

Improving the Time to Antibiotic Administration in Paediatric Febrile Neutropenia: Implementation of a Clinical Care Pathway in Saudi Arabia

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Abstract

The aim of this quality improvement practice project was to improve noted delays in the time to antibiotic administration in paediatric febrile neutropenic patients seen at King Faisal Specialist Hospital and Research Centre (KFSH&RC), Saudi Arabia. Larrabee's 6-step Model for Change of evidence-based practice guided the project. Clinical audit, nursing knowledge survey, comprehensive literature and international clinical guideline review were used to identify and design a clinical care pathway for paediatric febrile neutropenic patients at KFSH&RC. Post-implementation clinical audit showed a reduction in time to antibiotic administration and increased self-efficacy and knowledge among nursing staff in relation to managing the care of febrile neutropenic patients. This reflects similar improvements seen internationally in other centres following the introduction of a clinical pathway. This nursing led practice change was the first of its kind for KFSH&RC. It demonstrated that with support from key stakeholders, Larrabee's model for evidence-based practice change can be used for introducing a nurse-led clinical care pathway in Saudi Arabia.

Highlights

- A new clinical care pathway introduced in Saudi Arabia improved time to antibiotic administration in paediatric febrile neutropenic patients.
- Implementing a nurse-led clinical care pathway increased nurses' confidence with managing children with febrile neutropenia and the skills and knowledge related to the accessing and delivering medication via central access devices
- With key local stakeholder support evidence-based change frameworks such as that proposed by Larrabee can be used to improve nursing management in Saudi Arabia.

Keywords: Nursing, febrile neutropenia, clinical care guidelines, children.

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INTRODUCTION

Fever is a normal response of a child's immune system to a virus or bacterial infection and most healthy children tolerate a fever well. However, for children undergoing treatment for cancer, fever is a serious event and considered a medical emergency. Fever and neutropenia are the most common serious complications of childhood cancer treatment and potentially life threatening (Davis & Wilson, 2020). To avoid complications, prevent progression to sepsis and possible death, prompt recognition, diagnosis, and initiation of treatment with broad-spectrum antibiotics is essential. International guidelines and management

plans advocate for prompt (< 60 min) initiation of antibiotic administration (Burns *et al.*, 2019). Any symptoms such as lethargy, flushed cheeks, tachycardia, and subjective fevers which may suggest an infectious response, can be used to justify rapid antibiotic administration (Taplitz *et al.*, 2018).

There is no internationally agreed definition of febrile neutropenia (FN), the most recognised, defines FN as a temperature >38° C with an absolute neutrophil count of 500 cells/mm³, or less than 1000 cells/mm³, with an anticipated reduction to 500 cells/mm³ in the following 48 hours (Stephens, 2020; Weycker, Barron,

Kartashov, Legg, & Lyman, 2013). FN is most common among paediatric patients receiving chemotherapy for acute myeloid leukaemia (AML) and acute lymphoblastic leukaemia (ALL) (Davis & Wilson, 2020). The chemotherapy used to treat these conditions causes a severe reduction of white blood cells ultimately diminishing the neutrophil count. Once the absolute neutrophil count significantly drops, the bodies' ability to fight off and prevent infections is drastically reduced. Therefore, the longer a patient with FN is left untreated, the greater the risk of serious infection, and potential for irreversible organ damage (Stephens, 2020; Weycker *et al.*, 2013). Reducing the time to antibiotic administration (TTA) has been shown to directly reduce these adverse outcomes (Fletcher *et al.*, 2013; Salstrom *et al.*, 2015). Despite this, consistently meeting the goal of prompt antibiotic administration is not easily achieved (Nirenberg, Mulhearn, Lin, & Larson, 2004; Perrone, Hollander, & Datner, 2004).

King Faisal Specialist Hospital and Research Centre (KFSH&RC) serves a population of 33 million people from Saudi Arabia and surrounding regions. It is recognized as the nation's leading hospital specializing in Oncology, Organ Transplantation and Genetic diseases. Adult and paediatric patients travel across the country to access care at King Faisal. Prior to 2018 both paediatric and adult patients presented to the same emergency department (ED) for triage however in 2018, recognising the importance of specialised paediatric care, a separate paediatric emergency department (PED) was established. A key task identified at this time was the development of a best practice clinical pathway for the management of paediatric oncology patients. Working clinically and observing patient flow in the newly established PED it became apparent to the first author (MP) that there was not only a lack of

communication and confidence among the nursing staff with caring for FN patients but also a lack of urgency. Despite best practice literature and clinical guidelines clearly advocating rapid antibiotic administration and fluid resuscitation (i.e., completed within 60 minutes, and/or 30 minutes if critically unwell) (Bow & Wingard, 2020; Stephens, 2020; Taplitz *et al.*, 2018) observation and anecdotal evidence suggested that KFSH&RC was not meeting these international guidelines for treatment. A quality improvement project was developed with the aim of improving time to antibiotic administration for paediatric FN patient at KFSH&RC.

METHOD

The framework for this project followed the methodology of Larrabee's Model for Change of Evidence-Based Practice (Larrabee, 2009). Larrabee's model is a revised version of the model originally developed by Rosswurm & Larrabee in 1999 (Rosswurm & Larrabee, 1999). This model (figure 1) is based on change theory and guides nurses through a systematic process for change to evidence-based practice through six phases or steps:

1. Assess the need for change in practice
2. Locate the best evidence
3. Critically analyse the evidence
4. Design practice change
5. Implement and evaluate change in practice
6. Integrate and maintain change in practice

Ethical considerations

Approval for this project was gained from KFSH&RC review committee. This project was deemed a quality improvement project by the sites review committee and therefore did not require ethical approval.

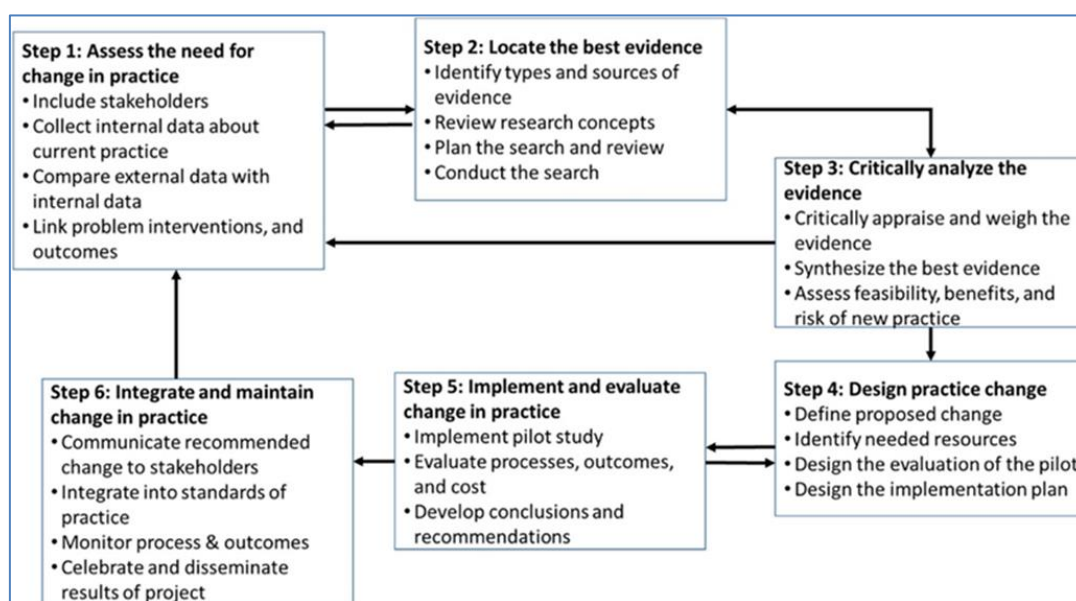


Fig-1: A Model for Evidence- Based Practice Change (Larrabee, 2009)

RESULTS (AND PROJECT PATH)

Given the interlinked and developmental nature of Larabee's Model the following section will report both methods used and the results of each phase of the project.

Faze One: Assess the Need for Change in practice

The major activities in this step focused on assessing the need for change in practice through identifying and including the stakeholders; collecting internal data about current practice; comparing the internal data with external data; identifying the practice problem; and linking the problem, interventions, and outcomes (Larabee, 2009). An internal quality audit completed between August - November 2019 confirmed suspicions that KFSH&RC was not reaching international best practice standards (<60mins from time arrival to antibiotic administration) with the average time to antibiotic administration for FN patients at KFSH&RC being 3 hours and 48 minutes.

The next step was to identify the stakeholders and examine the factors impacting the delay. Seven key stakeholders representing medical, nursing, and allied staff were identified and gathered to discuss the issues, brainstorm, and decide on ways to improve this area of practice. Key issues explored during this brainstorming session included previous experience with clinical care pathways, education issues, upskilling staff, goals and timelines. This group of stakeholders agreed to be part of the project team to further explore the issues and develop and implement a clinical care pathway for FN patients.

A paper-based survey of nursing staff working in the PED was conducted in November 2019. The survey was designed to gauge support for the development of a clinical care pathway and to provide information about paediatric nursing staff's knowledge and comfort in managing FN. The survey identified several key issues within current clinical practice and the self-efficacy of nurses with regards to caring for FN patients. Out of the total survey respondents (n=26 paediatric nurses), there was only one nurse who reported feeling confident to independently care for a FN patient with only one nurse specifically trained or educated in FN. Many reported their knowledge of FN as '*not enough to even get by*' with several saying they would '*actively avoid*' or '*completely rely on another nurses support and give direction*' when caring for paediatric patients with FN. Additionally, and importantly, this nursing survey revealed that 100% of those surveyed did not possess the knowledge or skills to access a central venous access device (CAVD), a pivotal device in enabling rapid intravenous access and administration of antibiotics in an efficient and timely manner (VanHouwelingen *et al.*, 2019). This survey also highlighted the need for education to support nurses with managing this patient group. At the end of this phase, it was clear there was overwhelming support

from stakeholders and a clear clinical practice need to provide a standardised approach for the management of paediatric FN patients as well as education to nurses on the management of these patients.

Phase Two: Locate the best evidence

In phase two a literature review was undertaken using key databases including Google Scholar, UpToDate, MEDLINE and Child and Adolescent Health Services library to determine current best practice. In addition to published literature other sources were identified such as previous practice projects exploring the topic of clinical care pathways, research studies and current best practice guidelines for the treatment of FN. Key search terms used were *paediatric/pediatric, *fever/febrile, *sepsis, *neutropenia/neutropoemia, *oncology management/treatment, and emergency department. In addition, commonly accepted terms for clinical care pathways such as 'clinical guidelines' and 'bundles' were also used. Resources were excluded if they dated prior to 1997, when the first approved guideline was introduced. Articles endorsed by medical governing bodies and tertiary organisations were included. Articles were selected based on credibility and use in current practice and were measured against the currency, relevance, authority, accuracy, and purpose (C.R.A.A.P) (Fielding, 2019).

Phase Three: Synthesis of evidence

In phase 3 articles and guidelines providing reference to and covering general management in the paediatric population of: neutropenia; fever and sepsis in a non-oncology setting; FN; and a combination of the above, were analysed and synthesised. One of the key and consistent findings from this synthesis was that management of FN was that it was time critical. Consensus among governing bodies and tertiary clinical centres stated that antibiotics should be administered within 60 minutes of presentation to an emergency department and 30 minutes if signs of shock are present (Bow & Wingard, 2020; Ku *et al.*, 2019; Skeen & Teague, 2020; Taplitz *et al.*, 2018). The review also highlighted that for the past two decades, rapid antibiotic administration has been a key determinant of successful outcomes for patients across all age groups. Clinical care pathways were shown to be a useful and practical tool to promote the prevention of delayed treatment and to be instrumental in decreasing the time to antibiotics and improving patient outcomes (Bekmezian, Fee, & Weber, 2015; Haeusler *et al.*, 2020; Murray, Alpern, Lavelle, & Mollen, 2017). Starship Hospital, Auckland, New Zealand (Skeen & Teague, 2020) and The Royal Children's Hospital Melbourne (2009) developed clinical care pathways for FN endorsed by The Cancer Institute NSW (2020) and the Australian and New Zealand Children's Haematology/Oncology Group [ANZCHOG] (2020). These endorsed and annually updated clinical care pathways provided useful templates for the

development of and design of the clinical care pathway at KFSH&RC.

Faze Four: Design Practice Change

Phase four activities include defining the proposed practice change, identifying the required resources, designing the pilot and the implementation plan (Larrabee, 2009). Strategies include involvement of change champions, creating educational sessions and materials, and undertaking audits and feeding back.

Following the synthesis of evidence, the project team met to plan and design the clinical care pathway which was based on a combination of internationally endorsed pathways, current best practice advice, and the ideas and visions of the key stakeholders. The pathway was drafted in accordance with local Saudi Arabia guidelines and presented to the key stakeholders. Feasibility, design, and priorities were all approved, and an education plan was designed and implemented.

Results from phase one of the project noted that two of the key factors influencing the delay in antibiotic administration were the shortage of nurses trained in CVAD and poor confidence and education regarding FN. Therefore, one of the specific items for action within this phase was to provide education and in-service education to nursing staff. Clinical educators delivered these which included workshops to upskill nursing staff on important aspects of the pathway including accessing CAVD, antibiotic preparations, verbal medication orders and general knowledge regarding FN. During this phase of education and informing staff about the project the project team delegated their roles for the pilot month, planned future meetings and allocated resources. In addition, they agreed upon the appropriate definitions, inclusion, and exclusion criteria for the patients and how the flow of

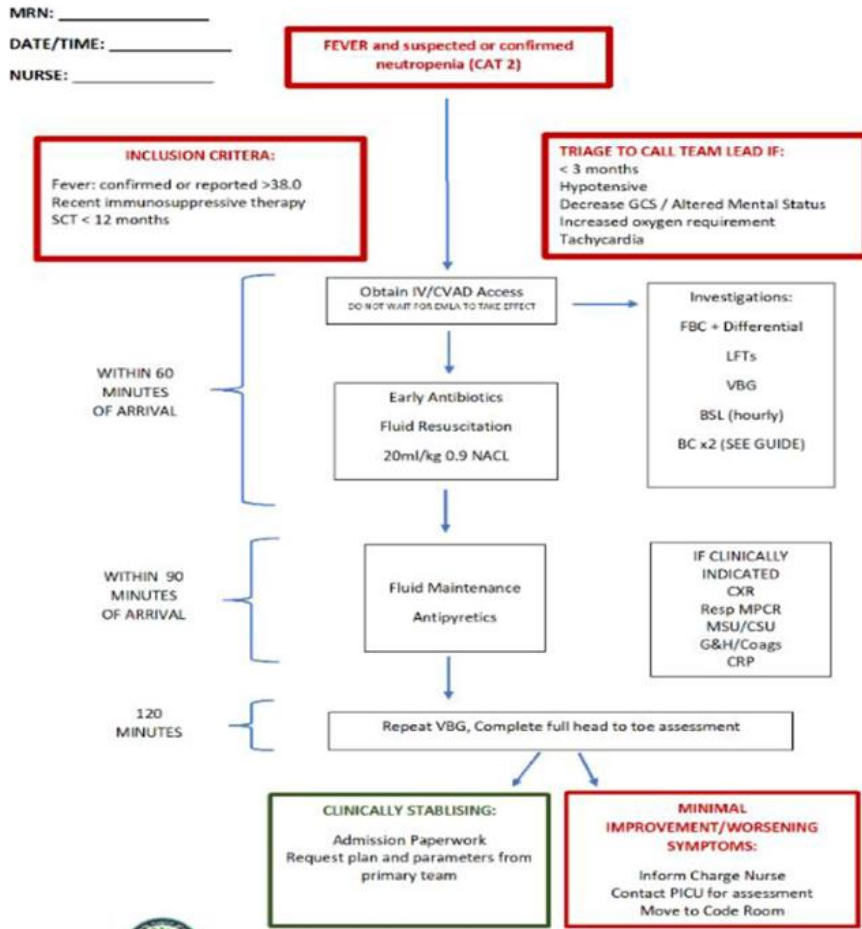
the department may need to be adjusted. In December 2019 the proposed pathway was sent to the chief medical officer and charge nurse manager for review, feedback, and subsequently approved for use.

Phase Five: Implementation and Evaluation

The first step in the implementation phase was the pilot period. This was completed during the month of December 2019. During this period nursing staff were provided with in-service trainings multiple times a week, and online educational resources. Nurses were given copies of the initial pathway as an educational tool to prepare them for the formal rollout. Medical staff was provided with training led by the paediatric physician.

By the end of December 2019 all PED nurses had completed sufficient in-service trainings with the clinical educators, and time to familiarise themselves with the proposed clinical care pathway. In addition, staff received training related to CVAD, which all staff completed by the end of January 2020. During the pilot period, clinical educators, and the project manager (MP) provided support to nursing staff by overseeing patients that fitted the pathway criteria, and shadowing nurses to ensure they felt safe and could ask any questions during practice. As time went on staff became more confident clinical educators were required less, however they remained available to answer and provide support where needed.

The project team met monthly for the first four months to discuss necessary changes or modifications. The clinical pathway went through four iterations throughout this time, with the final iteration of the pathway completed March 2020 (Figure 2). Minor changes were made from feedback from nurses and physicians in discussion with key stakeholders, and current evidence base practice resources.



NURSING NOTES:

DO NOT WAIT FOR LOCAL ANESTHETIC PRIOR TO IV ACCESS

DO NOT WAIT FOR BLOOD RESULTS PRIOR TO STARTING ANTIBIOTICS

Blood Cultures: Two samples, peripherally. If Dual lumen CVAD or Port accessed a sample should be taken from each lumen, and one peripheral sample.

CXR and MSU are if clinically indicated. If respiratory symptoms are present, encourage the ordering of a CXR. If urinary symptoms are present use appropriate resources to obtain clean catch urine sample. Do not wait for these investigations to be obtained to administer antibiotics.

Verbal orders for IVF and antipyretics are acceptable and should be documented within an appropriate time frame.

Fluid resuscitation: 20ml/kg 0.9% NACL BOLUS, the doctor may request a second bolus. This is acceptable, use nursing knowledge and patient condition to support your judgement.

Acetaminophen: 15mg/kg q4hrly

ALL MEDICATIONS TO BE DOUBLE CHECKED BY A SECOND NURSE

Report any unexpected lab results instantly to the EMS Paeds consultation on duty. If severe, consider informing the Charge Nurse and moving to the Code Room for further support.

Due to the nature of the patients, variability of conditions, severity and health history doctors will follow their own algorithm for antibiotic prescription. The first dose should be administered within an hour. This dose should be made by the nurses in the department. Do not wait for pharmacy to deliver. If concerns about delay in antibiotic administration inform Paeds TL.



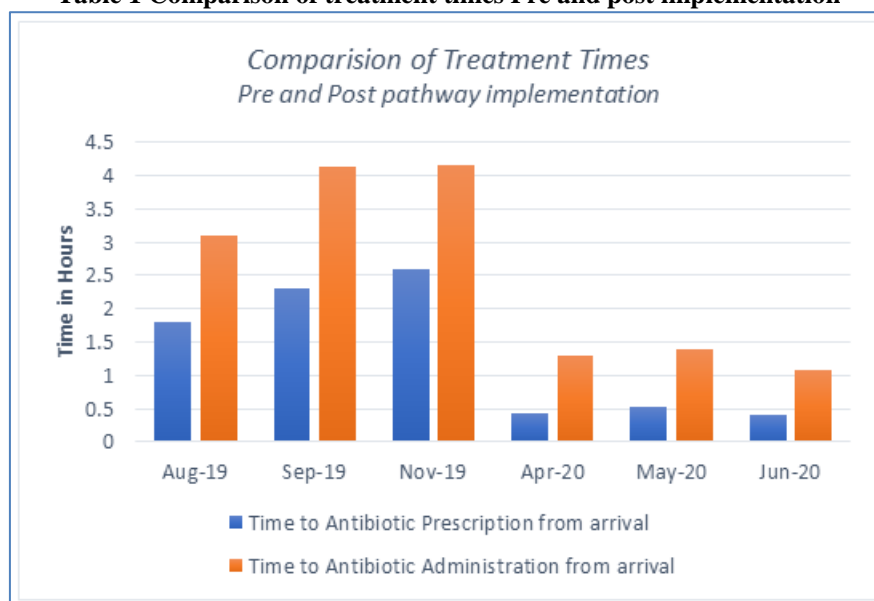
Fig-2: Final iteration of FN Clinical Care pathway here

During these meetings the nursing ‘champions’ role was introduced. ‘Nurse Champions’ are a concept used in healthcare to describe nurses who have a particular passion, interest or skill and take on responsibility for providing teaching and support to a change in practice. In this project, several nurses showed vested interest in learning more and became nurse champions for the clinical care pathway. As the project manager and clinical educators began to step back from constant practice observation the nurse champions took on more leadership roles including identifying strategies to improve patient flow based on the specific needs of KFSH&RC. One of the examples

of this was the suggestion of allocating two specific rooms for febrile neutropenic patients, equipped with the resources required. These suggestions enabled nursing staff and the stakeholder team to work collaboratively on this project and created a sense of ownership over the practice change for all those involved.

To determine the success of the pathway, a clinical audit following the same process as the initial audit was conducted 4 months post implementation (April -June 2020) (See Table 1).

Table 1 Comparison of treatment times Pre and post implementation



In this time there were a total of 104 patients managed on the pathway. The average time to antibiotic administration was 78 minutes in April, and 65 minutes in June. The average time to antibiotic administration reduced from 3 hours and 48 minutes, to 1 hour and 15 minutes. This clinical audit demonstrated that the project goal of reducing time to administration of antibiotic for FN patients had been achieved. Although still not meeting the recommended international guideline time of 60 minutes the results of this audit showed a trend of decreasing average time to administration with each passing month suggesting a promising continued improvement over time.

Phase Six: Integrate and Maintain

Due to the onset of the COVID 19 Pandemic the first author and project leader (MP) was required to leave Saudi Arabia and therefore the the sixth and final phase of Larrabee’s model cannot be fully reported in this paper. However, in communication with the remaining project team, anecdotal reports from the staff nurses and paediatric medical team shows continued support of the clinical pathway. Although no formal clinical audit has been conducted, the clinical care pathway has become the leading protocol within PED at

KFSH&RC with nurses now reportedly working more autonomously in the treatment of FN. The original paper-based pathway has now been moved to an online platform and is automatically attached to the patients record following triage. The future use and development of the pathway is now lead by the paediatric clinical educator who has taken over responsibility for the continuing updates in relation to evidence-based practice for FN and the development of paediatric services at KFSH&RC.

DISCUSSION

Febrile neutropenia is a relatively common but potentially fatal side effect of chemotherapy treatment for paediatric patients. The literature describes how antibiotic administration within <60 minutes of arrival is a quality-of-care measure for paediatric oncology patients with FN in the ED (Koenig *et al.*, 2020). For this this project there was strong support to implement a clinical care pathway and the evidence reviewed supported this as proven means to improve time to antibiotic administration (Bekmezian, 2015; Browne *et al.*, 2002; Haeusler *et al.*, 2018; Murray *et al.*, 2017; Williams *et al.*, 2014). Although a paucity of paediatric

specific FN studies and guidelines exist, the established hospital guidelines utilised for this project followed current best practice and provided useful templates from which to develop a clinical care pathway. The outcomes of more streamlined care and reduced treatment times at KFSH&RC echoed the results from others who had successfully implemented similar clinical care pathways (Bekmezian, 2015; Children's Hospital of Philadelphia, 2017; Weiss *et al.*, 2014).

Implementing a nurse-led clinical care pathway provided opportunities for the nurses to expand their knowledge and self-competence about treating and caring for FN patient. Improving skills regarding CVAD, was a pivotal and important aspect which influenced the success of the project due to the ability of CVAD to provide rapid venous access for antibiotics, blood samples and fluid resuscitation (VanHouwelingen *et al.*, 2018).

There were several strengths and limitations encountered while undertaking this project. Having the support of the medical team, led by a paediatrician who advocated to managers and other clinicians the importance of this project was essential to the success. The arrival of Covid 19 provided additional challenges as the final phases of the project were conducted virtually and through email communication with the project champions which added to the challenge of successful implementation.

The decision to utilise Larrabee's (2009) model for evidence-based practice change improved the flow and outcome of this project. Others have similarly found that through following the steps of this evidence-based model of change, successful implementation of practice change, and sustainment of the change is possible (Houser, DeButy, & Beal, 2019; Maramba, Richards, Myers, & Larrabee, 2004; Mohide & King, 2003; Skinner, 2015). Larrabee's model was systematic and detailed and provided a clear plan to ensure all aspects of changing practice were considered, and that the project was feasible and well supported by literature. This model holds potential for the development of other clinical care pathways to be implemented at KFSH&RC having proved its usage with the successful implementation of this project. Through following each phase of the framework, nurses can be empowered to question the quality of care, research evidenced-base practice, and create implementation plans to improve the standard of care being delivered.

CONCLUSION

This practice project involved the implementation of a clinical care pathway for King Faisal Hospital in Riyadh and was the first of its kind for Saudi Arabia. This project set out to improve the time to antibiotic in paediatric febrile neutropenic patients and through implementation of a clinical care

pathway successfully reduced time to antibiotic by two thirds (from 3 hours and 48 minutes, to 1 hour and 15 minutes). A positive side effect of this quality project in addition to improving time to antibiotics was increasing nurses' confidence with managing febrile neutropenia and developing the skills and knowledge related to the accessing and delivering medication via central access devices. Additionally, the introduction to clinical care pathways in Saudi Arabian healthcare may prompt further projects and create opportunities for nurses to broaden their knowledge through similar evidence-based health initiatives. Our experience using Larrabee's model indicated that it is a useful and pragmatic framework for nurses to implement an evidence-based change to practice.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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