Paediatric acute non-traumatic limp presenting to the emergency department: a retrospective observational study

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ABSTRACT

Background Acute non-traumatic limp in children has many causes, ranging from common benign and self-limiting disease to serious time-sensitive emergencies such as septic arthritis. We aimed to (1) describe the epidemiology and workup of paediatric acute non-traumatic limp presentation in three Australian EDs and (2) compare investigations and treatment between a tertiary paediatric centre and two non-tertiary centres.

Methods A retrospective chart review of children aged 0–16 years, with an initial presentation of non-traumatic limp to three EDs in Melbourne, Australia. Data on presentation, management and outcomes was systematically collected on all eligible patients.

Results Of 63 941 presentations over a 12-month period, 475 (0.7%) met inclusion criteria. The median (IQR) age of presentation was 5 (3–8) years, with a male predominance (61%). Blood tests and imaging were performed in 39% and 51%, respectively. 34% of presentations had no investigations. The most frequent ED diagnoses were transient synovitis (37%) and viral myositis (16%). 84% were discharged home after ED evaluation. Compared with the two non-tertiary hospitals, children who presented to the tertiary centre were less likely to have any investigation performed (OR=0.41, 95% CI: 0.27 to 0.62, p<0.001) and more likely to be discharged home after evaluation (OR=4.67, 95% CI: 2.79 to 7.81, p<0.001).

Conclusion Although mostly due to benign disorders, an important number of limping children who presented to the ED had serious disease, with approximately one-third of these not diagnosed at the initial ED visit. There is large variation in workup including blood test, imaging and decisions regarding ED disposition.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The differential diagnosis for paediatric patients presenting with acute non-traumatic limp is broad and ranges from common benign and self-limiting disease to serious time-sensitive emergencies such as septic arthritis. A number of clinical risk prediction tools have been derived, combining physical examination findings and laboratory results, to estimate risk of serious diagnosis such as septic arthritis; however, these tools have not been derived or validated for use in the ED setting.

⇒ Little is known about ED workup of children with non-traumatic limp or whether workup varies between centres.

WHAT THIS STUDY ADDS

⇒ This retrospective multicentre review of 475 paediatric patients presenting with acute non-traumatic limp demonstrated that existing clinical risk prediction tools are not being routinely applied (>60% of presentations did not receive any blood test). Of those with follow-up data available, more than half of those with a serious disorder were diagnosed with a benign disorder at the first ED visit.

⇒ There is considerable variation in investigations and management between hospitals. Patients who presented to a tertiary centre were significantly less likely to have any investigation performed, were less likely to receive any specialty consultation and were more likely to be managed in the ED without admission or transfer.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study highlights significant variability in workup and management of children presenting with acute non-traumatic limp.

⇒ Future research priorities include prospectively collected data on clinical presentation, workup and final diagnosis; and development and validation of clinical decision rules applicable to the emergency department setting.

BACKGROUND

Acute non-traumatic limp is a presentation regularly encountered in the ED care of children. The differential diagnosis is broad and ranges from benign self-limiting conditions (eg, transient synovitis) to serious (eg, haematological malignancy) and/or urgent conditions (eg, septic arthritis and slipped upper femoral epiphysis).[1–3] Although most children will have conditions that can be managed conservatively, a small proportion will have serious and/or urgent pathology that can result in significant morbidity and mortality if left unrecognised and inappropriately treated.

The relative rarity of serious diagnoses poses a challenge to ED clinicians, who on the one hand attempt to minimise costly, time-consuming and potentially harmful investigations, while also avoiding complications of delayed diagnosis in time-sensitive presentations.

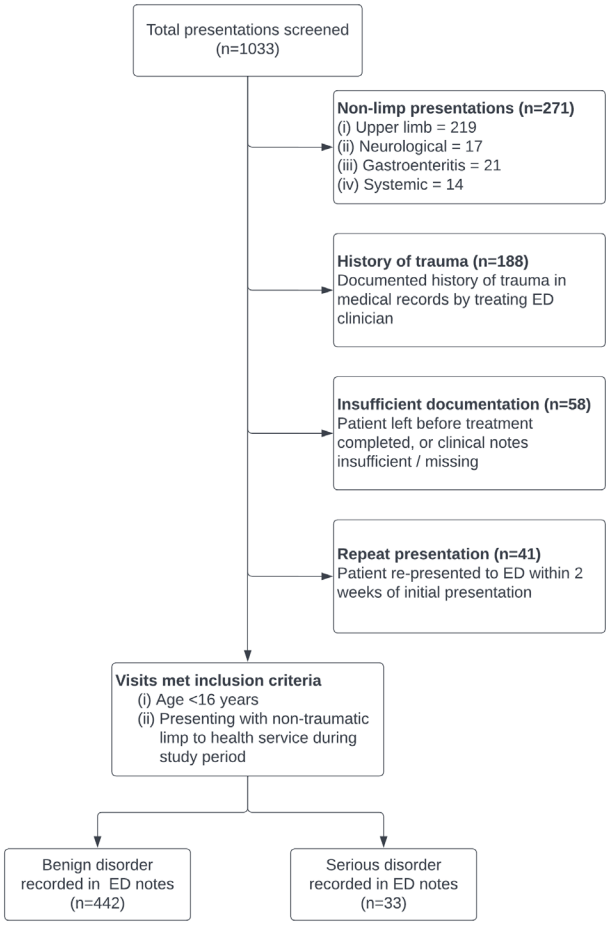

Figure 1 Study flow.

Several studies have previously attempted to create or compare algorithms for assessing acute limp using a variety of clinical signs, blood tests and imaging investigations.[2 4–12] There is considerable variation between recommended approaches, and little research has been conducted within the ED setting.

This paper aims to (1) describe the epidemiology and workup of paediatric acute non-traumatic limp presentation in three Australian EDs and (2) compare investigations and ED treatment between a tertiary paediatric centre and two non-tertiary centres

METHODS

A retrospective structured chart review was conducted of paediatric patients who presented to three metropolitan hospitals in Melbourne, Australia, with non-traumatic limp between 1 January 2015 and 31 December 2015. The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.[13] The hospital networks consist of a tertiary centre with a dedicated paediatric ED and two secondary hospitals with mixed adult/paediatric EDs. The departments are staffed by a combination of junior (not yet enrolled in a training programme), emergency medicine and paediatric trainees, with supervision by emergency physicians/paediatric emergency physicians from 8 am until midnight, 7 days per week. There was no funding associated with this study, and the study was not registered prospectively.

Patient selection

An initial database was established from the institution's ED electronic medical record system (Symphony, V.2.29.3, Ascribe Ltd, Bolton, UK). Eligible medical records were screened to identify patients aged less than 16 years who presented with non-traumatic limp to the ED. We used a combination of the presenting complaint recorded at triage (eg, 'Limb pain, no trauma' and 'limb weakness') and discharge codes (such as 'arthritis, infective', 'hip, irritable', 'joint effusion', 'joint pain/arthralgia') to screen ED presentations for inclusion (full list available in online supplemental table 1). Each record meeting these screening criteria was reviewed by a single author (JT), who determined whether the child had presented with a non-traumatic limp (abnormal gait and/or limb pain with no history of trauma). Patients were excluded if they had missing or insufficient clinical notes or left the ED before treatment was completed. Representations within 2 weeks of an initial presentation were not included as new cases, however, were reviewed to determine follow-up and/or final outcome data. Patients with presentations greater than 2 weeks apart were included as separate cases.

Prior to analysis, a panel of four specialists (emergency, paediatric orthopaedics, paediatric rheumatology and general paediatrics) defined a list of 'benign' and 'serious' conditions and indicated a clinically acceptable timeframe between ED presentation to eventual diagnosis for each condition. A condition was considered 'urgent' if there was consensus among all specialists that an acceptable time to diagnosis was within 48 hours of initial ED presentation.

Septic arthritis, osteomyelitis, slipped upper femoral epiphysis and neoplasm were all considered to be 'serious and/or urgent' conditions. All others were categorised as 'benign'.

Clinical variables were extracted from each medical record using a purpose-designed spreadsheet. Data was collected on patient demographics, presenting complaint, duration of symptoms, presence of fever, investigations conducted (imaging and pathology), and ED diagnosis and follow-up arrangements.

Fever was defined as temperature ≥38°C or if 'fever' was documented the medical notes. Elevated white cell count was defined as $\geq 12.0 \times 10^9$/L. Elevated erythrocyte sedimentation rate (ESR) was defined as ≥40 mm/h. Elevated C reactive protein (CRP) was defined as ≥20 mg/L.

Data extraction and processing

Standardised data collection forms were developed and reviewed by emergency physicians and paediatricians within Monash Health prior to study commencement. Each variable was specifically defined and coded to ensure standardisation. If there was conflicting information between nursing or medical notes, the information entered by medical staff was used. A copy of the spreadsheet used for data collection is provided as online supplemental file 1.

The primary investigator who conducted the screening and data collection (JT) in this study was not blinded to the study's hypotheses and aims. JT was a senior medical student who undertook a research year focused on acute paediatric limp and designed the data collection instrument. No specific additional training was provided. Regular meetings were held with the supervising emergency physician (SC) and paediatric rheumatologist (PG) to address potential areas of ambiguity in recording during the data collection phase. Such ambiguities were resolved by investigator consensus.

Data was recorded directly onto the study spreadsheet using Microsoft Excel for Mac (V.15.16. Washington (USA): Microsoft; 2015). Clinical findings, management and planned follow-up were collected from each patient's ED record, with additional inpatient or outpatient follow-up data collected where relevant. Investigation results were obtained from the hospital's pathology and imaging information systems.

The diagnosis recorded at the time of ED departure was recorded. For those patients where follow-up data was available (eg, orthopaedic clinic, paediatric outpatient clinic, return visit to ED within 2 weeks), a final diagnosis was recorded from either hospital discharge summary or outpatient clinical records.

Data analysis

Data analyses was performed using SPSS Statistics (IBM SPSS Statistics for Windows, V.24.0, Armonk, NY, USA: IBM Corp, 2016). Descriptive statistics were reported as number and percentage for categorical variables. Continuous data was described as median with IQRs.

Differences between children attending the paediatric ED and the non-tertiary EDs for categorical variables were determined using either Fisher's exact test for two-by-two tables or χ^2 test for larger contingency tables. Differences between non-parametric continuous variables were determined using the Mann-Whitney U test. P values <0.05 were considered statistically significant. OR with 95% CIs were used to measure the association between the paediatric ED and the non-tertiary EDs for categorical variables.

RESULTS

There were 63 941 presentations of children aged <16 years during the 12-month study period: 28 627 to the tertiary hospital, and 11 861 and 16 315 to the non-tertiary hospitals, 1033 potentially eligible clinical records were identified and manually reviewed. Fifty-eight were excluded due to incomplete/missing notes: 11 from the tertiary hospital and 47 from the non-tertiary hospital. Four hundred and seventy-five presentations met inclusion criteria and were analysed (figure 1). Thirty-five patients included in the study had repeated presentations within 2 weeks of their initial presentation: 29 had two presentations, 5 had three presentations and 1 had four presentations.

Acute non-traumatic limp made up 0.7% of all paediatric ED presentations; 64% were seen at the tertiary hospital. 'Limb pain, no trauma' was the most common presenting problem (76%) recorded at triage. The median age of those presenting was 5 (age 3–8) years. There was a slight male predominance (61%); 81% of cases presented within the first week of symptoms and the most common duration of symptoms was 1–7 days (37.3%, n=177). The hip was the most common joint involved (37.3%, n=175), followed by knee (23.2%, n=109) (table 1).

Table 1 Baseline and clinical presentation data of paediatric acute non-traumatic limp patients

	Overall (n=475), n (%)	Tertiary (n=303), n (%)	Non-tertiary (n=172), n (%)	P value*
Median age (IQR)	5 (3–8)	5 (3–8)	6 (3–9)	0.13
Male sex	290 (61.1)	192 (63.4)	98 (57.0)	0.17
History of fever	139 (37.6)	98 (38.9)	41 (34.7)	0.44
Fever documented in the ED	26 (6.5)	16 (6.2)	10 (7.0)	0.12
Symptom duration				
<6 hours	61 (12.8)	45 (14.9)	16 (9.3)	0.15
6–24 hours	147 (30.9)	90 (29.7)	57 (33.1)	
1–7 days	177 (37.3)	109 (36)	68 (39.5)	
1–4 weeks	53 (11.2)	30 (9.9)	23 (13.4)	
>1 month	25 (5.3)	20 (6.6)	5 (2.9)	
Not documented	12 (2.5)	9 (3)	3 (1.7)	
Joint involved				0.31
Hip	175 (36.8)	103 (34)	72 (41.9)	
Knee	109 (22.9)	74 (24.4)	35 (20.4)	
Ankle	30 (6.3)	18 (5.9)	12 (7)	
Non-localised	122 (25.7)	84 (27.7)	38 (22.1)	
Not-joint related	32 (6.7)	21 (6.9)	11 (6.4)	
Not documented	7 (1.3)	3 (1)	4 (2.2)	
Initial diagnosis of serious disorder†				
Septic arthritis	15	8	7	0.27
Osteomyelitis	9	5	4	
SUFE	7	1	6	
Neoplasm	2	2		

Missing data for 105 patients (history of fever). Missing data for 73 children (temperature measurement within the ED).
*All p values calculated using χ^2 test except age (Mann-Whitney U test).
†Eleven children were diagnosed with a serious disorder on follow-up after an initial 'benign' diagnosis in the ED. This included 10 children from the tertiary hospital, and one from the non-tertiary hospital.

Investigations

Sixty-four per cent of patients had at least one investigation (pathology and/or imaging) performed (table 2). Patients who presented to a tertiary centre were less likely to have any investigation performed (OR=0.41, 95% CI: 0.36 to 0.77, p<0.001). They were also less likely to have at least one blood test performed (OR=0.51, 95% CI: 0.35 to 0.75, p<0.001).

Blood tests were performed in 39% of cases. The most common tests were full blood examination (FBE), CRP and ESR. Blood cultures were taken in 59 (12%) cases and were positive in 5 patients. Identified organisms were *Staphylococcus aureus* (n=3), *Streptococcus pyogenes* (n=1) and *Acinetobacteri calcoaceticus-baumanii complex* (n=1); all were considered pathogens by the child's treating team. Joint aspiration and washout were performed in 8 (1.7%) children, all performed prior to antibiotic treatment. The identified organisms were *S. aureus* (n=2) and *S. pyogenes* (n=1).

Imaging was performed in 51% of cases. The most common imaging modalities used were X-ray (223, 46.9%) and ultrasound (74, 15.6%). Imaging was less likely to be performed at the tertiary centre than at other hospitals (OR 0.50, 95% CI: 0.34 to 0.74, p<0.001). Imaging findings were reported as normal in 72% of X-rays, 35% of ultrasounds, 25% of bone scans and 17% of MRIs (online supplemental table 1).

Diagnosis

An initial ED diagnosis of a 'benign' disorder was given in 93% (n=442) of cases, while 7% (n=33) received an initial ED diagnosis of a 'serious and/or urgent' disorder. The most common ED diagnoses were transient synovitis (n=176) and viral myositis (n=75). No definitive ED diagnosis was made in 16% (n=77) of cases. Septic arthritis was the most common 'serious and/or urgent' condition (n=15). Although we excluded patients with a documented history of trauma, four patients were diagnosed with a fracture.

Seventy-nine patients were admitted to hospital on their initial ED visit. Of these, 68% were diagnosed with a 'benign' disorder and 32% were diagnosed with a 'serious and/or urgent' disorder.

Table 2 Investigations and management in children with acute non-traumatic limp

Investigation/management	Overall	Tertiary hospital	Non-tertiary hospital	OR—Tertiary vs non-tertiary hospital (95% CI)	P value*
Any investigation	303 (63.8)	172 (56.8)	131 (76.2)	0.41 (0.27 to 0.62)	<0.001
Blood test					
FBE	177 (37.3)	96 (31.7)	81 (47.1)	0.52 (0.36 to 0.77)	0.001
CRP	161 (33.9)	86 (28.4)	75 (43.6)	0.51 (0.35 to 0.76)	<0.001
ESR	117 (24.6)	74 (24.4)	43 (25)	0.97 (0.63 to 1.49)	0.92
Blood cultures	59 (12.4)	39 (12.9)	20 (11.6)	1.12 (0.63 to 1.99)	0.78
Creatine kinase	43 (9.1)	24 (7.9)	19 (11)	0.69 (0.37 to 1.31)	0.32
LDH	5 (1.1)	5 (1.7)	0 (0)	N/A	0.17
Any blood test	183 (38.5)	99 (32.7)	84 (48.8)	0.51 (0.35 to 0.75)	<0.001
Joint aspiration	8 (1.7)	4 (1.3)	4 (2.3)	0.56 (0.14 to 2.28)	0.47
Imaging					
X-ray	223 (46.9)	126 (41.6)	97 (56.4)	0.55 (0.38 to 0.80)	0.002
Ultrasound	74 (15.6)	41 (13.5)	33 (19.2)	0.66 (0.40 to 1.09)	0.12
MRI	35 (7.4)	24 (7.9)	11 (6.4)	1.26 (0.60 to 2.64)	0.59
Bone scan	12 (2.5)	8 (2.6)	4 (2.3)	1.14 (0.34 to 3.84)	1.00
Any imaging	244 (51.4)	137 (45.2)	107 (62.2)	0.50 (0.34 to 0.74)	<0.001
Managed in ED without any specialty consultation	326 (69.1)	232 (76.5)	94 (54.7)	2.71 (1.82 to 4.05)	<0.001
Managed in ED without inpatient admission or transfer	396 (83.3)	276 (91.1)	120 (69.7)	4.43 (2.65 to 7.39)	<0.001

*P values calculated using Fisher's exact test.
CRP, C reactive protein; ESR, erythrocyte sedimentation rate; FBE, full blood examination; LDH, lactate dehydrogenase.

Five patients with a serious and/or urgent disorder were not admitted at the initial ED visit. Three were presentations of children with previous septic arthritis and concern for worsening or recurrence, who were discharged with early follow-up with their initial treating team. Two children were thought by ED staff to be likely to have a bone/joint infection: one was discharged after rheumatology and orthopaedic review in the ED, and one was planned to be admitted but self-discharged and later presented to another health service.

Follow-up data was available in 36% (169/475) of cases. Eighty-two per cent (139/169) of cases were diagnosed with a 'benign' disorder, while 18% (30/169) were diagnosed with a 'serious' disorder (figure 2). The most common follow-up diagnoses were transient synovitis (n=54), osteomyelitis (n=14) and slipped upper femoral epiphysis (n=7).

At follow-up, 156/169 (92.3%) children had no change to the seriousness of their diagnosis. Of the 30 children with a serious and/or urgent diagnosis at follow-up, 11 had an ED diagnosis of a 'benign' disorder on initial presentation (osteomyelitis 7, septic arthritis 3, neoplasm 1). Of these, five had no tests during their first ED visit, three had normal investigations, and three had at least one abnormality on initial investigations. One was admitted to hospital at their initial visit (online supplemental table 2). Ten of the children with a change from benign to serious diagnosis initially attended the tertiary ED.

Management

Most (84%) patients were discharged home after ED evaluation. Patients who presented to the tertiary hospital were more likely to be managed without any specialty consultation (OR 2.71, 95% CI: 1.82 to 4.05, p<0.001) and were more likely to be managed in the ED without admission or transfer (OR 4.43, 95% CI: 2.65 to 7.39, p<0.001).

Specific follow-up was organised in 76% of cases, while the remainder were advised to return to ED if symptoms worsened (16%) or did not have any documented discharge advice or planned follow-up (8%). The most common planned follow-up sites were the child's general practitioner, a 'rapid review' paediatric clinic and paediatric orthopaedic outpatient clinic.

DISCUSSION

Our retrospective review is one of the largest published studies of limping children presenting to the ED. Analysis of 475 presentations with acute paediatric limp has identified substantial differences in the initial workup between hospitals, with inconsistent utilisation of blood tests and imaging. However, it is unclear whether this reflects variation in the quality of care delivered or a difference in severity of presentation between hospitals. Our finding that one-third of children with limping due to serious/urgent disorders required repeat visits before a diagnosis was made highlights the difficulty in diagnosing serious disease in this population. It is uncertain if more comprehensive laboratory (or routine testing), validation and implementation of a clinical decision rule, or more advanced imaging (eg, POCUS) would improve diagnostic accuracy. Overall, the low proportion of paediatric ED presentations with acute non-traumatic limp, common diagnosis of transient synovitis and infrequent diagnosis of septic arthritis is consistent with international literature.[2 14 15]

Our recent systematic review demonstrated that much of the existing literature regarding diagnosis of septic arthritis is based on highly selected populations (ie, those undergoing joint aspiration and/or orthopaedic admission). Previous studies of the accuracy of imaging or blood tests have therefore been performed in children with a relatively high prevalence of septic arthritis (ranging from 4.6% to 70.8% for laboratory studies, and from 21.8% to 48.8% for imaging studies[12]). These findings may not be readily applicable to the less differentiated group of children presenting to the ED with acute limp, where less than 2% had joint infection.

Individual physical examination or laboratory findings are not particularly useful to rule in or rule out septic arthritis. In an attempt to improve diagnostic accuracy, a number of clinical risk prediction tools have been derived. These tools, focused

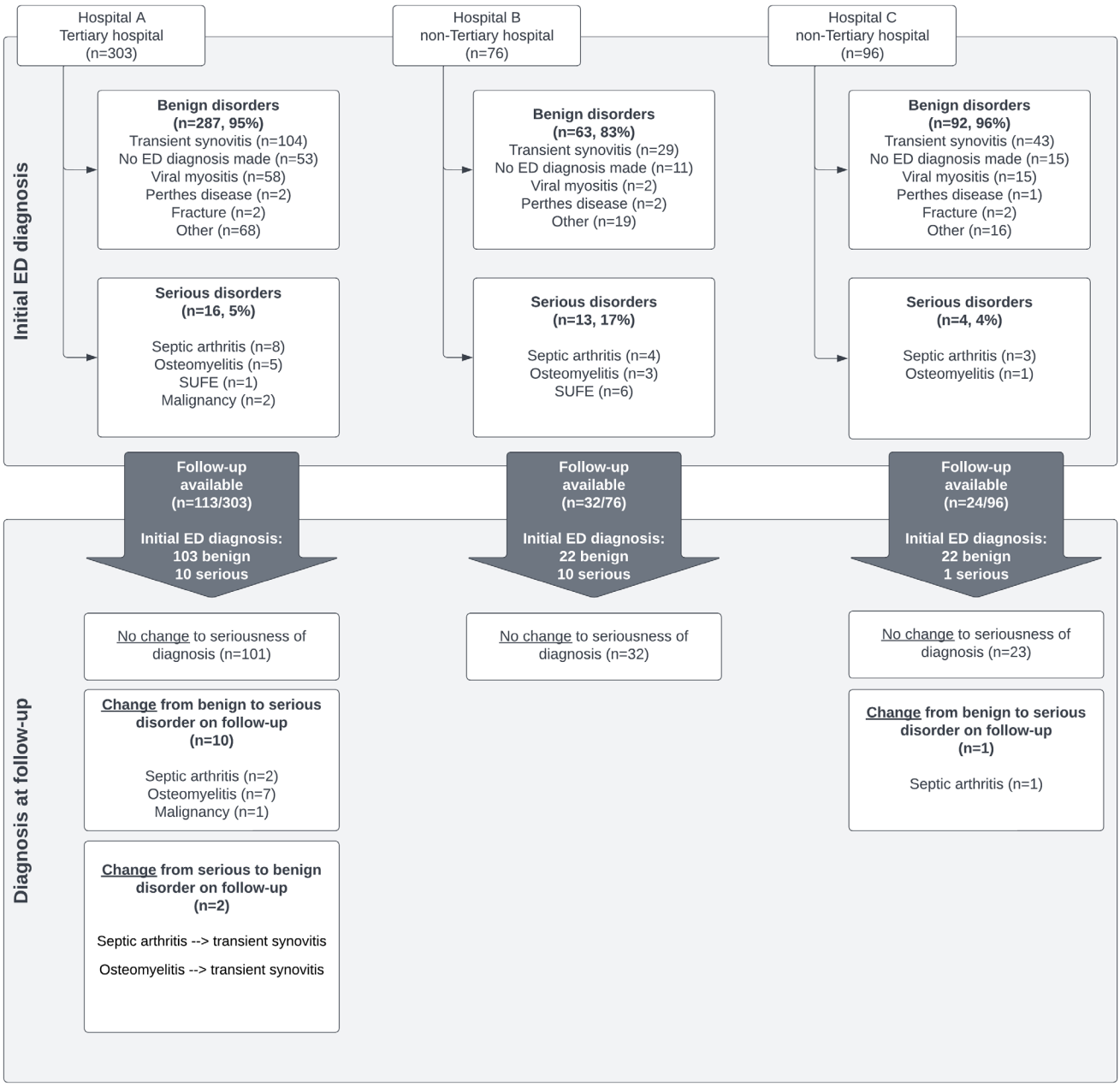

Figure 2 Diagnosis of 'serious and/or urgent' and 'benign' disorders.

on the hip joint, combine physical examination findings (such as weight-bearing status and presence of fever) with laboratory results (usually a combination of white cell count, CRP and ESR) to provide a risk estimate of septic arthritis.[6–8 16 17] None of these tools have been derived or validated for use in the ED setting.[12] It is notable that more than 60% of children presenting to the ED with non-traumatic limp did not undergo any blood tests, suggesting that these rules are not routinely applied in the ED setting.

Variation in imaging rates was notable within our study population. Ultrasound is more sensitive than X-ray at detecting joint effusions.[2 5 18] Ultrasound has been suggested as a primary imaging modality in the workup of a non-traumatic limp,[14 19] reserving X-rays for cases of suspected fractures, SUFE and Perthes disease. Ultrasound was used in 15.6% of our cohort, and the most common findings were unilateral joint effusion (51%) and a normal study (36%). Although the absence of an effusion on ultrasound makes the diagnosis of septic arthritis unlikely, the presence of an effusion does not differentiate septic arthritis from transient synovitis. Additionally, limited after-hours availability of ultrasonography may further limit its clinical use in the ED setting; however, there is some promising research supporting the use of ED physician performed ultrasound to detect joint effusions.[20]

X-rays were the most common imaging investigation performed. Plain radiographs were most useful in detecting the specific diagnoses of SUFE, Perthes disease and fracture; however, these diagnoses only made up a small proportion of all

X-ray findings (3%, 3%, 2%, respectively). Most X-rays (72%) were reported as normal.

The reasons for differences in workup and management between tertiary and non-tertiary centres are unclear, however, may relate to greater exposure to children with non-traumatic limp at the tertiary centre (over 60% of the entire cohort was seen at the tertiary hospital) and/or greater confidence in clinical assessment in a high-volume paediatric setting. Other potential reasons include training/supervision (ie, more trainees), unmeasured differences in populations (language, complexity of cases, socioeconomic status, underlying health conditions), differences in coding/documentation between hospitals and performance of diagnostic tests prior to transfer to the tertiary hospital.

Our study demonstrated differences between the workup of children presenting to a tertiary centre and to the non-tertiary centres, with lower rates of blood tests and lower rates of imaging studies. Of the children with follow-up data available, most of those who had a change in diagnosis from a benign condition to a serious condition had initially attended the tertiary hospital. Although the lack of follow-up data for nearly two-thirds of the study cohort makes it difficult to draw firm conclusions about the diagnostic accuracy of different hospitals, the lower rates of testing and apparently higher rates of delayed diagnosis of a serious condition warrant further exploration.

The workup in a child with a limp aims to exclude age-appropriate serious illnesses (eg, septic arthritis, osteomyelitis in younger children, slipped upper femoral epiphysis in adolescents), establish a working diagnosis, initiate treatment and ensure appropriate follow-up. We were unable to validate existing clinical prediction rules within our cohort due to lack of follow-up in a significant proportion of patients and a lack of consistent documentation of weight-bearing status.

Viral myositis was common (16% of all patients), however, is infrequently reported in studies involving more selected populations. During the study year, there was a higher than usual incidence of paediatric influenza infection in Australia.[21] Further, despite excluding patients with a known history of trauma, four cases of fracture were identified, suggesting that fractures may still be a relevant differential diagnosis, even in the absence of a clear history of trauma in a pre-school aged child.

The inclusion of patients worked up in both non-tertiary and tertiary settings suggests that these results should be broadly generalisable across Australia and other similar healthcare settings. A key exception to this would be areas where other causes of limp pain are prevalent such as rheumatic fever or Lyme disease.[22 23]

The primary limitation of this study is the retrospective design and reliance on complete documentation in the clinical records. We applied recommended practices for chart review studies,[24 25] including clearly defined data points (selected on the basis of regularly recorded and extractable data with minimal need for interpretation by the abstractor), a standardised data extraction form and an a priori consensus definition of serious and/or urgent pathology. However, the main reviewer (JT) was unblinded, and we did not assess inter-rater reliability).

Our exclusion of children with trauma was intended to ensure that we capture children with a non-traumatic limp, where evaluation for bone and joint infection is often a significant consideration. Minor trauma (such as falls, bruises and abrasions) have been reported to have preceded a diagnosis of bone and/or joint infection in approximately 20% of children in a prospective cohort study from Finland.[26] However, a similar rate of minor trauma was noted in healthy children. It is unclear whether exclusion of children with a presenting complaint of limb trauma or injury resulted in any missed diagnoses of serious pathology.

Unfortunately, there was limited availability of follow-up data in the study population, with only 36% of participants having a record of another visit within the hospital network. We were unable to determine a final diagnosis for a significant proportion of patients and have therefore interpreted our results relating to diagnosis with caution. We acknowledge that this study took place before the COVID-19 pandemic, and therefore, some approaches to patient assessment and follow-up may have changed.

In conclusion, an important number of limping children who presented to the ED had serious disease, with approximately one-third of these not diagnosed at the initial ED visit. There was significant variation in workup and management. A large multicentre prospective study collecting data on history, examination and investigations and with appropriate follow-up is required to determine a consistent, evidence-based approach to the assessment and management of children presenting with acute non-traumatic limp.

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Contributors SC, JT and PG conceived the study. JT collected the data, supervised by SC and PG. MH wrote the first draft of the paper. All authors have reviewed the final draft and approve submission.SC accepts full responsibility for the work and the conduct of the study, had access to the data, and controlled the decision to publish.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Monash Health and Monash University Human Research Ethics Committees prior to commencement (Monash Health HREC Ref: CF16/249—2016000116).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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Supplementary Table 1. Criteria for patient selection

Presenting complaint recorded at triage	Discharge codes recorded after ED visit
Limb pain, no trauma Limb weakness	Arthritis, infective Bursitis Congenital dislocation of hip Disorder of bone, other Gait, ataxia Groin pain Henoch-Schönlein purpura, allergic Hip, irritable Joint disorder, other Joint effusion Joint pain / arthralgia Lame / limping / limp Limb pain Muscle and musculoskeletal pain, myalgia Muscle spasm Osgood-Schlatter disease Osteomyelitis Perthes disease Tendon rupture, non traumatic Tendonitis Tenosynovitis / synovitis Thrombophlebitis of leg Walking difficulty

Supplementary Table 2. Patients with a "serious and/or urgent" diagnosis who had an initial ED diagnosis of a benign condition.

Case	Initial ED diagnosis	Investigations during 1st presentation	Diagnosis after 2nd presentation	Further ED workup during 2nd presentation	Disposition after 2nd presentation
1	Transient synovitis	None	?Septic arthritis	Ultrasound showed complex effusion with thin septations. X-ray normal CRP - raised ESR - raised WCC - normal	Transfer to tertiary orthopaedic service. Further details not available
2	?Transient synovitis	WCC – normal CRP – normal X-ray - normal	Discitis	Lumbar spine x-ray suggested reduction in disc height.	Admitted for bone scan / MRI under GA. Confirmed osteomyelitis and discitis in lumbar spine
3	Viral-related transient synovitis	None	?Bacteraemia	CRP - raised ESR - raised WCC - normal Ultrasound - normal X-ray - normal	Admitted. MRI demonstrated osteomyelitis of iliac crest. Blood cultures positive for *S. aureus.*
4	Limb pain (no clear diagnosis)	CRP – raised WCC - normal	Osteomyelitis	CRP – raised ESR - raised	Bone scan (organised prior to admission) confirmed osteomyelitis.
5	Sprain of ankle	None	Osteomyelitis	X-ray suggestive of osteomyelitis of foot. Normal blood tests	Admitted for intravenous antibiotics
6	Sprain of ankle	X-ray - normal	Osteomyelitis	MRI (outpatient) demonstrated osteomyelitis of distal tibia	Transferred to tertiary hospital for ongoing management
7	Sprain of ankle	CRP – normal	Septic arthritis of	CRP – raised	Transferred to orthopaedic service for joint

		WCC - normal	ankle	WCC – normal	aspiration and subsequent washout.
8	Hip pain	ESR – raised CRP – raised WCC - normal	Osteomyelitis of acetabulum	Ultrasound – hip effusion	Transferred to orthopaedic service for ongoing care. Unsuccessful aspiration under GA. Subsequent MRI demonstrated osteomyelitis.
9	Limping	ESR – raised CRP – slightly raised WCC – normal	Osteomyelitis of calcaneum	N/A	Admitted to hospital from clinic. Bone scan demonstrated osteomyelitis.
10	Limb pain	None	Osteomyelitis	CRP – raised ESR – raised WCC – normal Ultrasound – knee effusion	Seen in clinic and diagnosed with likely osteomyelitis. Referred to tertiary orthopaedic service. Further details not available.
11	Limb injury	None	Acute leukaemia	Full blood examination demonstrated pancytopaenia with blasts	Admitted to hospital for further investigations and management