Patients' understandings about cellulitis and views about how best to prevent recurrent episodes: mixed methods study in primary and secondary care

Running head: Preventing recurrent cellulitis

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Bulleted statements

What's already known about this topic?

- Cellulitis is an acute, painful and potentially serious bacterial infection of the skin and underlying tissue, which causes considerable impact on quality of life.
- Approximately a third of patients who have had cellulitis suffer recurrent episodes, and a number of different strategies for prevention have been proposed.
- The only treatment shown to reduce the risk of recurrence is long-term low-dose antibiotics but these appear to be under-used in practice.

What does this study add?

- Quantitative and qualitative data showed that people who have had cellulitis are often unaware of risk of recurrence or potential strategies to prevent recurrence.
- Enhanced foot hygiene, applying emollients daily and exercise appeared to be more acceptable prevention strategies than compression or long-term antibiotics.
- People were cautious of using long-term oral antibiotics, particularly if they had only experienced one episode of cellulitis.

What are the clinical implications of the work?

- Many participants were surprised they had not been informed about risk of recurrence and said they would go to substantial lengths to avoid recurrence.
- Although there is a lack of evidence for many prevention strategies, people with cellulitis are keen to know about possible preventative practices.
- Enhanced foot hygiene, applying emollients daily and exercise may be acceptable prevention strategies, but further research is needed to explore effectiveness and uptake in practice.

SUMMARY

Background: Cellulitis is a common painful infection of the skin and underlying tissues that recurs in approximately a third of cases. The only proven strategy to reduce the risk of recurrence is long-term, low-dose antibiotics. Given current concerns about antibiotic resistance and the pressure to reduce antibiotic prescribing, other prevention strategies are needed.

Objectives: To explore patients' views about cellulitis and different ways of preventing recurrent episodes.

Methods: Adults aged 18 or over with a history of first episode or recurrent cellulitis were invited through primary care, hospitals and advertising to complete a survey, take part in an interview, or both.

Results: Thirty interviews were conducted between August 2016 and July 2017. Two hundred and forty surveys were completed (response rate 17%). Triangulation of quantitative and qualitative data showed that people who have had cellulitis have wide-ranging beliefs about what can cause cellulitis and are often unaware of risk of recurrence or potential strategies to prevent recurrence. Enhanced foot hygiene, applying emollients daily, exercise and losing weight were more popular potential strategies than use of compression stockings or long-term antibiotics. Participants expressed caution about long-term oral antibiotics, particularly those who had experienced only one episode of cellulitis.

Conclusions: People who have had cellulitis are keen to know about possible ways to prevent further episodes. Enhanced foot hygiene, applying emollients daily, exercise and losing weight were generally viewed to be more acceptable, feasible strategies than compression or antibiotics, but further research is needed to explore uptake and effectiveness in practice.

INTRODUCTION

Cellulitis is an acute, painful and potentially serious bacterial infection of the skin and underlying tissue that can have a substantial impact on patients. Pain, feeling very unwell and the need for elevation of the affected limb can result in reduced quality of life and substantial periods of work absence amongst people with cellulitis.[1] Cellulitis also places a considerable burden on the NHS. Between 2015 and 2016, 123,644 patients were admitted to hospitals in England for cellulitis.[2] While even a single episode of cellulitis can have substantial impact on quality of life, approximately a third of people with cellulitis suffer recurrent episodes.[3 4] Risk factors for cellulitis recurrence include previous episode(s) of cellulitis; lymphoedema; obesity; diabetes and skin disorders producing breaks in the skin (e.g. fungal foot disease, dry skin or insect bites.)

The only treatment shown to reduce the risk of recurrence is long-term, low-dose antibiotics.[5] This strategy has not been widely implemented, possibly because of growing pressure to reduce antibiotic prescribing amidst fears of antibiotic resistance and possible side effects. The risk of further episodes may also be reduced by use of emollients for prevention of dry cracked skin, checking for and treating tinea pedis, and managing lymphoedema using compression garments.[6]

There has been little research into the role of skin care in the prevention of cellulitis but a role for dry skin has been hypothesised and regular application of emollient has been shown to reduce dryness.[7] Previous research also suggests that there is a high rate of fungal foot disease in patients with recurrent cellulitis as skin breaks caused by fungal infection provide a 'portal of entry' for bacteria.[8 9] Although fungal foot infection is common, many patients under-treat this as it can be asymptomatic[10 11], so it is possible that more active treatment of fungal foot disease may prevent recurrent cellulitis. In a recent James Lind Alliance Priority Setting Partnership for Cellulitis (PSP), patients and health professionals identified the need to determine the best non-antibiotic intervention for the prevention of cellulitis (e.g. skin care; foot care; moisturisers; antiseptics; lifestyle changes such as weight loss and exercise; compression garments/bandages; treating athlete's foot; complementary and alternative therapy) as a priority area for future research.[12]

Our long-term aim is to carry out a trial of non-antibiotic approaches to prevention of cellulitis. In order to effectively design such research, a greater understanding of patients' beliefs and understandings about cellulitis, their views and experiences of preventing recurrence and the factors likely to influence the adoption of different cellulitis prevention strategies is required.

The aim of our mixed methods study was to explore patients' views and experiences of cellulitis, beliefs about possible causes of cellulitis, views about potential methods of preventing recurrent

episodes and their information needs. This paper focuses on patients' perceived causes of cellulitis and views about possible prevention strategies. Our findings on patients' perceptions of cellulitis and their information needs are reported elsewhere.[13]

METHODS

A mixed methods study comprising a cross-sectional survey and semi-structured, face-to-face interviews was conducted to produce generalisable as well as in-depth findings regarding patients' views and experiences around cellulitis causation and prevention. We adopted a triangulation protocol to integrate the quantitative and qualitative data and gain a more complete picture of cellulitis patients' views and experiences.[14-16] Ethics approval was obtained from East Midlands - Leicester South Research Ethics Committee (ref: 16/EM/0306).

Participants and recruitment

Adults aged 18 years or over with a history of cellulitis (first or recurrent episodes) were eligible to participate. Eligible participants (i.e. diagnosed with cellulitis in the past 6 months or with 2 or more episodes of recurrent cellulitis within the past 3 years) in South West England were recruited through database searches and mail-outs from 25 GP practices, opportunistic recruitment in two NHS hospitals and advertising in local newspaper. GP practices and hospitals were invited to express an interest in the study in response to study advert circulated by the Wessex Clinical Research Network (CRN). We then identified and recruited GP practices in varying locations and from areas of differing levels of social deprivation (as defined by Public Health England[17]) were included in order to identify participants with a diversity of views. Participants could choose to take part in an interview or complete the survey, or both.

Qualitative interviews

Eligible participants were invited to complete and return a reply slip to the research team to express their interest in taking part in an interview. Interviewees were then purposively sampled for age, gender, recruitment setting and number of episodes of cellulitis (according to the reply slip) to achieve a maximum variation sample for the qualitative interviews. Written informed consent was sought prior to carrying out interviews. Interviews were conducted in participants' homes (n=26) or an alternative location of their choice e.g. local coffee shop (n=4). With participants' permission, interviews were digitally recorded and transcribed verbatim. We used a semi-structured interview

guide developed from existing literature and input from patient collaborators and the research team to guide the interviews (Box 1). All participants who took part in an interview received a £10 gift voucher.

Quantitative survey

The questionnaire (see supplementary materials) was developed by the research team based on existing research evidence and input from dermatology research experts, patient collaborators, clinicians and research psychologists. Eligible participants were provided with a paper version of the survey or a link (included in the study information sheet) to an identical online survey on iSurvey, a survey generation and research tool provided by the University of Southampton. The vast majority of participants (95%, n=227) chose to complete the paper survey rather than the online version, and returned it in the freepost envelope provided. Questionnaire data were entered into an Access database.

Analysis

Qualitative and quantitative data were initially analysed separately. An inductive thematic analysis was conducted to explore the qualitative interview data.[18] One author (EJT) read the transcripts several times to achieve familiarisation with the data and codes were applied line by line. Main codes were described and termed according to the language present within the data. Multiple codes were applied to comments that expressed multiple meanings. Codes were derived inductively from the data and grouped together to produce an initial coding frame. Codes were reviewed and compared to identify similarities and differences. A detailed coding manual was created to ensure transparent and systematic coding of the data. Codes and theme/sub-theme definitions were discussed with, and iteratively developed by, members of the research team (EJT, MS, PS, JC & AL) to offer diverse inferences and interpretation of the data. A negative case analysis was carried out to ensure that all data were taken into account rather than just selecting data that fitted with the authors' viewpoint. We finished data collection once data saturation of the main themes was reached. Using NVivo (version 11) enabled a detailed audit trail to be maintained.

We then used SPSS (version 24) to provide descriptive statistical analysis of the survey data. Chi-squared tests were used to explore associations between participant characteristics and responses to key questionnaire items. We then integrated the findings of each data set by comparing the key themes in the qualitative data and trends in the quantitative data to assess whether data agreed (convergence), complemented one another (complementarity) or contradicted each other (dissonance).[15]

RESULTS

The study sites sent or gave out 1,418 surveys (1,343 from primary care and 75 from secondary care). Of which 236 were completed and returned to the research team in the FREEPOST envelope provided (response rate = 17%). A further 4 surveys were completed by participants recruited via community advertising. One author (EJT) conducted 30 semi-structured, face-to-face interviews between August 2016 and July 2017. The characteristics of our participants are described in Table 1.

[Insert table 1]

Main findings

Analysis of interviews highlighted four main themes around understandings and concerns about cellulitis, and views and experiences of cellulitis prevention: **1) Diverse understandings about cellulitis causation, risk and recurrence, 2) Prior experience of preventing cellulitis recurrence, 3) Views about non-antibiotic cellulitis prevention interventions, 4) Views about long-term antibiotics for cellulitis prevention.** When we compared/triangulated the themes and subthemes with the trends in the survey data they were mainly convergent and complimentary. Therefore the main findings from the interviews and surveys are presented concurrently below. Quantitative results are presented in Tables 2-4. Selected quotes are used to illustrate each theme.

[Insert table 2]

Diverse understandings about cellulitis causation, risk and recurrence.

Perceived causes of cellulitis

In both the qualitative interviews and survey (table 2) participants expressed diverse beliefs about what had caused their cellulitis including sustaining damage to the skin from trauma, insect bites or surgery, oedema and fungal foot disease. Qualitative interviewees also cited causes that were not

included as a response option in the questionnaire, such as 'unhygienic' environments (e.g. woodlands, household lofts or coming into contact with matter such as bird faeces or dead rodents) and stressful life events.

> *"I knocked that little finger against a wing mirror. And that was all and it didn't even draw blood or scratch. There must have been something on the wing mirror, you know, it could have been anything, bird droppings or anything, just something obviously."* ***(P12, male, aged 82, First episode)***

> *"At that time I was under a considerable amount of pressure and what have you. Then the next big hit was – 2010 and again work was extremely busy… there was a big amount of stress at the time and just prior to that my father had died in 2009. So 2009, 2010 and it was like – a graze or something like that on my leg and I think I'd been under quite a bit of pressure, being kind of rundown, at a low ebb."* ***(P15, male, aged 63, recurrent cellulitis)***

Although some interviewees appeared to have a clear idea of the cause of their cellulitis, many were uncertain due to the lack of visible evidence of a bite mark or cut on the affected area. Similar uncertainty was reflected in the survey data.

> *"But the funny thing was, they couldn't find any reason why; when they were checking my legs for cuts that sort of thing, and mosquito bites, there was nothing. They don't really know what caused it, other than I got it ... and they treated it."* ***(P4, male, aged 61, recurrent cellulitis)***

> *"Well my legs were swollen, especially this left one, but then they have been swollen for some time – I mean I didn't cut myself or scratch myself or anything, you know, to bring on an infection. I just don't know. And the doctor, I don't think knows, either."* ***(P3, female, aged 83, first episode)***

Perceived risk factors

Diverse perceptions about risk factors for cellulitis were evident amongst survey participants and interviewees. A commonly expressed belief amongst interviewees was that cellulitis risk increases with age, which was not a risk factor we had included in the questionnaire. Older participants seemed to associate their risk of cellulitis as 'just part of ageing' whereas younger participants expressed surprise that they had got it as they had assumed it was typically something that older people get.

> *"I think I'm quite young to have it, because I normally think it's people in poor health and quite old, that have it, but – I don't know. I don't really know really."* ***(P27, female, aged 53, recurrent cellulitis)***

Other perceived risk factors reported by interviewees and survey respondents included having a comorbidity and being more susceptible to infection. Some interviewees acknowledged that having diabetes or lymphoedema or that taking immunosuppressant medication was likely to increase their risk of cellulitis. Others seemed to feel that they had an underlying weakness in their skin either due to prior trauma or having patches of thin skin, which made them more susceptible to skin infections in general.

> *"It's my lymphoedema because, as you can see, my feet are swollen now and my toes just swell up so big, they just split and then – it's my fault for walking around but I hate wearing shoes when my feet are like that***" (P27, female, aged 53, recurrent cellulitis)**

> *"Well I'm – I'm on immunosuppressant drugs because of the arthritis and also – this has come on after I've had a second drug; it's one of the ones you go to hospital and you have it over a period of, you know, like an injection, over a period of hours. And – I think that lowers your immune system even more, so I'm wondering whether it was anything to do with that, but I don't know. I don't know whether I would have got it anyway, but it's only come since I've had this second drug."* **(P5, female, aged 67, recurrent cellulitis)**

A less commonly expressed risk factor for cellulitis recurrence was having had cellulitis before. A few participants felt that they were at greater risk of cellulitis because they had had more than one episode. Sixteen percent (n=39) of survey respondents reported that having had cellulitis before was a risk factor for recurrence.

> *"So I'm one of those people who's prone to it and once you've – all I know is that once you've had it once, you're likely to be more susceptible in the future."* **(P2, male, aged 45, recurrent cellulitis)**

> *"Especially after you've had it the first time you are susceptible to it again. You're just going to end up with it again and again. They did warn me, that's one thing the nice doctor did for me – is warn me that it can come back again. It can re-occur now you've had it"* **(P13, female, aged 32, recurrent cellulitis)**

Views about cellulitis recurrence

Fifty-eight percent of survey respondents felt that they were more likely to experience a recurrence of cellulitis compared to other people (n=138). However, uncertainty about cellulitis recurrence was apparent amongst interviewees and over a third of survey respondents (n=88) were not sure whether they were more likely to get cellulitis again because they had experienced previous episodes.

"I didn't even know you can get it again and again and again; you told me that, I didn't even know that and I've been on that website. I've never read it. I thought you get it once and then it's gone, you won't get it again. I've only learned you can get a recurrence through you, which the doctor should tell you, really." ***(P11, male, aged 53, first episode)***

Furthermore, some interviewees expressed anxiety about possible recurrence of cellulitis and a desire to avoid experiencing another episode, but many expressed confidence about managing future episodes as they felt they had increased awareness of symptoms and so could be more proactive in seeking treatment.

"I think this idea that it could come back and – I really don't want to do that again. I think if it does come back, I will be a little bit more prepared for it and I'll know what it is and you go in with knowledge then, which reduces my anxiety about it." ***(P19, female, aged 53, first episode)***

"Now, when I see the signs, sort of red skin, I go to the doctor's straightaway and get – if they think it's cellulitis, then they'll give me antibiotics straightaway to get it while it's only the start. I don't leave it like I used to. As soon as – I mean my wife – she – she knows what to look out for as well, because she's seen it. My daughter, even – can tell; not that it's cellulitis, but she can tell that – daddy your skin's a bit red. And I go straight to the doctor." ***(P25, male, aged 39, recurrent cellulitis)***

Prior experience of preventing cellulitis recurrence

Two-thirds of survey respondents reported that they were not aware of any ways of trying to prevent cellulitis recurrence (66.3%, n=159). However, when asked whether they were currently doing anything to prevent cellulitis from coming back, 46% (n=110) reported that they were currently trying to prevent recurrence (Table 2). This higher proportion for the second question may seem inconsistent, yet free text comments suggested that participants were trying prevention through untested suggestions from friends, and it is also worth noting the lower response rate to this question.

Preventative behaviours that were reported most commonly amongst interviewees were cleaning wounds with antiseptic and using insect repellent. Some participants, particularly those who had experienced more than one episode of cellulitis, also reported moisturising legs and feet to treat or prevent dry skin, wearing compression stockings, leading a healthier lifestyle, taking long-term low-dose antibiotics as means of preventing cellulitis and avoidance of environments that were thought to lead to infections.

"It's just a little bit more awareness of being careful what you do, where you walk…I have been out once or twice, in the fields, and I've cut myself and I've got a medi wipe out straightaway and cleaned it all and so far it's no problem at all. I don't know what starts it off, to be quite honest. But, as I say, I've kept myself clean." ***(P10, male, aged 73, recurrent cellulitis)***

"Yes, I've got a big bottle of cream just to keep the skin supple and stop it from drying out. I use my cream if anything goes red and hot, even if it's my toes or anything, I've got cream between my toes so I don't get athlete's foot. So even if I end up with a crack, I've got cream on there to get rid of it straightaway." ***(P13, female, aged 32, recurrent cellulitis)***

Some participants spoke about keeping precautionary antibiotics at home that had been prescribed by their GP for immediate use if their cellulitis recurred, which seemed to reduce their anxiety about recurrence.

"So when I've got it – it just – it's debilitating, it just knocks you out and you can't do anything and so the best thing is to see a doctor and get an immediate course of antibiotics. So the good thing, this last time I saw my GP, I've got an emergency pack of antibiotics, flucloxacillin that I can take in case I get it. So thinking about it happening again fills me with dread almost, but the good thing is – I've got this backup emergency course of antibiotics that I can take if it happens again." ***(P23, male, aged 48,***

For some participants, the uncertainty around what caused their cellulitis seemed to have created uncertainty about prevention of recurrence. Some participants who had only experienced one episode of cellulitis felt that it was difficult to know how to prevent it from coming back as they were not certain what had caused their first episode of cellulitis.

"And I must admit, I didn't know that it was cellulitis till it was all written down; I thought I'd just got Strep A because of – I mean I suppose you won't know, can cellulitis alone do that to you? I mean, it nearly killed me, I'm very lucky to be alive and I certainly don't want it again, but I don't know what to do not to get it again. And no one does, and no one knows how I got it." ***(P8, female, aged 73, first episode)***

Others appeared to be more fatalistic about cellulitis recurrence, and this view of it being something 'you have to live with' seems likely to have influenced their engagement with cellulitis prevention strategies.

"Not deliberately, no, because I don't know what causes it still, even if it was a bite. To be fair, I did think – because I never wear socks and I'm wondering whether I should wear socks that cover my ankles,– that was one thing I thought of. I don't know whether just by covering my ankles up, that it wouldn't come back. I haven't tried it yet…I just thought it was a case of bad luck and something I'd have to live with. I

never really thought about trying to prevent it; I can't think – yes. Yes, I just assumed it was something you lived with and happened to be unlucky" ***(P26, female, aged 47, recurrent cellulitis)***

[Insert table 3]

Views about non-antibiotic cellulitis prevention interventions

Enhanced foot hygiene and care

Over two thirds of survey respondents reported that they would be willing to wash and dry feet carefully every day (75%, n=180) and apply emollients to their feet once a day (70%, n=168) or twice a day (46.3%, n=111) (Table 3). Moisturising feet daily appeared to be an acceptable and feasible option of cellulitis recurrence prevention for some interviewees, as it was seen as something familiar, similar to what they already do and easy to fit into established daily routines. Similarly, many interviewees seemed open to the idea of enhanced foot hygiene as a means of cellulitis prevention and viewed foot hygiene as a familiar behaviour and easy to adopt into established routines but something that could be improved upon in order to prevent recurrent episodes of cellulitis.

"It wouldn't be a problem. I do put cream on my legs every day, I do both legs just from the ankle upwards, to the knee. Nothing on my feet, I put cream on my feet for something else. But that wouldn't be a problem." ***(P4, male, aged 61, recurrent cellulitis)***

"Yes, it would be useful to have more information because I'm one of those people who just sort of stands on a towel and dries my feet and then hope for the best. Yes, that would be something I would – obviously I'm more aware of how you wash your hands now, but feet haven't really be mentioned very much: so that would be interesting to find out if that will prevent it." ***(P19, female, aged 53, first episode)***

In contrast, some interviewees expressed negative views about enhanced skin care and foot hygiene. In particular, participants felt that applying foot creams would be messy, too time-consuming and not necessary to do on a daily basis but rather only once the skin is particularly dry or affected by cellulitis. Some interviewees also spoke about perceived difficulties of adopting these prevention strategies such as bending down to reach feet while others felt that such difficulties could be overcome with support from significant others or carers, and/or other aids.

"Well, because I have a chair to get in and out the bath and I do find it difficult sometimes drying. But what I do in there when I come out the bath and I come downstairs, I put my feet on a stool and I can do them, unless my granddaughters are here, they will do it for me." ***(P14, female, aged 67, recurrent cellulitis)***

"No, feet is a difficulty with me because of the arthritis but I've always thought I've been very careful; I always make sure I get in between my toes and if I can't, even when I couldn't get down when I had my hip operation, I used to put cotton wool buds in my – grabber, you know, I've got a grabber, so I used to put the cotton wool and then sort of – put cream on." ***(P5, female, aged 67, recurrent cellulitis)***

Some participants felt increased foot hygiene was not relevant to them as they had experienced cellulitis in their leg rather than their feet, suggesting there is a low awareness of the potential mechanisms of skin infections (i.e. dry, cracked skin on the feet as an entry point for infection in the leg). Some said they felt they already washed and dried their feet sufficiently, although closer questioning suggested that perceptions regarding careful washing and drying differed.

"I think the drying of the feet is more – if you've got athlete's foot, which I don't suffer from, but I do understand that if you do suffer from athlete's foot, that can be a precursor to cellulitis because of the fact that you've got open wounds there and infection can get in." ***(P2, male, aged 45, recurrent cellulitis)***

"I shower and wash every day anyway, and dry myself, so – once I come in from work I always have a shower, clean myself up. I wake up in the morning and have a shower and go to work, so – hygiene-wise – I'd say I'm okay" ***(P1, male, aged 47, first episode)***

Lifestyle changes

Around half of survey respondents reported that they would be willing to increase physical activity (51.3%, n=123), and 47% reported that they would be willing to lose weight (n=113), if this had been shown to help prevent recurrent episodes. When explored in more depth, many interviewees felt that, although lifestyle changes might be a good idea in general, it was not particularly relevant to them e.g. they were already very active or used to be active but were unable to maintain the level of physical activity due to ill health. Others felt that it would be inappropriate to make lifestyle changes as they did not associate it with cellulitis prevention.

"Well I should be but – with my back, I can't do anything at the moment. I was going up on the gym, because we've got this gym in the park, sort of thing, and I was going up there for a while, but whilst my back's bad I can't go up there" ***(P10, male, aged 73, recurrent cellulitis)***

"I couldn't be more active….they are trying to blame lifestyle on too much because – I know obesity is what's going to ruin the National Health. People are obese and diabetic, so they're trying to get them to do more exercise and to change their lifestyle, but it can't all be people's lifestyle. So – I'm going to sound horrible, but I don't think ... unless it's the legs or – they are not looking at it widely enough." ***(P8, female, aged 73, first episode)***

Wearing compression stockings daily

Approximately one-third of survey respondents reported that they would be willing to wear compression stockings (34.6%, n=83) and the interviews showed very mixed views. Many participants felt it would not be feasible to wear compression stockings on a daily basis as they perceived them to be difficult to put on and uncomfortable to wear, more associated with flights and recovery after operations than everyday use and not practical to wear in the summer or with certain types of clothing. Some participants who had experience of wearing compression stockings reported similar reasons for being reluctant to wear compression stockings and associated them with reducing oedema but didn't connect this to cellulitis prevention.

"I find they're bloody awkward to put on; it takes two of you to put it on, it bloody hurts and I don't like them. If they had one out with a zip that means you put your foot in and zip it up: fine" ***(P7, female, aged 70, recurrent cellulitis)***

"In the summer, if I'm overheated, I don't want to be wearing socks or anything else, so that's not going to help. So in theory, I'd say, yes, absolutely fine, but I can imagine, in practice, it might not be the thing to do in the middle of summer. Again, ultimately if it was about my health, I probably would do it, but it wouldn't be my first choice. I'd rather stand and clean my feet for 20 minutes a day, for instance." ***(P16, female, aged 32, first episode)***

Views about long-term antibiotics for cellulitis prevention

Around a third of survey respondents expressed a willingness to take antibiotics every day to prevent recurrence of cellulitis (30.8%, n=74). (Table 3). Many interviewees expressed concern that taking long-term antibiotics would lead them to develop immunity against antibiotics, rendering them ineffective for future personal use (even for other health conditions), which suggests people may mistake antibiotic resistance as a property of the human body rather than bacterial cells.

> *"Over my life I've had – there was, at one time, I was having a lot of chest infections and this was before they knew that, you know, they were only prescribing antibiotics really and I was on a low dose for six months and – I'm a bit worried that – now, if I did get anything, I wouldn't – they wouldn't work on me. So, you know, the less I have, I think, the better."* ***(P5, female, aged 67, recurrent cellulitis)***

> *"No, because my body would become immune to it and I'd have to keep taking higher doses of it. You'd have to keep taking higher doses of it to have any effect and then eventually it will have no effect at all and if you get a bad case of it, what are they going to give you? So, no, it's not a good idea"* ***(P13, female, aged 32, recurrent cellulitis)***

Another common concern was being exposed to the side effects of antibiotics such as stomach complaints and some participants felt the long-term use of antibiotics was counterintuitive to the efforts being made within the health service to reduce antibiotic prescribing.

> *"… you end up with thrush and other things; it's like all medication, sometimes you always get these different side-effects"* ***(P17, female, aged 60, recurrent cellulitis)***

> *I don't mind doing a short one but – antibiotics – where your system is concerned, they tend to give you diarrhoea. ... if it wasn't for months I'd perhaps be happy.* ***(P18, female, aged 74, recurrent cellulitis)***

We explored differences amongst survey respondents in willingness to adopt cellulitis prevention behaviours, comparing participants who had experienced one episode of cellulitis with participants who had experienced recurrent episodes (Table 4). Only willingness to take antibiotics daily to prevent cellulitis showed a statistically significant difference between the two groups. Participants who had experienced two or more episodes of cellulitis reported they were more willing to take antibiotics daily (47%) compared with participants who had only experienced one episode (27%). This was reflected in the qualitative data. Some interviewees with recurrent cellulitis who were already taking low dose antibiotics appeared happy with this and those who were already taking several other medications felt that adding something else in wouldn't bother them.

"Well I take quite a lot of medication, so it wouldn't bother me, because it's another tablet, just adding on to that, so it doesn't bother me." ***(P25, male, aged 39, recurrent cellulitis)***

[Insert table 4]

DISCUSSION

Main findings

We found that people with experience of having cellulitis held diverse beliefs about causation, some of which would not have been uncovered by survey methods alone as they had not previously arisen in the literature, such as the view that cellulitis could be caused by 'unhygienic' environments. Interviewees expressed surprise that they had not been informed of risk of recurrent cellulitis or potential strategies to prevent recurrence and only 31% of survey respondents said they were aware of possible strategies to prevent recurrence of cellulitis. Quantitative and qualitative findings suggest a general willingness to adopt non-antibiotic cellulitis prevention interventions, with a preference for enhanced foot hygiene/care and lifestyle changes over other interventions, as they are perceived as familiar and easy to fit into established routines. There were more mixed views about compression and long-term oral antibiotics.

Comparison with existing literature

In the recent James Lind Alliance Priority Setting Partnership on cellulitis, one of the research priorities identified related to which patients are most likely to benefit from low-dose antibiotics to prevent recurrent cellulitis.[12] Our data would suggest that people who have had only a single episode of cellulitis are less likely to be willing to take long-term low dose antibiotics than those who have experienced multiple episodes. This is despite RCT findings suggesting that patients may benefit from 6-months of low dose antibiotic prophylaxis following their first episode in order to prevent future recurrence in the longer term.[19]

Concerns about 'developing immunity' to antibiotics and the reduced efficacy of antibiotics in treating infections as a result were prevalent in the qualitative data. This reflects a widespread misconception of antibiotic resistance as a property of the human body rather than bacterial cells (i.e. belief that it is the human becoming immune to antibiotics rather than the bacteria becoming resistant).[20 21]

We had not foreseen some of the perceived causes of cellulitis, such as stress or contact with 'unhygienic' environments such as woodlands, but it has been noted before that people develop their own models of disease processes that, though difficult to provide evidence for, aim to create rational explanations of causes of illness and linking them with life events.[22]

The Common-sense/Self-regulatory model of health and illness (CSM or SRM)[23] provides a framework for understanding how individual symptoms and emotions experienced during a health threat or illness influences how people make sense of, and respond to, the condition. It suggests that individuals seek to understand their illness by developing illness perceptions, which then guide subsequent coping behaviours. We found that participants experienced uncertainty with regards to cause, time-line and control of their cellulitis and the potential of recurrence. We also found that participants expressed uncertainty around identify and concern and surprise about the consequences of cellulitis, which has been reported elsewhere.[13] Our study suggests that illness perceptions exist amongst people with cellulitis and may affect their willingness to carry out potential preventative behaviours such as enhanced foot hygiene or wearing compression stockings. A greater understanding of the illness perceptions that people with cellulitis may have will enable us to address potentially misguided illness perceptions and uncertainty around cellulitis recurrence and its prevention.

Strengths and limitations

This is a novel study providing new insight into patients' understanding about causes of cellulitis and views about prevention of recurrence. A strength of our approach is that, by using both qualitative interviews and quantitative survey methods, we are able to examine experiences in detail, while also providing estimates that generalise about the number of patients willing to adopt different cellulitis recurrence prevention strategies. Further, by using purposive sampling for the interviews we were able to examine experiences of people with single episode or recurrent cellulitis, who may differ in their views and experiences. A limitation is the relatively low response rate to invitation to participate, meaning that these views may not be representative of all people with a history of cellulitis. Furthermore, with no sample frame for the participants elicited from community advertising an overall response rate can't be calculated, which may further compromise the study's external validity. It is also known that cellulitis can be incorrectly diagnosed, so it is possible that some of our participants may not have had cellulitis. To mitigate against including potentially participants without cellulitis, we asked our interviewees to confirm they had cellulitis prior to interview and also considered the type of symptoms discussed during the interview, noting symptoms that were unlikely to be cellulitis (i.e. bilateral leg symptoms).

Implications for clinical practice

A recent Cochrane review of interventions to prevent recurrent cellulitis concluded that prophylactic antibiotics are probably an effective strategy but that further RCTs are needed to explore the effectiveness of other interventions.[6] Given that approximately a third of patients with cellulitis will experience recurrent episodes, more research is needed to find effective strategies for prevention, although emollients, or active treatment of fungal foot disease, for conditions known to cause breaks in the skin barrier is likely to be effective. For people with lymphoedema, strategies such as compression hosiery or exercise may be effective. It would seem important that clinicians advise people that the condition is likely to recur and inform them that there is strong evidence to support the use of prophylactic antibiotics. Our findings suggest that many patients are not currently informed of this, both amongst those whose cellulitis has been managed in primary care and secondary care. The people we interviewed felt that they should have received more information. In pressured clinical environments this may mean directing patients towards evidence-based information leaflets or online resources.

Implications for research

Despite the lack of evidence for many prevention strategies, this study suggests that people with cellulitis are keen to know about, and are potentially willing to adopt, various non-antibiotic prevention strategies. Enhanced foot hygiene/care was generally viewed to be a more acceptable, feasible strategy than compression or antibiotics, but further research is needed to explore effectiveness and uptake in practice. However, this does present a potential dilemma as compression and antibiotics are likely to be the most effective ways of preventing recurrence. It might be that compression garments would be more acceptable in people with lymphoedema and a history of multiple episodes of cellulitis, rather than those who have only one or two episodes. An alternative approach could be to assess the effectiveness of multiple potential preventative strategies implemented simultaneously rather than testing one in isolation. Conducting an RCT with nested qualitative studies would enable researchers to examine and explore the effectiveness and potential uptake of different, and possibly multiple, non-antibiotic preventative behaviours, and could inform the development of interventions that support people with cellulitis to prevent recurrence.

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TABLES

Box 1

Quantitative survey	**Qualitative interview guide**
Fixed choice questions and free text questions about: • understandings and beliefs about causes and risk factors for cellulitis • awareness of cellulitis prevention • any current or past preventative practices • willingness to undertake 7 potential preventative practices • demographics and cellulitis history, including number of episodes and site of cellulitis	Open-ended questions about: • understandings and beliefs about causes and risk factors for cellulitis • views about the possibility of recurrence • awareness of methods for prevention of recurrence of cellulitis • any current or past preventative practices • attitudes to undertaking regular preventative practices

Table 1: Participant characteristics (interviewees and survey respondents)

	Number of interviewees n=30 (%)	Number of survey respondents n=240 (%)
Gender		
Female	**16 (53)**	**128 (53)**
Male	14 (47)	103 (43)
Missing	0 (0)	9 (4)
Age		
18-25 years	0 (0)	2 (1)
26-45 years	4 (13)	14 (6)
46-65 years	9 (30)	**80 (33)**
66-75 years	**11 (37)**	71 (30)
76-85 years	6 (20)	53 (22)
More than 85 years	0 (0)	14 (6)
Missing	0 (0)	6 (3)
Recruitment source		
Primary care	**16 (53)**	**216 (90)**
Secondary care	8 (27)	20 (8)
Community advertising	6 (20)	4 (2)
Number of cellulitis episodes		
First episode	10 (33)	109 (45)
Recurrent episodes	**20 (67)**	**130 (54)**
Missing	0 (0)	1 (1)
Location of cellulitis		
Lower leg	**25 (83)**	**170 (71)**
Upper leg	1 (3)	6 (3)
Arm/hand	4 (13)	6 (3)
Face	0 (0)	9 (4)
Multiple locations	0 (0)	34 (14)
Elsewhere on the body	0 (0)	14 (6)
Missing	0 (0)	1 (0)
Long-standing illness		
Yes	**23 (77)**	**166 (69)**
No	7 (23)	66 (28)
Missing	0 (0)	8 (3)

Table 2: Perceptions of cellulitis and prevention of recurrence

	Number of participants	Percentage
Perceived causes of cellulitis		
Insect bite	40	16.7%
Athlete's foot	8	3.3%
Eczema or other long-term skin problem	14	5.8%
Long-term leg swelling	38	15.8%
Don't know	86	35.8%
Other	51	21.3%
Missing	3	1.3%
Perceived risk factors		
No	58	24.2%
Don't know	47	19.6%
Yes being overweight	13	5.4%
Yes having diabetes	5	2.1%
Yes having had cellulitis before	39	16.3%
Yes, other	23	9.6%
Multiple responses	50	20.8%
Missing	5	2.1%
Perceived likelihood of recurrence		
Yes	138	57.5%
No	13	5.4%
Don't know	88	36.7%
Missing	1	0.4%
Awareness of prevention of recurrence		
Yes	74	30.8%
No	159	66.3%
Missing	7	2.9%
Current preventative behaviours		
Yes	110	45.8%
No	123	51.3%
Missing	7	2.9%

Table 3: Willingness to undertake potential cellulitis preventative practices

	Number of participants	Percentage
Wash and dry feet carefully every day		
Yes	**180**	75.0%
No	4	1.7%
Maybe	16	6.7%
Missing	40	16.7%
Apply cream to feet once a day		
Yes	**168**	70.0%
No	7	2.9%
Maybe	18	7.5%
Missing	47	19.6%
Apply cream to feet twice a day		
Yes	**111**	46.3%
No	26	10.8%
Maybe	36	15.0%
Missing	67	27.9%
Take antibiotics by mouth every day		
Yes	74	30.8%
No	**68**	28.3%
Maybe	48	20.0%
Missing	50	20.8%
Wear compression stockings every day		
Yes	**83**	34.6%
No	66	27.5%
Maybe	47	19.6%
Missing	44	18.3%
Increase physical activity		
Yes	**123**	51.3%
No	32	13.3%
Maybe	39	16.3%
Missing	46	19.2%
Lose weight		
Yes	**113**	47.1%
No	36	15.0%
Maybe	41	17.1%
Missing	50	20.8%

Table 4 Willingness to adopt cellulitis prevention based on experience of recurrence

Cellulitis prevention strategies	Number of participants (%)						
	First episode (n=109)			Recurrent episodes (n=130)			Chi-squared (P-value)
	Yes	No	Maybe	Yes	No	Maybe	
Wash and dry feet carefully every day	74/86* (86)	2/86 (2)	10/86 (12)	105/113 (93)	2/113 (2)	6/113 (5)	2.756; p < 0.252
Apply cream to feet once a day	67/83 (81)	5/83 (6)	11/83 (13)	100/109 (92)	2/109 (2)	7/109 (6)	5.271; P < 0.072
Apply cream to feet twice a day	45/78 (58)	13/78 (17)	20/78 (25)	65/94 (69)	13/94 (14)	16/94 (17)	2.615; P < 0.270
Take antibiotics by mouth every day	21/79 (27)	38/79 (48)	20/79 (25)	52/110 (47)	30/110 (27)	28/110 (26)	**10.640; P <0.005**
Wear compression stockings every day	30/82 (37)	32/82 (39)	20/82 (24)	53/113 (47)	34/113 (30)	26/113 (23)	2.348; p < 0.309
Increase physical activity	63/88 (72)	11/88 (12)	14/88 (16)	60/105 (57)	20/105 (19)	25/105 (24)	4.325; P < 0.115
Lose weight	46/82 (56)	19/82 (23)	17/82 (21)	66/107 (62)	17/107 (16)	24/107 (22)	1.599. P < 0.450

*reflects missing data