

# BMJ Open Protocol for a longitudinal cohort study: determination of risk factors for the development of first venous leg ulcer in people with chronic venous insufficiency, the VEINS (venous insufficiency in South Florida) cohort

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## ABSTRACT

**Introduction** Chronic venous insufficiency (CVI) affects up to one-third of the adult population yet venous leg ulcers (VLU), a significant complication of CVI, only affect 1%–2% of adults in the USA. Why some develop VLU and others do not is unclear. VLU have a significant impact on quality of life and are extremely costly and difficult to treat. Moreover, VLU prevalence is increasing, doubling in the last 20 years. In order to characterise the differences between people with CVI and those who ultimately develop VLU, we aim to set up the unique venous insufficiency in South Florida cohort.

**Methods and analysis** Subjects will be recruited from the University of Miami Hospital and Clinic's vascular laboratory database, which began in July 2011. Any adult age 18–95 who has had venous reflux detected on duplex ultrasound of the lower extremities is included. Approximately 2500 patients are already in the database that meet these criteria, with an estimated 2500 additional potential subjects to be recruited from the vascular laboratory database over the next 5 years. Subjects with a history of VLU prior to the duplex study date will be excluded. Data will be collected via review of the Doppler study report, patient phone interview and review of the electronic medical record. Subjects will be contacted for follow-up every 3 months for at least 5 years until the study endpoint, development of first VLU (fVLU), is reached. In order to estimate the time from reflux documentation to fVLU, Kaplan-Meier survival curves will be constructed. Cox proportional hazard regression models will be constructed to investigate possible risk factors.

**Ethics and dissemination** This study is approved by the University of Miami's Institutional Review Board. We hope to present the results of this study to the scientific community at conferences and in peer-reviewed journals.

## INTRODUCTION

### Background

Chronic ulcers of the lower extremities affect 1%–2% of adults in the USA.<sup>1–3</sup> Of these ulcers, around 70% are due to venous disease alone,

## Strengths and limitations of this study

- To our knowledge, this study is the first that seeks to prospectively track development of the first venous leg ulcer (fVLU) among a population of subjects with chronic venous insufficiency (CVI).
- The venous insufficiency in South Florida cohort will describe the natural history of CVI leading to fVLU, reveal specific risk factors for the development of fVLU and allow for the development of 3 and 5 years predictive models for fVLU occurrence.
- The data obtained from this study will support the development of VLU prevention strategies.
- This study does not address time in relation to the initial development of CVI, but rather time from documentation of CVI on venous duplex ultrasound, typically the point at which CVI becomes clinically significant.

while 20% are due to arterial or mixed arteriovenous disease.<sup>2</sup> Venous leg ulcers (VLU) are wounds that typically occur on the lower third of the leg between the ankle and knee, often referred to as the 'gaiter area', in the setting of chronic venous insufficiency (CVI). In the USA, roughly one-third of the adult population is likely to have CVI, while worldwide prevalence estimates are up to 60%.<sup>4</sup> CVI is characterised by sustained ambulatory venous pressure (aka venous hypertension) and by reflux on Doppler ultrasound. Reflux is typically defined as retrograde blood flow in the lower extremities greater than 0.5 s after provocation.<sup>5</sup> Typical causes of CVI include valvular defects, which may be acquired or genetic, ineffective calf muscle pump action and obstruction from deep vein thrombosis.<sup>1,2</sup> The pathophysiology of VLU remains unclear, though various observation-based

hypotheses implicating pericapillary fibrin cuffing, endovascular trapping of oxygen and nutrients, inflammatory cell infiltrates, cytokine trapping, and metalloproteinase dysregulation have all been areas of extensive research.<sup>6–8</sup>

VLU often have a very significant impact on a patient's quality of life.<sup>9</sup> Compared with matched controls, patients with VLU have more comorbid conditions, miss more days of work and use more medical resources.<sup>10–11</sup> While numerous advancements in treatment, such as cellular and acellular skin equivalents and biomaterials, have been made in recent years,<sup>1</sup> VLU prevalence seems to be increasing. The estimated prevalence of VLU has doubled in the last 20 years from 0.3% to 0.6% in adults under 65 and is up to 2.2% in adults over 65.<sup>10–12</sup> European epidemiological data have shown similar prevalence rates among these age groups, while revealing that VLU prevalence is even higher at 4%–5% in individuals older than 80 years<sup>13</sup> and may exceed 12% among certain elderly populations.<sup>14</sup>

Moreover, the costs associated with VLU have been increasing and represent a great burden for both the patient and public health system. Over the last 30 years, the estimated cost of treating a single, chronic VLU has more than tripled to US\$34 000 today.<sup>10–12</sup> Likewise, the annual cost of VLU treatment in the USA has risen from around US\$3 billion in 1987 to US\$15 billion in 2011.<sup>11</sup>

## RATIONALE

With an ageing population, it is likely that VLU prevalence will continue to rise, with more ulcers occurring in older, sicker patients who are costlier to treat. Despite the significant morbidity, high costs and continued difficulty in healing of VLU, little attention has been given to primary prevention. Thus, a paradigm shift, away from wholesale investment in advanced interventions and towards prevention, is warranted. The idea that a greater emphasis on VLU prevention is needed is not new, going back to at least 1997.<sup>15</sup> Nonetheless, no studies to date have focused on prevention of the first VLU (fVLU). Without these data, society and summary guidelines on VLU have not been able to make recommendations regarding primary prevention.<sup>12–16–17</sup>

Given that the pathophysiology of VLU is not well understood, risk factor analysis is a sensible strategy for studying prevention. With the goals of developing a predictive model for ulceration and overall prevention strategy in mind, this study aims to identify risk factors associated with the development of the fVLU. While certain risk factors have been described<sup>1</sup> (box 1), they are based primarily on either retrospective analyses that compared people with any VLU (ie, first or recurrent) to the general population or on expert opinion.

Furthermore, associations between VLU occurrence and certain medical conditions,<sup>18</sup> medications,<sup>19–20</sup> and other parameters<sup>21–23</sup> have been made, but the directionality of the association is not clear. Although these data are informative, they may not be clinically useful. A need

## Box 1 Risk factors for VLU

- ▶ Age older than 55 years
- ▶ Family history of CVI
- ▶ Higher body mass index
- ▶ History of pulmonary embolism
- ▶ History of superficial/deep venous thrombosis
- ▶ Lower extremities skeletal or joint disease
- ▶ Higher number of pregnancies
- ▶ Parental history of ankle ulcers
- ▶ Physical inactivity
- ▶ Ulcer history
- ▶ Severe lipodermatosclerosis
- ▶ Venous reflux in deep veins

CVI, chronic venous insufficiency; VLU, venous leg ulcer.

exists to distinguish risk factors for CVI and for fVLU, as only a small minority of patients with CVI proceed to develop an fVLU.<sup>24</sup> Particular risk factors specific for the fVLU are not known, and to our knowledge no study has prospectively tracked the development of the fVLU.

Therefore, the primary aim of this research is to answer a simple yet extremely complex clinical question: in a patient presenting with signs and symptoms of CVI, what are the risk factors that will help predict the development of an fVLU? Once these potential risk factors have been elucidated, appropriate interventions can then be pursued.

## Primary objective

1. Characterise risk factors associated with developing fVLU in people with CVI.

## Secondary objectives

2. Develop 3 and 5 years predictive models for risk of developing fVLU in patients with signs and symptoms of CVI.
3. Estimate the incidence of fVLU in people with CVI.

## METHODS AND ANALYSIS

### Geographical Context

Subjects will represent a diverse group from all over south-eastern Florida primarily, with the vast majority coming from Miami-Dade, Broward and Palm Beach counties in the USA.

### Study population

The venous insufficiency in South Florida (VEINS) cohort will include both men and women ages 18–95. Any adult who has had reflux detected on venous duplex ultrasound of the lower extremities is potentially eligible. Patients who have undergone venous duplex studies for any indication will be considered. Exclusion criteria include age under 18, inability to provide consent over the phone and history of venous ulcer prior to duplex study date.

## Recruitment of participants

Subjects will be recruited from a database of the University of Miami Hospital and Clinic's vascular laboratory. The database, which goes back to July 2011, will be queried for all patients who were found to have reflux of greater than 0.5 s on venous duplex ultrasound of the lower extremities. After reflux has been noted from the duplex study report, the subject's chart will be reviewed in the electronic medical record (EMR) to ascertain basic contact information. For this part of the study, a privacy waiver for recruitment purposes has been approved by the local institutional review board. The investigators will then call potential subjects by phone. The subjects will provide a verbal phone consent for a phone survey and further chart review of potential risk factors. During the verbal informed consent, all aspects of the study will be reviewed, including: why subjects were selected, researcher goals, procedures, relevant risks, benefits and subjects' rights. It is anticipated that a large portion of the study population is Spanish speaking. The verbal informed consent and survey have both been translated to Spanish and will be administered by Spanish speaking research staff, with the help of an interpreter as needed. Once consent is obtained and inclusion criteria confirmed, subjects will be enrolled into the cohort.

## Sample size

There are approximately 2500 lower extremity venous duplex ultrasound reports in the database that detected reflux going back to its inception in July 2011. In recent years, approximately 500 duplex studies that find reflux have been performed annually. Thus, over the next 5 years, we expect approximately 2500 additional subjects will be potentially eligible to enter the cohort. Given the paucity of data available on the incidence of fVLU, we will attempt to recruit as many subjects as possible.

## Study design: overview

This protocol is for a longitudinal cohort study with a retrospective and prospective components. The methodology for building the cohort and the following subjects is outlined in figure 1. The aim throughout is to identify subjects with venous reflux documented on ultrasound prior to the development of fVLU. Any subject who reports a history of an ulcer prior to the date of reflux study will be excluded from the cohort. The retrospective part of the study will cover all patients currently in the database. If a subject went on to develop an fVLU subsequent to the time of the duplex study (ie, after reflux was documented but before the first contact by the investigators), he/she will not be followed in any prospective manner. Instead, only an entry survey will be administered and the subject's participation will end (see 'EndPoint and Follow-up' section below). The prospective part of this study will include any subject who met inclusion criteria but has not yet developed a VLU. Regardless of when subjects enter the cohort, they will be followed prospectively for 5 years or until the occurrence of an ulcer, whichever occurs first.

Any subject who begins in the retrospective cohort can continue into the prospective cohort so long as the fVLU has not developed. New subjects will be continuously recruited as new patients come through the vascular laboratory for venous studies. We plan to recruit new subjects for at least 5 years, though we hope to have the option of extending this enrolment period and overall study duration depending on availability of resources.

## Endpoint and follow-up

The endpoint of this study is the development of fVLU, after which subjects will exit the cohort. If a subject has no history of fVLU, he/she will be contacted by phone for a follow-up survey every 3 months until the development of fVLU. At this time, the intention is that subjects will be followed for at least 5 years.

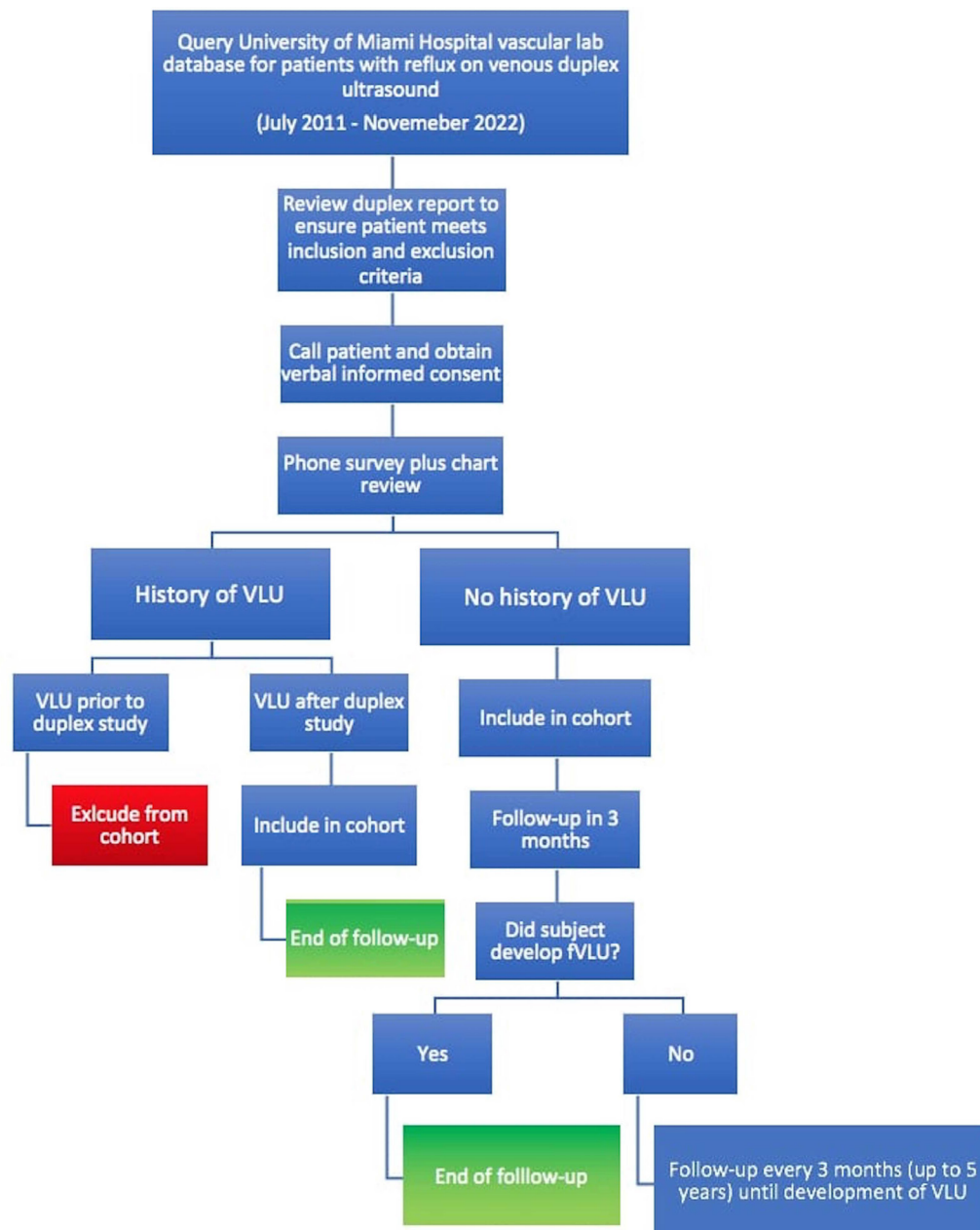
## Data collection and management

In all cases, data will be collected via three sources: venous duplex ultrasound report, phone survey and patient chart in the EMR. Venous duplex ultrasound reports will be accessed from a secure electronic database housed in the University of Miami Hospital and Clinic's vascular laboratory. For the phone survey, a script with exact wording for all questions and instructions has been created. Data on specific variables of interest will be ascertained from each source as outlined in table 1. A comprehensive initial assessment form and a follow-up form have been designed. These forms are quite similar, except that the follow-up form omits questions on unchanging historical and demographic data.

All data will be entered and stored electronically in Research Electronic Data Capture (REDCap), a secure, web-based application that facilitates creation and management of data collection instruments, monitoring of data quality and statistical analysis of data.<sup>25</sup> This software has commonly been used for epidemiological research, including similar cohort studies.<sup>26</sup> All investigators will be trained in data entry by the REDCap study administrator and must demonstrate proficiency with mock patients and data entry before being granted access to data collection forms.

## Evaluation of study endpoint: photo of wound

If a subject reports the development of fVLU, investigators will seek to obtain a photo in the patient chart or request that the subject submits a picture of the wound via secure email. We have developed a protocol for evaluating images received, which involves independent evaluation by two investigators. They will first confirm the presence of a wound, then determine if this can be considered a VLU: yes, no or indeterminate. In cases of disagreement, the case will be presented to a third wound expert (RSK) for final determination. Subjects will then be encouraged to see us in the clinic. While a photograph of the wound is an optional step in the study protocol, it can help validate that the wound is a VLU based on location and appearance. In cases where visual evidence is not



**Figure 1** Flow chart outlining the methodology for building the VEINS cohort and following subjects prospectively once they are enrolled. fVLU, first venous leg ulcer; VEINS, venous insufficiency in South Florida; VLU, venous leg ulcer.

available, ulcer validation will be supported by key questions regarding wound characteristics, such as location and duration. Moreover, there are data supporting the ability of patients to correctly self-assess the status of their chronic wounds with up to 97% accuracy when compared with expert evaluation.<sup>27</sup>

### Pilot study

A pilot study of 70 potential subjects was carried out. The first 10 venous duplex studies to report reflux from each year of the database's existence (2011–2017) were used. The purpose of this pilot study was to give investigators the chance to determine how well the phone survey and data collection forms performed with a variety of real

subjects, and to discuss any changes that should be made. Only minor technical changes in data coding were made. Of the 70 patients who were called, 22 were reached over the phone, 20 of whom enrolled in the study.

### Statistical analysis of data

For purpose of analysis, the data will be de-identified and exported from REDCap into IBM SPSS Statistics for Windows (IBM). Summary estimate and CIs will be calculated. In order to estimate the time from venous reflux documentation to fVLU, Kaplan-Meier survival curves will be constructed. Cox proportional hazard regression models will be constructed to investigate possible risk factors.

**Table 1** Variables of interest with corresponding data source

Venous duplex ultrasound report	Phone survey	Patient chart
Study date	Race	Sex
Study indication	Ethnicity	Height
Reflux location(s)	History of VLU (including ulcer start date)	Weight
Reflux time(s)	Limitation of ankle movement	Venous dermatitis
Presence of DVT or superficial vein thrombosis	Mobility (ie, use of a wheelchair or walker)	Lipodermatosclerosis
	History of DVT or PE	Atrophie blanche
	History of varicose veins	Medical and surgical history
	History of leg swelling	Ulcer photograph
	Chronic itch of lower extremities	
	Chronic rash of lower extremities	
	Lower extremity vein procedures	
	Lower extremity artery procedures	
	Use of compression on lower extremities	
	Elevation of legs when sleeping	
	No of pregnancies	
	Other medical and surgical history	
	Medications	
	Smoking history	
	Exercise	
	Family history of leg ulcers, swelling or varicose veins	

DVT, deep vein thrombosis; PE, pulmonary embolism; VLU, venous leg ulcer.

### Patient and public involvement

Patients and the general public were not involved in the development of the research question, outcome measures or protocol design.

### DISCUSSION

The aim of this study is to develop a cohort of patients with proven venous reflux that can be followed prospectively until the development of a VLU. In doing so, we hope to shed some light on who, of the millions of people with CVI, is at greatest risk of developing an fVLU. Previous studies have looked at recurrence rates and associated risk factors regarding venous ulcers, but data regarding fVLU are quite limited. In addition, VLU incidence data collected from the cohort will be informative, as the only incidence data available have been inferred from retrospective analyses. The VEINS cohort study seeks to determine, in a prospective fashion, the roles of traditional CVI risk factors and novel risk or protective factors in the development of fVLU. Where associations are detected, further studies will be pursued that seek to elucidate the nature of the association. Furthermore, in identifying particular risk factors and/or protective factors, we hope to develop a predictive model with risk scores for the likelihood of fVLU development within 3 and 5 years of clinically significant CVI. Of note, this study does not

address time in relation to the initial development of CVI, but rather time from documentation of CVI on venous duplex ultrasound. Though lead time bias could impact our analyses, lower extremity ultrasounds looking for reflux are typically only performed when CVI becomes clinically significant, which is usually concurrent with the first time a patient sees a doctor for leg problems.

Implementing early interventions that delay or prevent the development of a chronic and morbid condition is the guiding principle behind these efforts. In doing so, the whole of society benefits both economically and socially from a happier and healthier population.

### Potential benefit to subjects

While there is no direct benefit to subjects, being asked about their health status by a member of the research team every 3 months may raise the subjects' awareness of their health. Additionally, if a patient develops an ulcer while in the cohort, he/she will be referred to a wound clinic for appropriate management and wound care.

### Ethics and dissemination

The primary investigator has extensive training and experience in clinical research and relevant bioethics. The research staff will include a team of primary researchers that have extensive qualifications and expertise to lead the study. All study staff are trained and routinely

re-educated about the ethical conduct of human subject research. There are no anticipated physical, social, legal or economic risks associated with the study. There is minimal risk of breach of confidentiality. No vulnerable populations are specifically targeted in this study. Pregnant women will not be excluded.

### Data protection

All subject-specific data will be kept confidential in a password-protected university desktop that can only be accessed by investigators. Study offices are kept locked and are protected by around-the-clock university of Miami security services. All records containing personal health information will be kept confidential and, to the extent permitted by the applicable laws and/or regulations, will not be made publicly available. De-identified collected data may be used for future analysis and publication.

### Dissemination

We hope to present the results of this study to the scientific community at conferences and in peer-reviewed journals.

**Contributors** All authors, JSM, RSK and HL-T, made substantial contributions to the conception and design of this protocol. All authors have critically read this manuscript and have made their revisions, and they have now all approved this final version for submission. All authors agree to be accountable for the future integrity of this study.

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**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** All aspects of this study, including verbal informed consent, data collection and photo acquisition, have been approved by the University of Miami Institutional Review Board.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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