injuries in July, November, February and April, whereas the least number of injuries were recorded in September, January and May (Walden et al. 2013). However, these studies, including ours, showed an overall increase of ankle sprains in summer as compared to winter. As our study included all patients who attended the emergency department including those who participate in recreational sports, it could be hypothesized that sport activities are more practiced in summer, as compared to winter.

In terms of days of the week, Sunday was the busiest day of the week with 157 (17%) ankle sprain attendances. Saturday is the quietest day of the week with a number of 98 (11%) ankle sprain attendances. In terms of single hour of the day, 11 am on Sunday had the maximum number of attendances (1.7%) followed by the same hour on Thursday (1.6%). Similar results showed higher number of ankle sprain attendances to an emergency department in Norway during weekends (p < 0.001) with 20.2% occurring on Sundays (Maehlum and Daljord 1984).

## Radiography referrals

As a routine assessment in emergency departments, the Ottawa Ankle rules (OAR) are frequently used as a valid clinical measure to identify patients who may have ankle fracture (Bachmann et al. 2003). They were found useful in reducing the number of x-rays, which in turn may reduce length of stay and waiting times in emergency departments (Curr and Xyrichis 2015). However, we observed that 808 patients (89%) diagnosed with ankle sprain were referred to the radiology department for ankle and foot and radiographs. This is a substantial number of patients who had ankle/foot x-rays taken compared to those who did not. Others have also noted a high percentage (95%) of ankle and foot radiographs taken for individuals attending an ED with ankle sprain in Malta (Borg and Pickard 2008). Therefore, a clinical query could be asked whether those patients who were sent to radiology department fulfilled the criteria of OAR for ankle and foot x-ray. A previous clinical audit reported that two patients that were not referred to the radiography department fulfilled the OAR criteria for ankle and foot fractures (Borg and Pickard 2008). Of those who were sent to radiology department, 19.4% did not fulfil OAR criteria for ankle fractures and 32.4% did not fulfil OAR criteria for foot fractures. These results clearly illustrate inconsistency in clinical practice more specifically using OAR as a clinical screening tool in the emergency department. Borg and Pickard (Borg and Pickard 2008) recommend an implementation strategy for OAR to be used in emergency departments that in turn, according to their results, may reduce unnecessary radiographs by about 22%. Others also recorded an overall reduction of 26.4% in inappropriate practice including failure to follow OAR guidelines (Stiell et al. 1995). In terms of average medical charges per patient, a potential saving of $90 can be achieved by reducing the number of ankle and foot x-rays for patients admitted to emergency departments with ankle sprain (Stiell et al. 1995).

The high number of radiography referrals in the current study highlights an important clinical question as to whether all referrals to radiography, for ankle injuries such as these, are essential. It would be useful to know if OAR tools are used in ankle sprain to aid the decision of onward to the radiography department. This was outside the scope of the current study, however may be a useful clinical investigative consideration for future.

## Common cause of injury and sport type

A subsample of records of 106 patients were manually reviewed to identify a common cause of injury for acute ankle sprain and type of sport. Tripping was reported as the most common cause of injury (29%) whereas sport accounted for 26%. We found that there is high number of patients (26.4%) for whom cause of injury was not specified although the mechanism of injury, inversion, is recorded. Although evidence showed that ankle sprain is a common injury in sports such as football (Nelson et al. 2007; Cloke et al. 2009), we were unable to appropriately categorise type of sport because data was missing in some records of the subsample (26%). It is possible that there might be more people who had their injuries during sport activity but this was not captured in the current record system.

## Limitations

Potential limitations exist within this investigation and thus findings should be interpreted within the context of those limitations. The review highlighted that there were large number of cases sent to the radiology department. The necessity for these radiographs in the current data was not evaluated as we only selected to manually review 10% of patients’ records from total study population. It would be more appropriate if we calculated how many patients were sent to the radiology department and did not have ankle and foot fractures. The only way to investigate both the accuracy of initial diagnosis and number of unnecessary radiographs is to review all records. Unfortunately, this was beyond the scope of the current study. However, this could be a potential area of research in future.

The included cases in this study were assigned a diagnosis by combining two elements: diagnostic area (lower limb-ankle) and local diagnosis description (sprain). These two elements are diagnosis codes in the online record system. However, some of the cases were not valid ankle sprain and the diagnosis did not correlate with what had been written in the patient notes. This was discovered during manual review of the clinical notes of some patients in the subsample. They were recorded as “ruptured right calf” and “fracture distal tip of plantar”. The only method to verify the correct diagnosis is to go through all patient notes, which was again beyond the scope of this study. Despite this, we assumed all other information that was retrieved from the online patient records system is correct and included in the analysis. In addition, we were unable to appropriately categorise cause of injury and sport type because it is not documented in about one quarter of all records of the subsample. It is possible that there might be more people who had their injuries during sport activity but this was not captured in the current record system of the emergency department because of incomplete documentation of history of injury. This information is important in order to identify individuals at risk of ankle sprain and set relevant prevention programs. We agree with a previous review that quality review of patient records in the emergency department is highly recommended (Bridgman et al. 2003). We also acknowledge that this is a snapshot of a certain number of months (May to November); therefore, the results might not be representative for every season of the year.

# Conclusion

The current study highlighted some important clinical aspects that need to be investigated to improve current practice relative to management of acute ankle sprain in an emergency department. It is important that complete and consistent information about diagnosis, causes of injury and sport type be collected upon arrival of patients to an ED. Keeping records that include disease-specific statistics that cover both demographic and clinical characteristics of admitted patients may identify those at risk of this injury. This would also help clinicians and sport clubs medical teams to set prevention programs for those individuals. In addition, the use of clinical assessment tools for ankle sprains such as OAR should be audited to potentially reduce unnecessary radiographic investigations. Future research should focus on investigating the use of OAR to reduce the burden for referrals to radiography department. Future research could also focus more on determining those at risk of ankle sprain injury and subsequent economic impact and the most effective management of this injury.

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