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An exploration into registered nurses' knowledge of adult fever in Scotland

Citation for published version:

Chen, LYA, Fawcett, TN & Chandler, C 2022, 'An exploration into registered nurses' knowledge of adult fever in Scotland: A mixed method study', *Nurse Education in Practice*, vol. 63, 103411.
<https://doi.org/10.1016/j.nepr.2022.103411>

Digital Object Identifier (DOI):

[10.1016/j.nepr.2022.103411](https://doi.org/10.1016/j.nepr.2022.103411)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

Nurse Education in Practice

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Title: An exploration into registered nurses' knowledge of adult fever in Scotland: A mixed method study

Abstract

Background: Fever may be a result of many causes, infective or non-infective. Nurses' fever management can be affected by their knowledge and beliefs, and also by patients' beliefs. Consequently, an understanding of fever is vital in the diagnosis, treatment and follow-up of various ailments and diseases. Greater knowledge of fever will guide more accurate assessments of the epidemiology of fever and its management.

Objectives: This study explored nurses' knowledge in the context of fever and identified factors that affected this knowledge acquisition.

Methods: A mixed methods approach was used with a validated questionnaire designed to gather information about nurses' knowledge of fever. This was followed up by semi-structured interviews to explore factors associated with the acquisition of fever knowledge. The online survey was distributed to registered nurses in Scotland.

Results: A total of 177 questionnaires were completed. The questionnaires were scored with a correct answer 1 point, while a wrong answer -1 point. The mean total score in the knowledge section was 0.47. Only 49.2% of participants scored above 0. The stepwise linear regression demonstrated working experience in critical care unit, acute care unit and the role of nurse practitioner together could predict 10% of the total knowledge score ($P < 0.05$). Through analysis of associations and qualitative data, it was found that many factors had contributed to the nurses' knowledge about fever, specifically educational content, individual confidence and the Sepsis Six bundle.

Conclusions: Considerable misconceptions were found to exist in the nurses' understanding of fever. Only a few factors were found to be associated with the total knowledge score. It was highlighted that due to the strong influence of the Sepsis Six bundle, participants often assumed a direct causal connection between fever and infectious disease or sepsis. The study result indicated a concern in nurses' acquisition of fever knowledge.

Tweetable abstract: Misconceptions from foundational learning were found in nurses' understanding of fever. However, the Sepsis 6 was found to impact their current knowledge of fever.

1. INTRODUCTION

Fever is one of the oldest clinical indicators of disease and the most common

reason for medical consultation worldwide (Circiumaru et al., 1999; Hinson et al., 2018). Although the precise process of fever is not fully understood, fever occurs when the human body activates a corrective response to the effects of pathogens, infectious diseases, autoimmune diseases, drugs, and other unknown insults to the body. The guidelines of World Health (2012, 2013) did not suggest antipyretics for fever management, instead, the priority of fever management for in hospital patients was to explore its underlining cause and to provide hydration. NICE (2017) also suggested that the management of fever methods to lower body temperature should be used to relieve a patient's discomfort instead of being commonly prescribed and administered for the only purpose of controlling body temperature. Although it is the physicians who prescribe the pharmacological antipyretics, it is usually a nurse's choice as to whether and when to administer them (Greensmith, 2013; Thompson & Kagan, 2011). There is a little evidence to guide the treatment of fever and strong arguments exist to justify both treating and not treating pyrexia (Niven et al., 2013). This leaves the decision to treat elevated body temperature to the discretion of the prescriber and the bedside nurse (Greensmith, 2013; Thompson & Kagan, 2011). The question that originates, is whether nurses fully understand the concept of fever. These primary thoughts prompted the need to investigate the factors that influence nurses' knowledge about fever.

2. BACKGROUND

Fever is a very common symptom experienced within a wide variety of disorders. There are many conditions that stimulate the release of fever-causing cytokines. However, when confronted with fever, most care providers immediately consider infection, which usually plays a role in 50% of fevers. Increased metabolism, such as metabolic disorder, tissue injury and exposure to toxins play a role in 35% of fevers, while, in 15% of cases, either no diagnosis is made, or the pyrexia with no known cause resolves spontaneously (Ames et al., 2013; Balli & Sharan, 2020; Thompson & Kagan, 2011). Exposure to higher temperatures can be directly cytotoxic for pathogens and can inhibit their growth. Moreover, fever can defend host cells and regulate immune responses (Balli & Sharan, 2020; Prajitha et al., 2018; Walter et al., 2016). Pyrexia can therefore be seen to be of benefit to the patient during the life cycle of a disease. On the other hand, it can also present patients' immune systems with daunting metabolic challenges especially if it is accompanied by shivering to effect the raised set point. Evidence states that each 1°C increase in core temperature results in a 10% to 12% mean increase in energy expenditure alongside an increase of 20% in oxygen consumption (Janz et al., 2015; Niven et al., 2012; Young et al., 2015). Yet, inconclusive findings about the administration of antipyretics were noted. Some evidence proposes that the application of antipyretics could be harmful (Zhang et al., 2015), while the majority of the literature reveals that the use of antipyretics does not have a

statistically significant correlation with the length of hospital stay, ICU stay or mortality (Janz et al., 2015; Niven et al., 2012; Young et al., 2015).

Fever is not only one of the vital signs but also an important factor to consider when risk assessing the procedure for managing certain conditions such as systemic inflammatory response syndrome (Singer et al., 2016). Especially during the COVID-19 outbreak, the fever symptom is a risk factor for triage, screening and predicting mortality in patients with COVID-19 (Ayebare et al., 2020; Erika et al., 2020). As the provider of direct patient care, the bedside nurse is the primary decision maker regarding antipyretic interventions. It is, therefore, important for nurses to know how to manage the symptoms of fever and have a comprehensive understanding about fever. However, limited published articles discuss nurses' knowledge of fever. Most of the articles investigating the fever knowledge of nurses were in the field of paediatrics, and knowledge deficits appeared in every study (Baran & Turan, 2018; Brick et al., 2017; Peetoom et al., 2016; Richardson & Pursell, 2015).

Almost every nurse has had to care for a patient with fever. Consequently, an understanding of fever and the febrile response is vital in the diagnosis, treatment and follow-up of various ailments and diseases. It is crucial that all nurses practise consistently in accordance with the latest scientific evidence. Therefore, understanding nurses' knowledge about fever must have primacy. Greater knowledge of fever will guide more accurate assessments of the epidemiology of fever and its management. This research aims to understand nurses' knowledge of fever and factors that impact on nurses' pyrexia-related knowledge.

3. METHODS

3.1 Design

A mixed methods approach was used with a validated questionnaire designed to gather information about nurses' knowledge followed by semi-structured interviews to explore in-depth the relationship between factors influencing fever knowledge. An online questionnaire was designed and distributed through health boards in NHS Scotland. In appreciation, an educational package about fever and its management was sent to the participants after completing the questionnaire. At the end of the questionnaire, participants were asked whether or not they would like to take part in a future study and, if interested, to provide their contact information. Those who voluntarily left their contact information were contacted and invited to be interviewed.

3.2 Instrument

The demographic data including age, gender, experience and nursing role were collected as well as the participants' thoughts about fever. Participants' thoughts of whether controlling body temperature during fever could reduce hospital stay or reduce mortality were also contained in the questionnaire. The questionnaire of fever knowledge was adapted from two questionnaires. Ten of the questions were from

Kiekkas et al. (2014), translated to English and seven questions were from Walsh et al. (2005). The pre-validated questionnaire from Kiekkas et al. (2014) had a Cronbach's alpha of 0.8. The reliability test by Walsh et al. (2005) yielded a Kappa of 0.644. There were a total of 17 questions in the knowledge questionnaire. The questionnaire included the causes of fever (3 questions), the measurement of human body temperature (4 questions), antipyretics (6 questions), fever benefits and disadvantages (4 questions). Content validity was checked by experts in the field of health care. A pilot study was conducted to ensure the validity and reliability of the questionnaire. The Cronbach's alpha was 0.745. At the end of the questionnaire, there was an open question asking for participants' thoughts of fever.

To gain an in-depth understand of the factors that might relate to fever knowledge, the questions in the semi-structured interview were designed after a brief analysis of the survey, which revealed the areas that required further inquiry. An initial analysis of the survey showed uncertainty both in relation to fever pathology and its management. This prompted further questions:

- What are your thoughts about fever and fever control?
- Can you tell me about your recent experiences of fever in your patients? / What would you do if you have a patient with a fever?
- What is it that makes you feel you need to intervene and manage fever?
- What do you think influences your decision making to intervene? (Where do you think this comes from?)
- How would you evaluate your knowledge and skills in relation to fever?

3.3 Sample

The study was designed to recruit registered nurses in Scotland. The online survey was distributed from January 2017 to September 2017. There was a total of 177 participants who completed the questionnaire about fever knowledge. Amongst the 177 participants, 57 participants voluntarily completed the open-ended question. Participants were recruited if they had completed the survey and indicated their willingness to participate in the interview until the data reached saturation. A total of 5 participants were interviewed. The interviews were carried out from October 2017 to February 2018.

3.4 Data analysis

The quantitative data from the questionnaire about fever knowledge was analysed using the Statistical Package for Social Sciences, version 21.0. The qualitative data read and re-read, from which preliminary codes were generated and collated into themes. Codes and themes were crosschecked and mapped until a rich understanding emerged of participants' perspectives on the concept of fever and the factors that

related to fever knowledge. The thematic analysis was conducted with the support of NVivo 9 software.

3.5 Ethical considerations

Ethical committee approval was obtained from research project for review by the Section of Nursing Studies Ethics Research Panel, the University of Edinburgh (Ref: NURS019). The study was also assessed by the NHS Research and Development, Scotland in each region and deemed to be service evaluation, which only required an institutional ethics review.

4. Result

4.1 Participant characteristics

The participants consisted of 156 (88.1%) women and 21 (11.9%) men (Table 1), with more participants, 61 (34.4%), in their 40s than in any other age decade (Table 1). Overall the participants' years of work experience showed a fairly even spread. The majority of participants in the study were from NHS Lothian (36.2%) and from NHS Greater Glasgow & Clyde (33.3%); while others were from NHS Fife (8.5%), NHS Highland (7.3%), NHS Dumfries & Galloway (6.8%) and NHS Lanarkshire (6.2%); and a few from the other NHS health boards. A total of 28.3% participants had their highest education level in Nursing BSc/BN. More than half of the participants were working in the hospital setting. The details of the demographic data and thoughts about fever of the participants who completed the questionnaire was demonstrated in Table 1.

In qualitative data, a total of 57 participants give their thoughts about fever in the last open-ended question. There were 5 interviewees participated in the interview stage.

4.2 Result of Fever knowledge

A correct answer scored 1 point, whilst a wrong answer scored -1 point, and an answer of 'not sure' scored 0 points. This negative marking approach ensured that the 'not sure' responses were not grouped with incorrect answers. The total knowledge score could range from -17 to 17. The mean fever total knowledge score for all participants was 0.96 with a standard deviation of 4.25. The 95% confidence interval of the mean is 1.59 to 0.33. There were 49% of the participants who scored 0 or below. Figure 1 shows the distribution of the total knowledge score. Moreover, more than 80% of the participants thought controlling body temperature during fever could reduce hospital stay (n = 149) and reduce mortality (n = 153).

The relationship between individual questions, categories of fever knowledge questions (fever cause, measurement of human body temperature, antipyretics, fever benefits and disadvantages) were also analysed with total knowledge score. Only question 20, which concerned the mechanism of antipyretics, had significant correlation with total knowledge score (Pearson's correlation coefficient=0.456, $p < 0.0001$). Table 2 demonstrated the result from the questionnaire and the themes that emerged from the quantitative data. In relation to the purpose of fever, participants showed misunderstandings about the causes and basic mechanisms of fever (mean score = 0.11~0.12). The qualitative result suggested that participants believed that fever was directly related to infection.

*It's the body's reaction to infection or bacteria of some kind, or viral. I can't think of anything else that would bring that [fever] on.
(participant 68)*

The result echoed with the questions relating to fever cause, which 43.5% of participants believed that only infectious aetiology could attribute to fever. When it came to the benefits and disadvantages of fever, it appeared that participants had limited knowledge about its benefits and tended to exaggerate its disadvantages, leading to an overall fear of its presence. Therefore, both the quantitative data and qualitative data showed that participants had poor understanding in fever benefit and disadvantage (mean score = -0.06 ~ -0.49, see Table 2). The results from the questionnaire showed that participants' understanding about the dosage of pharmacological antipyretics was sufficient; less than 10% of the participants were 'not sure' of the answer.

4.3 Factors related with fever knowledge

Correlations between total knowledge score and other variables such as demographic data were analysed. No significant relationships between total knowledge score and the nurses' age, experience or highest educational qualification were found. A significant but weak correlation ($p=0.012$) was found between the number and variety of units at which participants had worked and their total knowledge score (Pearson's correlation coefficient=0.190). The result demonstrated that the relationship between the variety of experience and fever knowledge was

positive. The correlations between different institutions, hospital setting, working units and total knowledge score were analysed using the Mann-Whitney U test. Participants who were working in the non-hospital setting ($U=2824.50$, $p=0.01$) and community ($U=1847.50$, $p < 0.0001$) had a significantly lower mean rank of total knowledge score. Participants who had experience of working in the critical care ($U=2135.50$, $p < 0.0001$), acute care ($U=2584.50$, $p < 0.0001$) and neuroscience units ($U=94.00$, $p < 0.0001$) had a significantly higher mean rank of total knowledge score, while participants who had experience of working in a rehabilitation unit ($U=1626.00$, $p=0.04$) had a significantly lower mean rank of total knowledge score. The participants' role was also found to be associated with their knowledge score. Participants who only had the role of registered nurse were found to have a lower mean rank in the knowledge score ($U = 2794.5$, $p = 0.01$), while participants who had the role of nurse practitioner were found to have a higher mean rank in the knowledge score ($U = 698.00$, $p < 0.0001$). The findings relating to the participants' thoughts about fever, suggest that participants who thought managing fever could decrease hospital stay tended to have a positive correlation with the total knowledge score (Spearman's $\rho = -0.172$, $p = 0.02$)

After confirmation of the correlation between total knowledge score and variables in the study, a stepwise linear regression analysis was conducted to investigate further the influence of significant variables. In table 3, the result of stepwise linear regression showed that question 20 could explain 21.6% of the total knowledge score. The other factors, including working experience in critical care unit, acute care unit and the role of nurse practitioner together could predict 10% of the total knowledge score. However, the R square of the model was only 31.6%, which indicated a general concern with their fever knowledge.

Correlation between participants' thoughts about fever, included participants who thought managing fever could decrease hospital stay or decrease mortality were also analysed. Variables, such as participants' experience and their highest education level were correlated with participants' thoughts about fever. Those variables which had a significant correlation with the belief that controlling body temperature during fever could reduce hospital stay and reduce mortality, were then analysed. The result is as presented in table 3. The R square in the thoughts that controlling body temperature during fever could reduce hospital stay and reduce mortality were about

10%, which was relatively small.

The data were further analysed looking at the qualitative data. When asking about participants' thoughts about fever knowledge, all the participants believed that education played a key role in their knowledge of fever. It would seem, perhaps obviously, that nursing education helped with the production of participants' fever knowledge. Secondly, it was noted that clinical experience enhanced the participants' knowledge of fever gained during their training. None of this proved surprising.

I think the knowledge was provided. Thinking about that in a classroom is so much different than thinking about it on a busy ward. You just forget things. ... Looking back at my old physiology notes from my training, this all makes sense It feels like my specific knowledge like that has decreased a bit, but practically applying the knowledge is maybe a bit better (Participant 21)

Confidence was another element that had a huge impact on generating fever decisions. 'Confidence about fever knowledge' was one of the themes identified in the results of the qualitative data. Although the results indicated that there was a concern about the lack of overall knowledge of fever, most of the participants were confident about their knowledge of fever before completing the questionnaire. However, many expressed the realisation that, having completed the questionnaire, that they might not understand fever as much as they had thought. Finally, the 'Sepsis Six' bundle (Figure 2) was found to have a great influence on fever knowledge. The Sepsis Six bundle is an assessment tool and sepsis management guide developed in the UK to help healthcare professionals deliver more efficient and reliable care to patients who might be suffering from sepsis (Brent, 2017; Burke et al., 2019). It would seem that as the Sepsis Six bundle had been successfully established, and notably underpinned participants' thoughts about fever.

Following the Surviving Sepsis campaign and national roll out of the Sepsis Six, there is greater emphasis on sepsis as a syndrome, than of fever as a numerical marker of illness. (Participant 14)

The above extract illustrates that participants immediately think of the Sepsis Six guidelines when encountering fever which echoed the result that almost half of the participants believed fever was attributed only to infection.

5. Discussion

The findings from this study clearly demonstrate the participants perceived their education preparation to be the foundational source of their knowledge of fever. However, it was clear that the full understanding of the concept of fever gained from foundational pre-registration education was weak and arguably not retained in practice leading to what is identified as unconscious incompetence (Gabbay & Le May, 2010; McVicar et al., 2010). The potent source of the currency of their fever knowledge was from practice and from the experiences of, and rising concern over, poorly detected sepsis. The immediate impact of the sepsis six and fever symptoms caused by infections accelerated the development of participants' fever knowledge. This resonates with the learning process model by Horvath et al. (1996) and Eraut (2000), which categorized the learning process into formal and informal learning. Formal learning includes learning at educational institutions; learning for specific outcomes. Non-formal learning is defined as learning in the absence of explicit knowledge about what was learned (Reber, 1993). According to Eraut (2000, 2004), non-formal learning could be spontaneous and unplanned. There would be no awareness of non-formal learning at the time it takes place. However, non-formal learning had considerable effects on the development of fever knowledge. Participant 28's statement summarized the ideal development in such as fever knowledge.

...what will happen is that the classroom information and the patient information will come together and I'll have the both knowledge appropriately. (Participant 28)

As stated in the quotation, the impact of the clinical practice has both currency and immediate relevance. In the case of fever, the Sepsis Six bundle was abstracted from practice and developed into the fever knowledge. However, it also reinforced participants' assurance, wrongly, that fever was only infection related. It would be easy to extrapolate and suggest that the knowledge learnt from the pre-registration education could be easily replaced by potent custom and practice, be it soundly evidence based or otherwise. Gabbay and Le May (2010) suggested that instead of strictly evidence-based practice, clinicians developed their knowledge through practice-based evidence. The day-to-day practice reinforced their tacit guidelines and internalised their clinical knowledge.

In the case fever knowledge development, it would seem that participants intuitively connected fever with an infectious cause and this was reinforced by the emphasis on the use of the Sepsis Six bundle. Therefore, through this practice-based route of fever knowledge development, participants were more concerned about the disadvantages of fever. Moreover, their knowledge about fever disadvantage were limited (table 2).

It was found that participants were confident about their knowledge of fever. From the results of the questionnaires and interviews, it was evident that there was a resultant widespread concern about their lack of knowledge of the purpose of fever about which they had, until then, had implicit confidence. Participants were surprised by the fact that what they have learnt in their pre-registration education had not necessarily been retained in the practice. Most of them trusted their knowledge in fever before completing the study. Therefore, the concerns about keeping the knowledge up to date was noted.

These things change over the years as well. What we think is a way to manage something when we finished our nursing training, 10 years later it is totally out of date. (Participant 18)

The result of this study demonstrated a need for nurses to revisit the knowledge underpinning clinical practice in fever in order to create a more robust foundation in the knowledge about fever. This reinforced the recognized registration priority of continuing professional development founded on evidence-based research but that may not actually tap specific deficits. According to the Nursing & Midwifery Council (2021), nurses should undertake 35 hours of continuing professional development (CPD) courses in every 3 year period of registration. CPD activity, aimed to equip practitioners with knowledge and skills necessary to close identified gaps, is dependent on successful knowledge translation in the workplace, and recognises and assumes practitioners value the use of different types of knowledge necessary to improve practice (Manley et al., 2018; Villalobos Dintrans et al., 2019). Currently, the selection of CPD is the individual's choice. There is, perhaps, an argument for regular assessment of the possible knowledge gaps between practice, healthcare service need and the latest evidence against which nursing care should be carried out (King et al., 2021; Manley et al., 2018). Our study highlighted that participants had not been aware of their knowledge gap between the clinical management of fever and the best

evidence on which practice should be based. The respondents saw such a value with the provision of the 'thank you' educational package and the desire for more evidence based standardisation for practice.

Quotation here.....

With the established awareness of evidence-based practice, it is important to generate or improve the practice-based learning approach.

Indeed, the pandemic of COVID-19 will have had new influences on nurses' thoughts and understanding about fever. Arguably, with so much new practice-based knowledge, the relevance of accurate foundational knowledge is thrown into sharp relief (Gul et al., 2021). The professional concern, from the earliest days as a preregistration student nurse, must be to ensure that new knowledge and understanding is built on firm foundations – on rock, not sand. The foundational knowledge of fever is unlikely to be the only knowledge deficit. This indicates that an expansion of foundational knowledge for nursing could be argued to be a priority.

6. Conclusion

The result of this study demonstrated that the participants did not have sufficient knowledge or understanding about the concept of fever, where a total of 49% participants scored 0 or below. Although the variation of clinical experience, nursing role, working experience in acute and critical care had positive correlation with participants' knowledge about fever, the association between fever knowledge and the above factors was weak. This resulted in a concern about a lack of overall knowledge of fever. Of greater concern is, arguably, that prior to completing the questionnaire it would seem the participants were confident about their knowledge in fever. Therefore, they would not have looked to update or 'recover' their knowledge of fever. Moreover, it would seem that the practiced-based learning had considerable impact on the development of fever knowledge. The question to be explored might be the impact of Covid-19 on nurses' knowledge of fever and how this potent experiential knowledge might have demanded the revisiting and enhancing of the fundamental knowledge of fever. It is soundly argued that a greater in depth knowledge of fever will guide more accurate assessments of fever and its optimal management.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of interest

The authors declare that there is no conflict of interest.

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