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Community Nurses' Judgement for the Management of Venous Leg Ulceration: A Judgement Analysis

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ABSTRACT:

Background: Nurses caring for the large numbers of people with leg ulceration play a key role in promoting quality in health via their diagnostic and treatment clinical judgements. In the UK, audit evidence suggests that the quality of these judgements is often sub optimal. Misdiagnosis and incorrect treatment choices are likely to affect healing rates, patients' quality of life, patient safety and healthcare costs.

Objectives: To explore the diagnostic judgements and treatment choices of UK community nurses managing venous leg ulceration.

Design: A judgement analysis based on Brunswik's psychological Lens Model theory.

Setting: UK community and primary care nursing services

Participants: 18 community generalist nurses working in district (home) nursing teams and general practitioner services and 18 community tissue viability specialist nurses.

Methods: During 2011 and 2012, 36 nurses made diagnostic judgements and treatment choices in response to 110 clinical scenarios. Scenarios were generated from real patient cases and presented online using text and wound photographs. The consensus judgements of a panel of nurses with advanced knowledge of leg ulceration judged the same scenarios and provided a standard against which to compare the participants. Correlations and logistic regression models were constructed to generate various indices of judgement and decision "performance": accuracy (r_a), consistency (r_s) and information use (G) and uncertainty (r_e).

Results: Taking uncertainty into account, nurses could theoretically have achieved a diagnostic level of accuracy of 0.63 but the nurses only achieved an accuracy of 0.48. For the treatment judgement (whether applying high compression was warranted) nurses could have achieved an accuracy of 0.88 but achieved only an accuracy of 0.49. This may have been due to the nurses giving insufficient

weight to the diagnostic cues of medical history and appearance of the leg and ulcer and insufficient weight to the treatment cues of type of leg ulcer and pain.

Conclusion: Clinical judgements and decisions made by nurses managing leg ulceration are complex and uncertain and some of the variability in judgements and choices can be explained by the ways in which nurses process the information and handle the uncertainties, present in clinical encounters.

KEY WORDS

Bandages; Community health nursing; Decision making; Judgement Analysis; Leg ulcer; Research; Varicose ulcer; Wound healing.

HIGHLIGHTS

What is already known about the topic?

- Leg ulcer care is an important part of UK community nurses' workload. Nurses' judgements and decisions impact on both on patients' quality of life and health costs.
- Previous evidence suggests the quality of diagnosis and treatment of venous leg ulceration is below that which should be expected.
- Accuracy in diagnosis and treatment is important because misdiagnosis and incorrect treatment choices are likely to have a significant impact on healing rates, patients' quality of life, patient safety and healthcare costs.

What this paper adds

- Clinical decisions and judgements about the management of venous leg ulceration are made in environments that are irreducibly uncertain.
- Nurses' judgements are less accurate than is possible.
- Nurses give appropriate weight to the diagnostic cue of ABPI but insufficient weight to the diagnostic cues of medical history and appearance of the leg and ulcer and insufficient weight to the treatment cues of type of leg ulcer and pain.

BACKGROUND

Leg ulceration affects many people worldwide and nurses are closely involved in making diagnostic judgements and treatment decisions for these patients (Srinivasaiah et al., 2007). The clinical responsibilities of the different professions in relation to leg ulceration will vary from country to country but in the UK, community nurses work as part of a larger multi-disciplinary team but are often responsible for making clinical judgements and decisions. The judgements and decisions of community nurses are a key determinant of the quality of care and outcomes in patients with leg ulcers. However, in the UK at least, leg ulcer practice and outcomes vary (in ways that are unwarranted) between different healthcare providers (Royal College of Nursing, 2001, Royal College of Nursing, 2008, Srinivasaiah et al., 2007, Vowden and Vowden, 2009). Exploring how nurses make judgements and decisions about managing venous leg ulceration may help understand the role of nurses in creating this variability.

Between 0.6% and 3.6% of adults will have a leg ulcer at some point in their lives (Graham et al., 2003, Posnett and Franks, 2007). The UK spends at least £168 - £600 million per year on leg ulcer care (Posnett and Franks, 2008, Nelzen, 2000). The most common form of leg ulceration is venous leg ulceration, a chronic condition in which high blood pressure in the leg veins results in an open sore on the lower leg (British Association of Dermatologists, 2008). Leg ulceration can also result from an inadequate arterial supply to the lower leg and some patients will have both venous and arterial insufficiency. A small proportion of patients will also present with rare forms of leg ulceration due to conditions such as pyoderma gangrenosum and cancer (Morison and Moffatt, 1994).

The recommended treatment for venous leg ulceration is graduated high compression where the greater pressure is applied at the ankle and graduates to less pressure up to the knee (Royal College of Nursing, 2006). Graduated high compression can be delivered through bandaging such as four-layer or short stretch systems or through specialist hosiery. Accurate diagnosis is important in order

to offer appropriate treatment especially since graduated high compression, is contra-indicated for patients with arterial insufficiency (Royal College of Nursing, 2006).

Clinical judgements and decisions link a patient's condition with the treatment they receive. These links are often compromised by differences of opinions, values and motives, errors, biases and uncertainty (Eddy, 1996 p308). Uncertainty will always exist within the clinical environment because of the variability of individual patients and clinical situations. Therefore, there will always be a level of 'irreducible' uncertainty which cannot be reduced at the moment that action is required (Hammond, 1996a). To manage uncertainty, nurses will use different decision strategies – all of which are affected by levels of clinical experience, knowledge, patient preferences and the resources available (Thompson, 1999b, Van Hecke et al., 2008). Some judgement strategies are more effective (given the judgement) than others (Hammond, 1996b, Thompson, 1999a). Thus, it is possible for different nurses, using more or less effective reasoning styles, to reach very different judgements, even when faced with the same information or clinical scenario.

Clinical guidelines are one means of reducing unwarranted variations in judgements, decisions and practice (Eddy, 1994). Ideally, guidelines are based on the existing relevant research evidence base but when this is lacking, recommendations for best possible practice will be based on expert, experiential knowledge. In the UK, several national guidelines on managing venous leg ulceration exist (CREST, 1998, SIGN, 1998, Royal College of Nursing, 2006) but the supporting evidence base is of variable quality. Some recommendations are based on robust clinical trial evidence; for example, Doppler assessment of ankle brachial pressure index (ABPI) to be included in leg ulcer assessment to identify arterial insufficiency (Callam et al., 1987); the use of multi-layer high compression to promote healing of venous leg ulcers (O'Meara et al., 2012) and the use of pentoxifylline as an adjuvant therapy to compression for healing venous leg ulcers (Jull et al., 2012). However, for many judgements and choices in the management of leg ulcers the evidence is too poor quality or even absent. For example, there is little reliable evidence to indicate the relative effectiveness of different

types of dressings or the appropriateness of using 0.8-1.2 as the ABPI cut-off points for assessing arterial insufficiency. Consequently, reliable ways to reduce uncertainty in clinical practice often do not exist.

However, for aspects of care where good evidence does exist, audits of leg ulcer practice suggest that leg ulcer care may not be reaching the levels of care that should be achievable. For example, a European position document and the UK national clinical guidelines recommend the use of Doppler assessment of ABPI as part of leg ulcer assessment to exclude arterial insufficiency and high compression for treating venous leg ulceration uncomplicated by arterial insufficiency (Royal College of Nursing, 2006, SIGN, 2010, EWMA, 2003). However, UK audits of Doppler assessment of ABPI and high compression use (Royal College of Nursing, 2001, Royal College of Nursing, 2008, Srinivasaiah et al., 2007, Vowden and Vowden, 2009) suggest that practice varies widely and a considerable proportion of patients receive neither. A search of the literature found no evidence to explain why some areas are delivering care that closely adheres to guideline recommendations while other areas are not so this study sought to unpack the 'black box' of clinical judgement and decision making for venous leg ulceration.

METHODS

Aims

The aims of the study were to:

1. assess the accuracy of the diagnostic judgements and the treatment judgements in relation to offering high compression.
2. explore the use of available information cues for diagnosis and treatment;

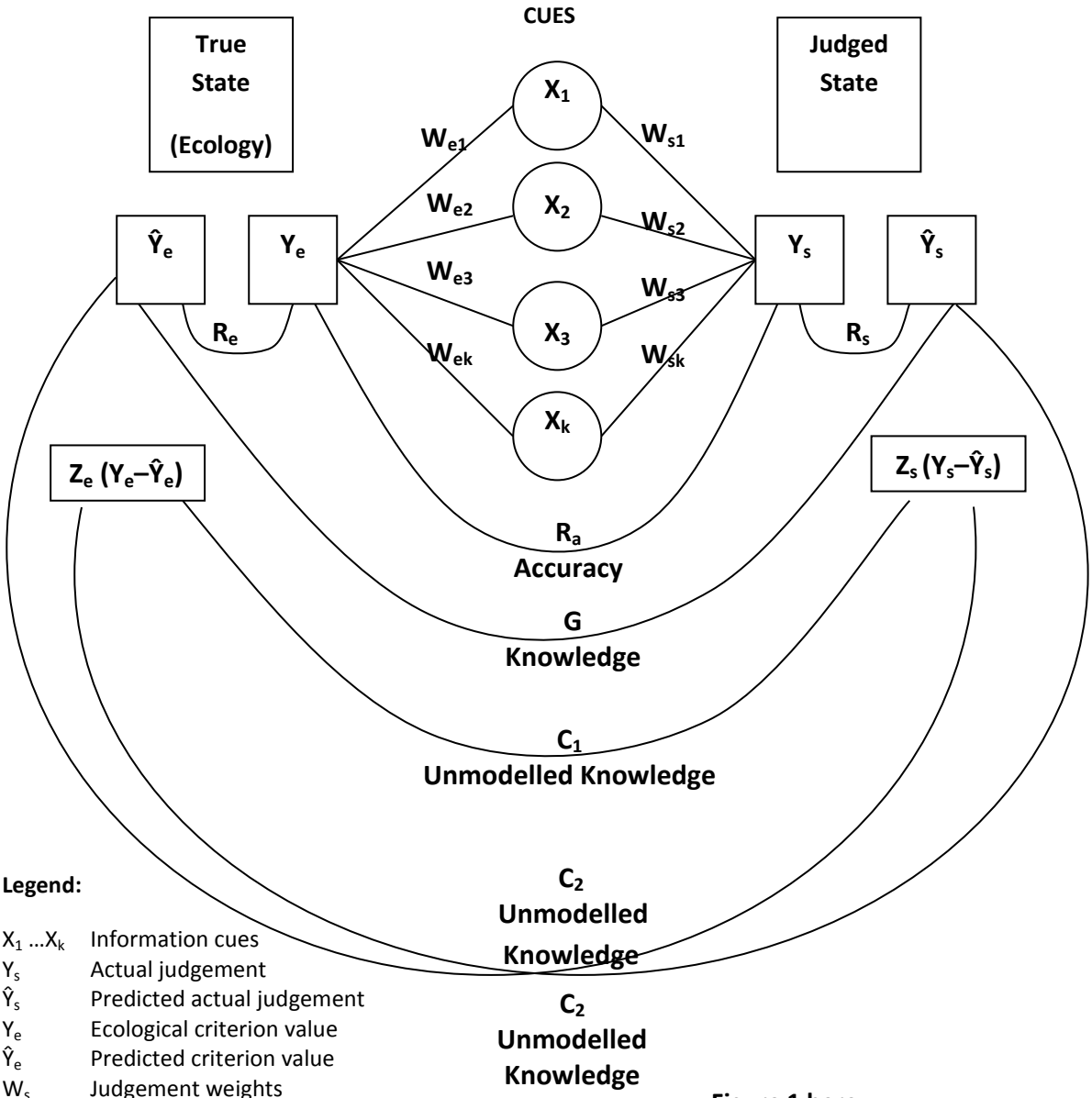
Theoretical Framework and Research Design

This study focused on how community nurses manage the uncertainty of venous leg ulceration when making diagnoses and treatment judgements. Therefore, a theoretical approach, capable of incorporating the complexity and clinical uncertainty in the clinical environment, was required. The approach needed to be capable of considering what *should* be considered and what *is* considered by clinicians. The only theoretical approach which bridges both ideal (normative) and real-life (descriptive) judgement and decision making is Social Judgement theory and its associated methodology: Judgement Analysis (Cooksey, 1996).

Social Judgement theory is a correspondence-based theoretical approach which evaluates quality in terms of accuracy (Dowding and Thompson, 2003). Accuracy is not always the most important criterion against which to assess the quality of a judgement. For example, in clinical emergencies, a judgement that is fast but 'good enough' may be better than one that is more accurate but slower. However, since leg ulcer management is a chronic long term condition (where speed of judgement is less of a consideration) then accuracy is an appropriate criterion for assessing quality. The accuracy of a leg ulcer diagnosis (or treatment judgment) is assessed in judgement analysis by examining the correspondence between the clinician's diagnosis (or treatment judgement) and the true diagnosis or treatment judgement(Cooksey 1996).

Judgement analysis has been used successfully in a range of professional settings including finance and weather forecasting as well as for studying clinical reasoning (Cooksey, 1996c, Harries and Harries, 2001, Thompson et al., 2008, Yang and Thompson, 2011). It takes as its starting point that the accuracy of a judgement is dependent both on the judge's (i.e. nurse's) use of information present in a judgement environment but also the uncertainty present in the environment itself (Cooksey, 1996c). This dependence can be portrayed as a model in the form of a 'lens' in which the nurse's judgement 'focuses' the information contained in a clinical situation (see figure 1).

Figure 1. Logistic Lens Model for comparing the judgement policy of a nurse judge against an ecological criterion (Stewart, 2004, Cooksey, 1996d)



Legend:

$X_1 \ldots X_k$	Information cues
Y_s	Actual judgement
$\hat{Y}_s$	Predicted actual judgement
Y_e	Ecological criterion value
$\hat{Y}_e$	Predicted criterion value
W_s	Judgement weights
R_a	Accuracy
R_s	Cognitive control
R_e	Predictability
G	Knowledge
$C_1, C_2 C_3$	Unmodelled knowledge
Z_e	Ecological residual
Z_s	Actual residual

Figure 1 here

The judgement environment is termed the *ecology* (or 'true diagnosis/ treatment) and is represented by the left side of the model. Various information *cues* are linked to this side of the model (such as the ABPI, level of pain etc.) and each cue carries a weight in terms of its contribution (importance) to the judgement. The right side of the model represents the nurse's judgement of the situation (or 'judged diagnosis / treatment). Correlation statistics and logistic regression are used to model the relationship between the cues and the judged diagnosis / treatment and the cues and the true diagnosis / treatment (Cooksey, 1996c).

The model and its components in figure 1 contain a number of key measures or indices:

- $X_1 \ldots X_k$ information cues;
- $W_1 \ldots W_k$ relative weighting of information cue;
- $Y_s/_e$ actual judged diagnosis / treatment or true diagnosis / treatment criterion value;
- $\hat{Y}_s/_e$ predicted judged diagnosis / treatment or true diagnosis / treatment criterion value, representing the degree to which a linear model varies in accuracy in predicting the true diagnosis / treatment.
- R_a achievement (correlation between judged diagnosis / treatment and true diagnosis / treatment);
- $R_s/_e$ control (correlation between actual and predicted judged diagnosis / treatment / true diagnosis/ treatment - the degree to which a nurse judge varies in the weight they attach to the individual cues within a judgement task;
- G knowledge - linear reasoning (correlation between predicted judged diagnosis / treatment and predicted true diagnosis / treatment) - the extent to which the nurse's use of the information cues provided in the scenario corresponds to how these cues are used in the 'true diagnosis/ treatment'

- C_1, C_2 and C_3 unmodelled knowledge - non-linear reasoning (correlation between residuals of the judged diagnosis / treatment and true diagnosis / treatment models) – the extent to which the nurse's use of information not measured in the diagnosis / treatment models corresponds to how this information is used in the true diagnosis/ treatment model.

The lens equation that stems from the model presents 'achievement' as accuracy (R_a) which is a function of linear knowledge use (G), predictability (R_e), cognitive control (R_s) and unmodelled or non linear use of knowledge (C1, C2 and C3) (Cooksey, 1996a, Stewart, 2004).

For this study two judgement tasks were constructed: i) the diagnosis of venous leg ulceration, and ii) the need for high compression treatment.

Setting

This study was conducted in the UK. The participants were recruited from primary care trusts in the north of England and one primary care trust in the south of England.

Ethical considerations

Ethical approval was provided by university and local NHS ethics committees (REC Ref No 09/H1311/86). Research governance approvals were granted by local NHS research governance committees.

Construction of the judgement tasks

The most commonly cited recommendation for the sample size for the number of scenarios is a minimum of at least five scenarios to every cue used. However a recent Judgement Analysis study found that this ratio resulted in logistic regression models with large and unstable standard errors (Yang, 2009). Therefore, the number of scenarios was based on Stewart's formula (Stewart, 1988, p.19) to provide stable standard errors. The same patient scenario furnished both the diagnosis judgement profile and the treatment judgement profile with the diagnostic judgement forming a cue

for the treatment judgement. There was a total of eleven cues but as there were only six cues for the each judgement, the sample size calculation could be based on six cues which reduced the sample size and cognitive workload for the participants. Ninety clinical scenarios were created based on the clinical records of ninety patients with leg ulcers being cared for by community nurses across the UK. Twenty of these clinical records were selected by stratified random sampling based on type of leg ulcer and added to the judgement task as replicated records to allow judgement consistency to be assessed(Cooksey, 1996c). The final judgement task consisted of one hundred and ten scenarios.

Judgement Analysis scenarios should be as representative of the natural environment as possible (Cooksey, 1996c) so the diagnoses in the scenarios mirrored the prevalence in the UK population of patients with leg ulcers (Srinivasaiah et al., 2007, Vowden and Vowden, 2009).

Table 1. Sampling according to recorded diagnosis

Aetiology	**Venous**	**Mixed venous/ arterial**	**Other**	**Total**
Percentage of sample	59%	36%	5%	100%
No of records sampled	53	33	4	90
No of replications	12	7	1	20
Data Source	Trial data	Trial data and patient data	Patient data	

Random sampling was used to select the records of patients with venous or mixed leg ulceration from a clinical trial data set. The records of patients with mixed, arterial or unusual diagnoses were purposively sampled from a population of patients with leg ulceration receiving care in a community setting who consented to take part in this study.

Each scenario contained a written vignette and a photograph of a wound and included the relevant cues identified from the literature (Adderley, 2005, Ashton and Price, 2006, Boxer and Maynard,

1999, Bryans and McIntosh, 1996, Hall et al., 2003a, Hall et al., 2003b, Hallett et al., 2000, Kennedy, 2002, Lauri and Salantera, 2002, Luker et al., 1998, Luker and Kenrick, 1992, Offredy, 2002, Thompson et al., 2000). Some cues, such as 'patient safety' or 'nurses' knowledge' could not be operationalised and so were omitted. Cues included were:

- Medical History
- Position of the ulcer
- Appearance of the lower limb
- Level of pain (as indicated by a pain score)
- Patient's age
- ABPI reading
- Diagnosis (this cue was generated by the nurse participant)
- Signs of infection
- Exudate levels
- Patient's gender
- Patient preferences about compression therapy

The cues were either explicitly described (e.g. such as 'ABPI = 0.82') or could be inferred from the written description or photograph (e.g. such as 'wound appearance'). An online survey package (www.surveymonkey.com) was used to present the scenarios and to collect the data. The nurses could complete the judgement task in stages at their own convenience but were asked to complete the whole task within one month.

The judgement criteria and weights in the left (true diagnosis / treatment) side of the Lens Model were generated using nominal group techniques (Black, 2006). The consensus panel consisted of four community tissue viability specialist nurses with advanced knowledge and experience in managing leg ulceration from four different healthcare organisations in the north of England. All members of this panel had been actively involved in NHS funded venous leg ulcer trials and had at least two years specialist leg ulcer nursing experience. Although this was a small group, research evidence suggests that the group was an adequate size (Hutchings and Raine, 2006). These nurses

were asked to independently complete the online survey before the consensus meeting date. These data were examined by the researcher in advance of the meeting to identify areas of consensus and disagreement. At the consensus meeting, the panel was presented with each scenario in turn and informed of the range of individual answers they had given prior to the meeting. Following group discussion, a group answer was agreed for each question in each scenario. All disagreements were resolved by discussion and without any intervention from the researcher.

Participants

Judgement Analysis is an idiographic research approach , able to capture the judgement policy of an individual judge as well as groups of participants and this can be achieved with very few participants (Cooksey, 1996b). 36 nurse participants were purposively sampled (Carter and Henderson, 2005) of which 18 were community generalist nurses (e.g. nurses working in general/ family practice and district/home care nurses) from one primary care trust in the north of England and 18 were community tissue viability specialist nurses from the north and south of England. To be included nurses had to be a registered nurse either responsible for the care of at least one community-based patient with leg ulceration at the time of the research or who had been responsible for the care of at least two patients in the previous three months. Participants were invited to take part via tissue viability nurses, community nurse managers and general / family medical practices by letter and e mail. Following receipt of written consent, nurse participants independently completed the judgement task online survey which asked them to diagnose each of the 110 scenarios and recommend a type of compression (if any). All nurse participants recruited to the study completed the whole task.

Data analysis

First, a logistic regression model was constructed for each nurse participant to derive the Lens Model statistics for each nurse. See appendix A for details of the formula used (Stewart, 2004 p19).

The beta weights in the logistic regression model for each nurse formed the basis for deriving 'relative cue weights' which expressed the weight given to each cue by each nurse in their diagnostic and treatment judgements. Each nurse's level of accuracy was represented by the coefficient of correlation (R_a) between their judgments (Y_s in Fig. 1) and the ''criterion'' values (Y_e in Fig. 1) of the ecological criterion. All the cues were simultaneously entered into the logistic regression models. SPSS version 20 was used to conduct the analysis (IBM Corp, 2011). Given the ideographic nature of the research, statistical tests of difference between nurses were not conducted.

RESULTS

The nurse participants

Data were collected in 2011 and 2012. Recruitment was slow but 36 community nurses completed the judgement task of whom nine worked in district nursing teams, nine in general practice nursing teams and 18 were community tissue viability specialist nurses. Table 2 shows the demographic characteristics of the nurse participants. A large proportion of the participants reported that others perceived them as having a high level of expertise or having advanced skills despite a relatively small proportion having educational qualifications at degree or post graduate level. However, most of the participants had over ten years nursing experience, job titles which indicated seniority and high levels of professional autonomy.

Table 2. Demographic characteristics of the nurse participants (n = 36)			
	Mean	**SD**	**%**
Age	46.39	7.93	
Female			100
More than 10 years of nursing experience			78
No of hours worked per week	32.57	6.79	
No of hours per week on leg ulcer care	10.82	7.57	
Educated to degree level or held post graduate qualifications			33
Degree or post graduate study relating to leg ulceration			19
Nurse Prescriber			30
Non-Medical Prescriber			25
Senior and/ or Specialist Nurse			95
Viewed as having considerable skills in leg ulcer care			72
Viewed as having advanced skills or expertise in leg ulcer care			53

Accuracy of nurses' diagnoses and treatment judgements

Table 3 shows the lens model statistics for diagnosis and whether or not to treat with high compression. The lens statistic, R_e measures the level of accuracy that could (theoretically) be achieved in the simulated task. An R_e of 1.00 would indicate a perfectly predictable task (Stewart et al., 1997). Thus Table 3 reveals that the predictability of the model for diagnosis was only 0.63 indicating that the nurses could only reasonably be expected to have a correlation of accuracy of up to 0.63. Given the unpredictability of the task, there was a medium to large degree of diagnostic accuracy (R_a=0.48, SD=0.17) indicating that the nurses' level of accuracy was below that which was possible. Nurses were consistent in their judgements and in how they assigned importance to information (R_s=0.58, SD=0.13). The correlation for linear and non linear use of information was low (G=0.23, SD=0.11; C1=0.16, SD=0.93, C2=0.00, SD=0.01, C3=0.00, SD=0.01) which suggests that the nurses' use of the information cues presented in the scenarios and the information not measured in the diagnosis model did not closely correspond to how it was used in the true diagnosis model. .

The treatment choice was a far more predictable (i.e. less uncertain) judgement task: R_e was 0.89 but the nurses showed medium to large levels of achievement (R_a=0.49, SD=0.18) which was below that which was achievable. The nurses had strongly positive levels of cognitive control/consistency (R_s = 0.78, SD = 0.13). Linear processing of information cues was more pronounced than in the

diagnostic judgement (G = 0.33, SD = 0.14) with non-linear processing accounting for negligible amounts of the overall judgement policies. (C_1=0.02, SD=0.03, C_2= 0.09, SD=0.07, C_3=0.05, SD= 0.03). This suggests that the nurses used the information cues presented in the scenarios in closer correspondence to how they were used in the true treatment model than they had for diagnosis.

Table 3– Lens model statistics
Nurse participants(n = 36)

Diagnosis of venous leg ulceration	**Mean**	**SD**
R_a Accuracy	0.48	0.17
R_s Cognitive Control	0.58	0.13
R_e Predictability	0.63	0.00
G Knowledge	0.23	0.11
C_1 Unmodelled Knowledge	0.16	0.93
C_2 Unmodelled Knowledge	0.00	0.01
C_3 Unmodelled Knowledge	0.00	0.01
Treatment with high compression	**Mean**	**SD**
Ra Accuracy	0.49	0.18
Rs Cognitive Control	0.78	0.13
R_e Predictability	0.89	0.00
G Knowledge	0.33	0.14
C_1 Unmodelled Knowledge	0.02	0.03
C_2 Unmodelled Knowledge	0.09	0.07
C_3 Unmodelled Knowledge	0.05	0.03

How was the available information used?

Relative weights are equivalent to having 100 points to divide between the cues. Table 4 shows how the cues were weighted by the nurses. *ABPI* was the most important cue for the diagnosis of venous leg ulceration. The nurses gave this cue a similar weighting to the true diagnosis model indicating appropriate use. *Medical history* was the second most important cue in the true diagnosis model but the nurses gave similar levels of importance to all the cues (except *ABPI*), thus over-weighting *age* and *pain* and under-weighting *medical history* and *appearance*.

Diagnosis of the type of leg ulcer was the most important cue for whether or not to treat with high compression but the nurses gave this cue less importance than was given in true diagnosis model. The next most important cue in the true treatment model was *pain*, but for the nurses this was one

of the least important cues. The nurses gave more importance to *patient's preferences* and *infection* than in the ecology. *Gender* was given very low weighting in the true treatment model but nurses assigned it the same importance as pain and 'exudate level'.

Table 4 – Relative Cue Weights

Diagnosis of venous leg ulceration - Ecology vs. Nurse participants					
Cue	**Ecology**		**Nurse Participants (n= 36)**		
	Rank	**Weight**	**Rank**	**Mean Weight**	**SD**
ABPI	1	53	1	52	16.67
Medical History	2	28	2	14	9.02
Appearance	3	15	5	9	6.15
Pain	4	2	4	12	9.00
Age	5	2	3	13	10.31
Treatment with high compression- Ecology vs nurse participants					
Cue	**Ecology**		**Nurse Participants (n= 36)**		
Diagnosis of leg ulcer type	1	68	1	56	19.22
Pain	2	13	4	7	7.52
Infection	3	8	2	12	13.75
Exudate levels	4	7	4	7	5.1
Patient preferences re compression	5	4	2	12	8.26
Gender	6	1	5	6	6.68

DISCUSSION

This study sought to assess the accuracy of diagnoses and treatment judgements in relation to offering high compression and to explore the use of available information cues for diagnosis and treatment. The complexity of individual patients and clinical situation means that there will always be a level of irreducible uncertainty within the clinical environment. This means that some variability in clinical judgement is inevitable but this study found that the nurses' judgement performance for both the diagnostic task and the treatment task was not as good as it could be. Given that the treatment task was more certain (i.e. more predictable given the information presented), it was surprising that nurses were no better at making treatment judgements.

The reasons for the nurses' levels of accuracy are unclear. When diagnosing venous leg ulceration and making judgements about applying high compression, important cues were underweighted

while less important cues were over weighted. It is possible that this misuse of cues may have contributed to the nurses' levels of accuracy. There are various theories such as Miller's theory of short term memory (Miller, 1956), Gigerenzer's fast and frugal reasoning (specifically, the "take the best" heuristic) (Gigerenzer, 2004) and heuristics and biases theory (Tversky and Kahneman, 1974) which suggest that people tend to focus on relatively few cues (which may not necessarily be the most appropriate cues). It is possible that the information might have been poorly synthesised by the nurses. The nurses may have been over or under-confident about their diagnoses which may have led to them making less accurate treatment judgements about high compression. However, this question requires more investigation and to speculate would go beyond the findings of this study.

Accuracy in diagnosis is important because misdiagnosis and incorrect treatment choices are likely to have a significant impact in terms of suboptimal healing rates, diminished quality of life in patients, reductions in patient safety and increased healthcare costs. It is important to note that in current UK community nursing practice, no positive test for venous insufficiency is available and therefore diagnosis is based on excluding other possible diagnoses. The ABPI cue that emerges from this study as the most important diagnostic cue for venous leg ulceration does not indicate venous insufficiency but the likely presence or absence of significant arterial disease. It has been argued that the ABPI should not be regarded as the "Holy Grail" of leg ulcer assessment (Vowden and Vowden, 2001) but, at present, it does offer the best available means in the community of differentiating between leg ulceration that is or is not complicated by significant arterial disease.

Judgement Analysis measures accuracy by correlating judgements against an acceptable 'gold standard'. In this study, the gold standard was the consensus judgements of a panel of nurses with advanced specialist knowledge - a well-established technique in both health and law (Samanta and Samanta, 2003); whilst a solid comparator it was still an imperfect solution. In using the term

'accuracy' to describe the community nurses' performance, it is important to remember that this refers to the level of agreement with a 'gold standard' which itself is socially constructed.

It is also important to consider the context within which these judgements and decisions are made. Some level of variability (and associated irreducible uncertainty) will always exist within the clinical environment. This is due to the nature of clinical practice and the variability of individual patients' preferences, the uncertain nature of the relationship between cues and diagnosis, the information available to clinicians, and treatment outcomes (Eddy, 1996). The presence or absence of information and the influence of time constraints will impact on judgement processes and outcomes (Cader et al., 2005, Hammond, 1996b, Thompson et al., 2008). In this study we controlled the information available to the nurses and did not seek to replicate the time pressures that exist in real clinical practice. It is therefore possible that the judgement performance in this study may be stronger (with more and better quality information to hand), or indeed weaker (due to time constraints) in clinical practice or higher fidelity simulations (Yang and Thompson, 2011).

Limitations

We sought to make the judgement task as representative as possible but inevitably there were some areas where this was difficult. Internal validity was increased by the scenarios being drawn from real patient clinical records in diagnostic proportions that reflected the UK leg ulcer population and random sampling of patient records for the venous leg ulceration scenarios. However, a large proportion of the patient records were sampled from a randomised controlled trial population. Even though this was a pragmatic trial - and thus more likely to reflect the population of patients with venous and mixed leg ulceration - these patients may not be entirely representative on all factors that may impact on the diagnosis and treatment of venous leg ulcers.

Internal validity was also increased by inclusion of most of the cues that the literature reported as relevant and by presenting these cues in naturally occurring measurement units of information (such

as wound photographs and actual ABPI measurements). However, it was not possible to operationalise all the relevant cues as some were difficult or impossible to operationalise or previously unreported in the literature. The impact of these omitted cues is unknown.

Predictive validity and judgement consistency was checked by the inclusion of replicated scenarios within the judgement task. The Judgement Analysis task was a reliable tool in that complete data were obtained from all participants and the same task was administered to all participants. This was achieved by using written/ photographic scenarios rather than real patient consultations. Although this increased the representativeness of the scenarios, it did not mirror leg ulcer assessment in clinical practice thus reducing ecological validity. The increasing interest in telemedicine within healthcare in general and wound care in particular, may make computerised scenarios less of a limitation in future wound care research that uses Judgement Analysis methodology (Binder et al., 2007, The Kings Fund, 2012) but it is possible that the judgement task is over- simplified. It must be also acknowledged that an online Judgement Analysis task cannot exactly replicate real life clinical practice with its additional stresses such as time pressures and illegible or missing clinical notes.

Most of the participants were highly experienced and perceived as highly skilled and thus may not adequately represent of the population of community nurses who provide leg ulcer care. Furthermore, the generalist community nurses were only sampled from one geographical region in the UK. Therefore, the results may over-estimate the level of achievement of UK community nurses in general and are unlikely to accurately estimate levels of achievement in non-UK settings.

Judgement analysis is an ideographic approach in which the "power" comes from the number of scenarios. This study sampled a much larger number of scenarios than the standard recommendation and succeeded in deriving stable logistic regression estimates which increases the external validity. External validity was increased by sampling community nurses who regularly made these sorts of judgements in real life. However, the generalist nurse participants were mainly

highly experienced and relatively senior so may not be representative of the generalist community nursing population who care for patients with leg ulcers.

Overall, the principle strengths of this study lie in its high level of representative design and a sample of scenarios sufficiently large to reliably identify patterns of within-nurse information use.

Implications for practice and research

In this study the *ABPI* cue was the most important cue for diagnosis of venous ulceration. Together with the *medical history* cue these accounted for 79% of the total weight in the diagnosis ecology model but nurses only gave these cues a total weight of 52%. Nurses should be encouraged to give these cues sufficient weight in their diagnostic judgements. Similarly, the *diagnosis* cue accounted for 63% of the weight in the judgement as to whether or not to apply high compression but the nurses only gave this cue 45% of the total weight. High compression is unlikely to cause harm to a leg with an adequate arterial supply so nurses should be encouraged to treat venous ulcers with an adequate arterial supply with high compression.

The relatively low predictability and relatively large 'unmodelled knowledge' parameter (C_1) of the ecology lens model for diagnosis suggests that this model does not capture some of the information that nurses use to make their diagnostic judgements. This combined with the paucity of robust research based knowledge to support the diagnosis of venous leg ulceration noted earlier suggests that research is required to identify the additional cues that nurses currently use. Research is also needed to evaluate the accuracy in terms of sensitivity and specificity of cues thought to be relevant for diagnosis of venous leg ulceration. The data from this study may also be helpful in designing further research to develop decision rules to aid judgement and decision making for treating venous leg ulceration.

CONCLUSION

In this study, UK community nurses did not agree with expert judgements and their judgements did not improve significantly (from diagnosis to treatment choice) as uncertainty in the task was reduced. This study has exposed the complexity of the clinical environment in which clinicians are required to manage patients with venous leg ulceration. Although this study was conducted in a UK setting, it is likely that this complexity is an issue for the global nursing and clinical community responsible for managing venous leg ulceration. The models for diagnostic judgment and treatment choices for venous leg ulceration set out in this paper provide a starting framework for developing strategies for supporting judgement and decision making. In sum, the study suggests that judgement can be improved and that supporting the judgements and decisions of nurses and clinicians may help narrow the gap between expert judgements and those who provide the majority of care in this area.

Appendix A

In order to derive the Lens Model statistics we used Stewart's revised formula (2004) which is:

$$R_a = G\frac{\sigma \hat{Y}_e \, \sigma \hat{Y}_s}{\sigma Y_e \; \sigma Y_s} + C_1\frac{\sigma Z_e \, \sigma Z_s}{\sigma Y_e \; \sigma Y_s} + C_2\frac{\sigma \hat{Y}_e \, \sigma Z_s}{\sigma Y_e \; \sigma Y_s} + C_3\frac{\sigma Z_e \, \sigma \hat{Y}_s}{\sigma Y_e \; \sigma Y_s}$$

Ra continues to represent accuracy as the linear measure of correlation between the nurse participant's judgements and the ecology judgements.

$G\frac{\sigma \hat{Y}_e \, \sigma \hat{Y}_s}{\sigma Y_e \; \sigma Y_s}$ represents knowledge as the linear measure of correlation between the predicted judgement (perfectly consistent model) of the participants and the predicted criterion (perfectly consistent model of the ecology).

$C_1\frac{\sigma Z_e \, \sigma Z_s}{\sigma Y_e \; \sigma Y_s}$ represents unmodelled knowledge as the correlation between the residuals of the two regression equations.

$C_2\frac{\sigma \hat{Y}_e \, \sigma Z_s}{\sigma Y_e \; \sigma Y_s}$ represents the correlation between the predicted judgement of the ecology and residuals of the nurse participant's regression model.

$C_3\frac{\sigma Z_e \, \sigma \hat{Y}_s}{\sigma Y_e \; \sigma Y_s}$ represents the correlation between the predicted judgement of the nurse participant's model and the residuals of the ecological regression model.

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