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# Nurse-led study on treatment delay and streamlining antibiotic therapy among haematology patients with febrile neutropenia post chemotherapy

## AUTHORS

DELILAH M SHELLEY RN, MN<sup>1,2,7</sup>ADWIN THOMAS<sup>3</sup>KAREN STRICKLAND RN, PhD<sup>4,5,6,7,8,9</sup>

1. Research Health Graduate, University of Canberra, Canberra, Australia
2. The Cancer Ambulatory Services, Canberra Health Services, ACT Health, Canberra, Australia
3. ACT Health Summer Scholarship Program, Canberra, Australia
4. School of Nursing and Midwifery, Edith Cowan University, Western Australia
5. School of Nursing, Midwifery & Public Health, University of Canberra, Canberra, Australia
6. Faculty of Health, PACES Research Group, University of Canberra, Canberra, Australia
7. SYNERGY Nursing & Midwifery Research Centre, ACT Health Directorate, Canberra, Australia
8. School of Nursing, Midwifery and Paramedic Practice, Robert Gordon University, Aberdeen, Scotland, UK
9. School of Clinical Sciences, Auckland University of Technology, Auckland, New Zealand

## CORRESPONDING AUTHOR

DELILAH M SHELLEY, Cancer Ambulatory Services, Canberra Health Services, ACT Health, Yamba Drive, Garran 2605 ACT Australia. Email: [delilah.shelley@act.gov.au](mailto:delilah.shelley@act.gov.au)

## ABSTRACT

**Objective:** The aim of the study is to identify gaps that exist among health professionals that may impact practices in caring effectively for patients with febrile neutropenia (FN).

**Background:** Haematology patients with FN following chemotherapy frequently experience delays in antibiotic administration that may be linked to poorer clinical outcomes. To aid timely review and treatment, FN care pathways have been developed. However, observations of clinical practice and patient anecdotal reports have highlighted that the care pathways may not be adhered to. The impact on patient care outcomes due to treatment delays and the rate of protocol adherence to the FN management pathway is unknown due to insufficient evidence.

**Methods:** Using the Clinical Records Integrated System (CRIS), data were collected by auditing patients' electronic health records (EHR) from November 2017 through to November 2018. Information retrieved were screened using the inclusion and exclusion criteria.

**Inclusion criteria:** Haematology patients with FN (temperature  $\geq 38^\circ$  and neutrophil count  $< 1.0 \times 10^9/L$ ) post chemotherapy, and 18 years or older.

**Exclusion criteria:** Medical oncology patients and patients who were under 17 years old.

**Results:** The mean time for antibiotic administration from first temperature spike was  $90 \pm 15$  minutes for inpatients ( $n=48$ ). The mean time for antibiotic administration from medical officer review was

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significantly lower at  $48 \pm 5$  minutes for outpatients ( $n=31$ ). Inpatients who were given antibiotics within 60 minutes or less of their first temperature spike, their mean length of total stay in the ward was  $17 \pm 1$  whilst inpatients who were given antibiotics 60 minutes after their first temperature spike, the mean length of their hospital stay was slightly greater at  $21 \pm 3$  days. Outpatients who were given antibiotics within 60 minutes or less of their first temperature spike, their mean length of stay was  $12 \pm 2$  days. For outpatients given antibiotics 60 minutes after their first temperature spike, their mean length of hospital stay was slightly shorter at  $9 \pm 3$  days.

**Conclusion:** The study identified antibiotic delays among inpatient population, and with correlation to increased length of hospital stay and mortality. Another key factor identified in the study was delayed medical officer review although reasons for delays are outside the scope of this study to report.

**What is already known:**

- Febrile neutropenia is a serious and life-threatening illness.
- Delays in antibiotic administration exists among healthcare facilities.
- Adherence to FN treatment guidelines among healthcare settings are challenging.

**What this review adds:**

- Standardised orders to allow timely administration of antibiotic therapy that may reduce morbidity and mortality.
- Increased education on the seriousness and outcome from delayed antibiotics to patients, families, and healthcare staff.
- Further studies are required to standardise the clinical pathway and make antibiotics accessible for prompt delivery.

**Keywords:** chemotherapy, cancer, febrile neutropenia, haematology malignancies, myelosuppression, neutropenia.

## INTRODUCTION

Febrile Neutropenia (FN) following chemotherapy is a life-threatening condition which may result in significant morbidity or death.<sup>1</sup> FN occurs in an estimated 10–50% of patients with solid tumours or lymphomas and in more than 80% of patients with haematological cancers.<sup>2</sup> Mortality rates from FN are reported at 10–20% with gram negative bacteraemia identified in this cohort of patients.<sup>3</sup> According to the FN management pathway via the ACT Heath Policy Register,<sup>4</sup> FN is defined as a rise in temperature of  $38^\circ\text{C}$  or greater and an absolute neutrophil count of  $1.0 \times 10^9/\text{L}$  or less than  $0.5 \times 10^9/\text{L}$ . Further, FN is an oncological emergency requiring urgent medical attention. The definition of FN varies across institutions and states.<sup>5</sup> An alternative definition regards FN as a temperature of  $38.3^\circ\text{C}$  and/or a neutrophil count of  $<1.5 \times 10^9/\text{L}$ .<sup>6</sup> For the purpose of this study, the definition from the FN management pathway will be used.<sup>4</sup>

Presenting with a fever and low neutrophil count (neutropenia) is an early warning sign of severe sepsis. It is also important to note that neutropenia can also be present in the absence of pyrexia. Hypothermia and hypotension in combination with neutropenia can lead to severe sepsis.<sup>5</sup> Medical and nursing staff need to be aware of all signs indicating sepsis, and act promptly.<sup>7</sup> The FN pathway advises urgent review by a senior medical officer (Registrar).<sup>4</sup> The pathway calls for blood cultures (i.e., peripherally and via central venous catheters) and administration of broad-spectrum antibiotic B-lactam such

as Piperacillin Tazobactam.<sup>8</sup> Further examinations and tests are required as part of the treatment pathway. Any delay in the commencement of antibiotic may lead to life-threatening complications causing increased morbidity and mortality.<sup>9</sup>

The incidence and mortality rates of FN vary and are dependent on the type of malignancy and the chemotherapy treatment regimen being used.<sup>10</sup> For example, Acute Myeloid Leukaemia (AML) contain long intensive and high doses of chemotherapy which lead to severe neutropenia. Shorter and less aggressive treatment regimen used on other malignancies such as ovarian, prostate or lung can anticipate a less impact on the bone marrow function.<sup>9</sup> Nonetheless, FN is a serious complication and often proves challenging to diagnose and treat effectively. Further studies surrounding FN report the significant impact of this condition leads to high costs of care due to the requirement of intensive care thus leading to long hospital stays. Furthermore, the increased need for physical and mental rehabilitation and the impact of family and quality of life has also been highlighted.<sup>2</sup> All these occur within the background of workforce shortage issues, budgetary constraints and expertise and skills imbalances within inpatient settings.<sup>8</sup>

## AIM

The aim of the study is to identify the gaps that exist among health professionals that may impact practices in caring effectively for patients with febrile neutropenia (FN). Knowledge gaps will be assessed by evaluating the current management of FN among haematology patients following

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chemotherapy. This will provide information about staff behaviours, and potential gaps in knowledge and practice.

### The following questions will be addressed:

- What is known about the time required to administer antibiotics to patients presenting with fever in the background of neutropenia?
- What is the rate of FN protocol adherence in the treatment of patients with FN?
- Is there an impact on patient outcomes where there are delays between temperature spike and the time of antibiotic administration?

## STUDY DESIGN

### DESIGN

Retrospective patients EHR Audit Between November 2017 to November 2018. Ethics approval for the study was obtained from the ACT Health Human Research Ethics Committee with study number 2018/ETH00606. Patient information were stored and secured in designated laptop with patient details de-identified to maintain patient confidentiality and privacy and in line with ACT Health ethics requirements.

### INCLUSION AND EXCLUSION CRITERIA

Outpatients (emergency department and Rapid Assessment Unit (RAU)) and inpatient haematology patients with FN (temperature greater than 38 and neutrophil count less than  $1.0 \times 10^9/L$ ) post chemotherapy and are 18 years or older. Inpatients are patients on the ward admitted for chemotherapy, while outpatients are patients who were sent home following chemotherapy and continuing to receive care through the community and outpatient cancer services. Oncology patients and patients who were 17 years old or under were excluded from the study. Neutrophil count  $>1.0 \times 10^9$  was also an exclusion criterion for outpatient however, this was added during the EHR auditing.

### METHOD

Patient files were accessed through the Clinical Record Integration System (CRIS) records. Data collection focused on type of admission (inpatient or outpatient), demographics including age, gender, admission, and discharge dates, hematological malignancy, type of chemotherapy, as well as outcomes such as time of temperature spike if inpatient, or time of first medical officer review if outpatient, time of antibiotic administration, neutrophil count, temperature reading, blood culture result and discharge location. Since outpatients were admitted with elevated temperature from home, time difference from initial spike to antibiotic administration could not be measured. Time of first medical officer review was chosen as a comparable measure to first temperature spike with inpatients as both processes represent the first stage of the FN management found in the

ACT Health Policy Register (2018).

After compiling the data from patients who had a visit from November 2017 to November 2018, inpatients with incomplete medication chart, or spiked at home were excluded ( $n=38$ ). Similarly, outpatients who had incomplete medication chart, no time stamp for first medical officer review, had a temperature reading of under 38 degrees were excluded ( $n=42$ ).

A total of 167 patient records were left for further screening. After exclusion, inpatient ( $n=48$ ) and outpatient ( $n=31$ ) data were separated, mean, median and the range interquartile (75<sup>th</sup> percentile minus 25<sup>th</sup> percentile) for time to antibiotic administration was calculated, as well as the overall protocol adherence rate was calculated. Protocol adherence was defined as measuring all the following data points: temperature, carrying out blood culture, urine collection and chest x-ray. If all these procedures were documented, a “yes” score was assigned and if any one of these procedures were not documented, a “no” score was assigned. Percentage of “yes” protocol adherence was determined.

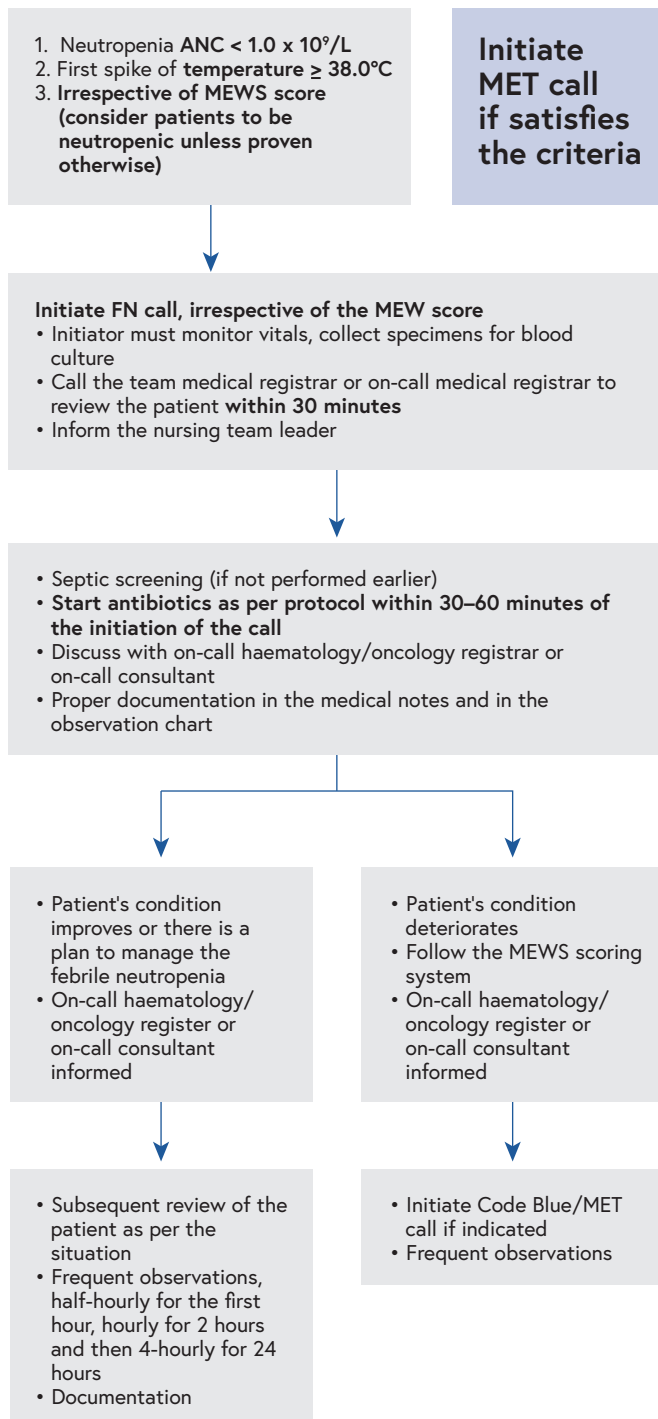
To determine consequences of delayed antibiotic administration, both inpatients and outpatient data was sorted into two further groups, one with antibiotic administration less than 60 minutes from initial temperature spike (under 60min) and the other group with antibiotic administration given greater than 60 minutes from initial temperature spike (over 60min). Outcomes such as length of stay (discharge date minus admission date), ICU admission (yes or no), positive blood culture result, and mortality rate (number of patients died under febrile neutropenia management over patients that returned home) was determined.

The inclusion criteria and protocol adherence were all based upon the Flow Chart for Haematology Oncology Patients (Figure 1). All statistical analysis was performed using Graphpad-PRISM 8. Unless otherwise indicated, data are presented as means with error bars representing standard error of mean (SEM).

### PARTICIPANT DEMOGRAPHICS

The mean age for patients in this study was 61 years (26 to 85 years) with 59% males and 41% females. This demographic profile is consistent with the demographics in other FN studies.<sup>11-13</sup> The top three haematological malignancies the patients had were Acute Myeloid Leukemia (AML), Multiple Myeloma (MM) and Mantle Cell Lymphoma, with 61% of the patients being inpatients. Patient demographics are detailed in Table 1.

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**FIGURE 1: FLOW CHART FOR THE MANAGEMENT OF FEBRILE NEUTROPENIA**

Retrieved via ACT Health. (2022). Canberra Hospital and Health Services Clinical Guideline: Febrile Neutropenia Management.

**TABLE 1: PATIENT DEMOGRAPHICS**

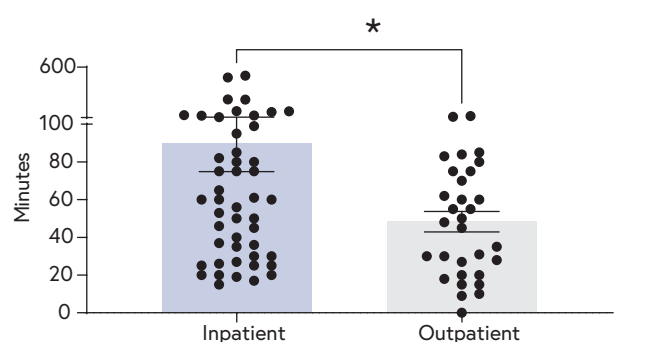
| Patient Demographics (n=79)   |             |        |
|-------------------------------|-------------|--------|
| Age range                     | 26-85 years |        |
| Mean Age                      | 61 years    |        |
| Gender                        |             |        |
| Male                          | 59%         | (n=47) |
| Female                        | 41%         | (n=32) |
| Admission                     |             |        |
| Inpatient                     | 61%         | (n=48) |
| Outpatient                    | 39%         | (n=31) |
| Haematological malignancy     |             |        |
| Acute Myeloid Leukaemia       | 29%         | (n=23) |
| Multiple Myeloma              | 21.5%       | (n=17) |
| Mantle Cell Lymphoma          | 11%         | (n=9)  |
| Non-Hodgkin's Lymphoma        | 5%          | (n=4)  |
| Acute Lymphocytic Leukaemia   | 4%          | (n=3)  |
| Chronic Lymphocytic Leukaemia | 4%          | (n=3)  |
| Follicular Lymphoma           | 4%          | (n=3)  |
| Other                         | 21.5%       | (n=17) |

## RESULTS

Following the diagnosis of FN, a broad-spectrum antibiotic should be administered within 30-60 minutes (Figure 1). What this also means is that broad-spectrum antibiotics must be administered within 30-60mins following fever detection. To determine the current performance of nursing and medical staff at Canberra Health Services (CHS) in following the FN pathway, we measured time taken for patient to develop fever and the time taken for antibiotic administration. The mean time for antibiotic administration from first temperature spike was recorded at 90±15minutes for inpatients (n=48) (Figure 2). The mean time for antibiotic administration from medical officer review time was significantly lower at 48±5minutes for outpatients (n=31). Time taken for antibiotic administration from first temperature spike was significantly greater in inpatients compared to outpatients, ( $p<0.05$ ) (Figure 2). For outpatients, the time for antibiotic administration ranged from 0 and 115 minutes respectively, with a median time of 48 minutes.

The mean time for antibiotic administration from first temperature spike was recorded at 90±15minutes for inpatients (n=48). The mean time for antibiotic administration from medical officer review time was significantly lower at 48±5minutes for outpatients (n=31). Time taken for antibiotic administration from first temperature spike was significantly greater in inpatients compared to outpatients, *Unpaired Student's T test*,  $p<0.05$ .

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**FIGURE 2: TIME OF TEMPERATURE SPIKE TO TIME OF ANTIBIOTIC ADMINISTRATION**

### IMPACT OF DELAYED ANTIBIOTIC THERAPY

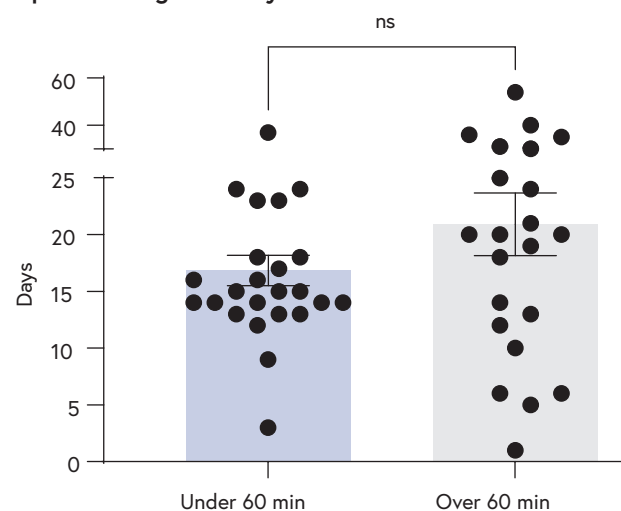
To determine whether delayed antibiotic administration resulted in increased length of hospital stay, a comparison was made between patients with antibiotic therapy over 60 minutes and patients with antibiotic therapy under 60 minutes (figures 3A and 3B). For inpatients given antibiotics under 60 minutes, the mean length of hospital stay was  $17 \pm 1$  days ( $n=25$ ) whereas inpatients given antibiotics over 60 minutes, the mean length of hospital stay was slightly greater at  $21 \pm 3$  days ( $n=22$ ). For inpatients, 23 ( $n=48$ ) patients were outside the 60 minute window and 10 ( $n=31$ ) patients from outpatients were outside the 60 minute window.

For outpatients who received antibiotics under 60 minutes, the mean length of hospital stay was  $12 \pm 2$  days ( $n=21$ ) while the mean length of hospital stay was slightly short at  $9 \pm 3$  days for patients who received antibiotics over 60 minutes. It is not known why patients with delayed antibiotic therapy showed a shorter length of stay compared to those within the recommended 60 minutes. Whilst this finding may seem anomalous, the result was not considered statistically significant [ $p < 0.05$ ].

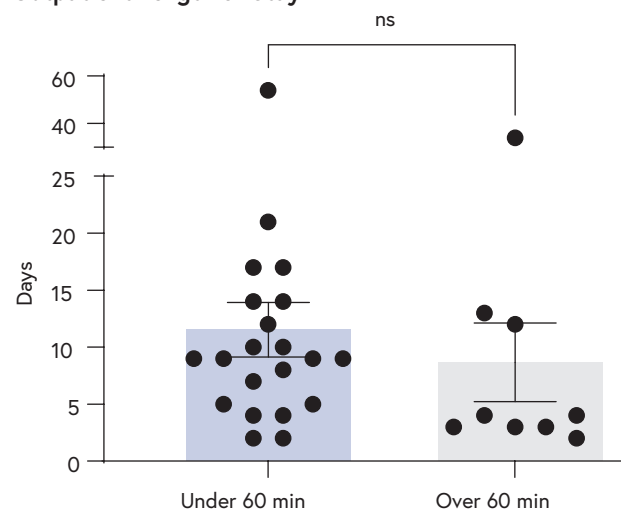
For inpatients who were given antibiotics under 60 minutes, their mean length of hospital stay was  $17 \pm 1$  days ( $n=25$ ). For inpatients who were given antibiotics over 60 minutes, their mean length of hospital stay was slightly greater at  $21 \pm 3$  days ( $n=22$ ), however not significant (ns, *Unpaired Student's T test*  $p > 0.05$ ).

To determine further complications of delayed antibiotics administration, patient outcomes such as ICU admission rate, positive blood culture rate and mortality rate were determined (Table 2). Our analysis revealed the ICU admission rate for inpatients who received antibiotics over 60 minutes compared to patients who received antibiotics under 60 minutes from FN increased from 4 to 19%. Similarly, mortality rate increased to 9% for inpatients who received antibiotics over 60 minutes from 4% for inpatients who received antibiotics in under 60 minutes. Positive blood culture rate did not increase due to delayed antibiotics administration for inpatients. No outcomes increased for outpatients due to delayed antibiotics administration.

### Inpatient Length of Stay



### Outpatient Length of Stay



**FIGURE 3: INPATIENT AND OUTPATIENT LENGTH OF HOSPITAL STAY (LOS)**

In addition, the overall FN protocol adherence rate for both inpatients and outpatients were calculated which was recorded at 94 and 91% respectively. The only exception for not getting 100% protocol adherence rate was due to delayed antibiotics and unclear patient notes which did not clearly show blood culture or post work up notes and hence could not be deemed as following protocol adherence.



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TABLE 2: PATIENT OUTCOMES

| Patient Outcomes (n=79)    |     |        |
|----------------------------|-----|--------|
| ICU Admission              |     |        |
| Inpatients (under 60min)   | 4%  | (n=3)  |
| Inpatients (over 60min)    | 19% | (n=15) |
| Outpatients (under 60min)  | 14% | (n=11) |
| Outpatients (over 60min)   | 10% | (n=8)  |
| Positive Blood Culture     |     |        |
| Inpatients (under 60min)   | 60% | (n=47) |
| Inpatients (over 60min)    | 43% | (n=34) |
| Outpatients (under 60min)  | 35% | (n=28) |
| Outpatients (over 60min)   | 20% | (n=16) |
| Mortality Rate             |     |        |
| Inpatients (under 60min)   | 4%  | (n=3)  |
| Inpatients (over 60min)    | 9%  | (n=7)  |
| Outpatient (under 60min)   | 0%  | (n=0)  |
| Outpatient (over 60min)    | 0%  | (n=0)  |
| Overall Protocol Adherence |     |        |
| Inpatient                  | 94% | (n=74) |
| Outpatient                 | 91% | (n=72) |

## DISCUSSION

## DELAYS IN ANTIBIOTIC ADMINISTRATION

This study identified delays in administration of broad-spectrum antibiotic therapy to inpatients with FN. The mean time of  $90 \pm 15$  minutes in delay were clearly outside the 30-60 minutes timeframe as stated in the CHS FN ACT Health Policy Register (2018).<sup>4</sup> Most of the delays occurred within the inpatient haematology area and is of concern, as this is an area with specialised skilled nursing and medical staff who are easily accessible during business hours. Factors causing the delays were beyond the scope of this study and thus not examined. However, lack of awareness, high patient acuity, delays in medical officer review, poor staffing and/or clinical skills among nursing and medical staff are believed to be the main contributing factors resulting in delays in this study. Similarly, a previous study also reported similar reasons for delays in broad-spectrum antibiotic administration.<sup>5</sup> Increasing awareness of the FN pathway among medical staff to ensure appropriate review and care escalation were highlighted as important aspects in improving protocol adherence in their study.<sup>5</sup> Mean time for broad-spectrum antibiotic administration from medical officer review time was significantly lower at  $48 \pm 5$  minutes for outpatients. The reason/s for a lower mean time in broad-spectrum antibiotic administration for outpatient compared to inpatient may have been due to the effective use of the triage system in ED, access to medical officer and their ability to prescribe broad-spectrum antibiotic in the outpatient clinics. Whereas

for inpatients, access to medical officer for appropriate and timely care and treatment can be challenging due to number of factors. Busy workload among nursing staff due to high patient acuity, absence of medical officers due to ward rounds and/or meetings, and inadequate skill mix, all impact on staff ability to perform physical examination, blood sampling and administration of broad-spectrum antibiotics. The increase mean time for broad-spectrum antibiotic administration, have the potential to impact on patient outcome.

## PATIENT OUTCOME

Previous studies have found a correlation between delayed antibiotics and patients being admitted to ICU.<sup>5,14</sup> Similarly, the present study found that 19% of inpatients who had antibiotics administered over the 60 minutes timescale were admitted into ICU, compared to those under 60 minutes. Similar findings were reported for patients in the outpatient areas where 10% of patients given antibiotics over 60 minutes were also admitted into ICU. It is unclear if the admissions into ICU were a direct result of delayed antibiotic administration. Patients admitted into ICU showed neutrophil levels ranging from  $0.01 - 0.08 \times 10^9/L$  and with haematological malignancies identified as Acute Myeloid Leukaemia (AML), Multiple Myeloma (MM) and Lymphoma. The chemotherapy treatment protocols linked to these patients were Melphalan (as part of the autologous stem cell transplant), GRAALL, Flag-Amsacrine, R-CHOP + BEAM, 7<sup>3</sup> Induction, HIDAC and ICE. Severe and prolonged neutropenia from these high-risk chemotherapy protocols lead to FN thus delaying or a reduction in treatment dosages.<sup>15</sup> These influence long-term survival.<sup>14</sup> Granulocyte colony-stimulating factors (G-CSF) is included in these chemotherapy protocols to support white cell recovery, particularly the neutrophils.<sup>6</sup> But G-CSF may not prevent ICU admission or mortality rate as complications from these high-risk chemotherapy protocols and other comorbidities can have a life-threatening consequence on a FN patient. Timely and evidence-based treatment approaches are crucial to ensure supportive medications such as G-CSF and appropriate antibiotics are used to reduce LOS and promote faster recovery from the neutropenic phase.<sup>6</sup>

Blood culture samples collected from both inpatients and outpatients showed a range of both gram-negative and gram-positive organisms. These were seen in patients with under and over 60 minute timeframes. The main gram-negative organisms seen in this study were: *Escherichia coli*, *klebsiella*, *pseudomonas aeruginosa*, *Enterobacter cloaca*, and *Enterococcus faecium*. Gram-negative bacteraemia is common among immunosuppressed patients and is associated with high overall morbidity and mortality.<sup>3</sup> Gram-positive organisms were *streptococci*, *staphylococcus*, *streptococcus oralis*/ *salivaries/viridans*, and *staphylococcus epidermis/ aureus*. Recent evidence reported that extended spectrum beta-lactamase (ESBL) producing *Escherichia Coli* (*E coli*) are an increasing

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issue among haematological malignancies. Other multiple drug resistant bacteria (MDR) are *enterococcus faecium*, *Staphylococcus aureus*, *klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa*. It is believed that the prevalence and pattern of resistance varies among different health institutions.<sup>3</sup> Bloodstream infections in FN patients in developed countries were understood to be caused by gram-negative organisms. This may perhaps be due to infrequent use of central lines and prophylactic antibiotics. However, last decade or more, has seen the return of gram-positive pathogens predominantly with coagulase-negative staphylococci (CoNS) remaining as the cause of bacteraemia.<sup>3</sup> Nonetheless, FN patients with a positive culture increases the risk of developing life-threatening complications and consequently death.

Patients from this current study who had antibiotics under the 60 minute timeframe had a mortality rate of 4% while patients who had antibiotics over the 60 minute period had a 9% mortality rate. This is a correlation between broad-spectrum antibiotics given over 60 minutes and mortality rate.

This finding is similar to another study who examined 307 cases of FN and found 29 deaths.<sup>16</sup> The study identified that time to antibiotic administration (TTA) was independently associated with mortality within a month period (28 days)<sup>16</sup>. Delays in antibiotic administration by an hour increased the risk of mortality within 28 days by 18%.<sup>16</sup> These findings are significant and demonstrate the importance of urgent intervention to FN patients.

### LENGTH OF HOSPITAL STAY

The study found that inpatients who received antibiotics over the 60 minutes experienced an increase in hospital length of stay (LOS), of four days compared with the group who received antibiotic therapy under 60 minutes, however the difference was not statistically significant. In current hospital settings, LOS is regarded as an important indicator in better understanding of the clinical severity experienced by patients and the number of resources needed to ensure effective care.<sup>16</sup> The issue among FN patients with increased LOS are placing themselves at an increasing risk of developing hospital acquired infections, delays in their antineoplastic treatments which in turn, have further implications for cancer treatment outcomes. Furthermore, given that diagnostic and treatment procedures in patients with FN are often associated with large financial expenditures, increased LOS negatively impacts on healthcare resource use and costs. Financial burden on the healthcare system due to increased use of medications, cost on beds and the overall cost on patients and their families is well established.<sup>5,16</sup> Evidence show that the median cost to run a specialised centre is phenomenal with the median cost of hospitalisation per episode of FN may potentially be as high as \$24,000 USD (\$33,404 AUD).<sup>16</sup> In the current

study, there were 79 FN patients and each patient required hospitalisation, with some patients getting admitted into ICU. Based on Rose and Goldani's study calculations, the average hospitalisation cost for all 79 FN patients would roughly be \$2,638,966.56 AUD. The care and treatment for patients suffering from sepsis is expensive. For a more accurate cost analysis and more up to date costing by a health economist within the Australian healthcare system would be required as costs vary from one health institution to another.

By understanding the factors that prolong LOS in patients with FN and the financial burden on the healthcare system, perhaps our ability to improve practice for better patient outcome therefore cost effective can be less challenging. We are also improving the quality of life among our most vulnerable patients.

### FN TREATMENT PROTOCOL ADHERENCE

Evidence-based guidelines such as the Sepsis Kills Program, Australian Sepsis Network, the National Comprehensive Cancer Network (NCCN), and the Infectious Diseases Society of America (IDSA) all recommend prompt intervention among FN patients.<sup>7,9,17</sup> These guidelines provide clear and detailed information to ensure timely administration of treatment. The overall protocol adherence rate for inpatient was 94% while outpatient was 91%. However, an American study found high rates of poor practice (>96% non-adherence in low-risk patients) in outpatient management consequently resulting in inappropriate hospital admissions and over-prescription of antibiotics such as Vancomycin.<sup>18</sup> Adherence rates elsewhere in Australia is not clearly known. Current management of FN requires urgent review by a senior medical officer (registrar), blood culture sampling and other routine bloods are taken immediately prior to commencing antibiotic. Other tests samples such as urine, stool, sputum and/or swabs are required but not required urgently. A chest x-ray is also required as part of the physical examination. We found that most of the FN patients from the study had all steps in the pathway followed. This resulted in high adherence rate. However, issues that came out of the study were that a junior medical officer was noted to have reviewed the FN patients and not the senior medical officer (registrar). Delays were caused because of delay from the medical officer review therefore delay in prescribing the antibiotic. Further examination of current practice within the hospital system must occur to better understand knowledge and skills gaps among nursing and medical staff specifically to those within specialty areas.

The NCCN recommend the use of the Multinational Association for Supportive Care in Cancer (MASCC) Risk Index. However, it is unclear if the MASCC risk index is utilised appropriately during discharge planning following chemotherapy. Clinical settings such as a haematology wards dealing with patients following chemotherapy and stem cell transplants demand the use of MASCC risk index

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for thorough risk assessment and appropriate prescribing of antibiotics. Further, safe discharge planning means that patients have preventive measures in place to avoid unwanted complications, thus returning to the hospital.<sup>19</sup>

### STUDY LIMITATIONS

A change in the hospital documentation system during this study changed how information was stored and recorded. There was a change from paper charts to computer-based where all patient information was recorded on the computer. The study was further complicated with various electronic systems being used throughout the hospital. Areas within the hospital such as ICU and ED had their own systems for recording and storing patient clinical data. This made it challenging to retrieve information as accessing these different systems required individualised passwords to be set-up in addition to learning how to use the different systems. As highlighted in the exclusion criterion (Table 3), unclear medication information including time for temperature spike was a major problem across both inpatient and outpatient groups.

Future studies will be greatly improved with a universal patient record management system which requires nursing staff and/or medical officers to record time of temperature spike, time for antibiotic administration, type of antibiotic given. The NCCN recommend the use of the Multinational Association for Supportive Care in Cancer (MASCC) Risk Index. However, it is unclear if MASCC is utilised appropriately during discharge planning following chemotherapy. Research into the utilisation of MASCC and review of current FN pathway are needed to ensure evidence-based information. Structured and consistent education sessions is vital among nursing, medical staff, and the after-hours medical team to increase awareness.

### CONCLUSION

The study identified antibiotic delays among inpatient population, and with correlation to increased length of hospital stay and mortality. Another key factor identified in the study was delayed medical officer review although reasons for delays are outside the scope of this study to report. There is a significant need for change of practice and in the way we manage patients experiencing FN within the hospital and cancer outpatient centres. Strategies to enhance staff response and care to patients with FN for a positive healthcare outcome is warranted. Increased education concerning the seriousness and outcome from delayed antibiotics need to be delivered to patients, families, and staff. Further research into the barriers impacting on the effective delivery of care to FN throughout the organisation needs to be examined. FN is a life-threatening condition and prompt response can save lives. This study has presented true, reliable, and genuine evidence from a small sample size,

and from a single tertiary health organisation. The evidence gathered from this study needs to contribute to change in practice not only within the organisation but also within the community.

### IMPLICATIONS FOR RESEARCH, POLICY, AND PRACTICE

#### REDUCING TIME FOR ANTIBIOTIC ADMINISTRATION FOR FN PATIENTS

Delays in antibiotic administration were identified in this study. Delay in patient review by medical officer at time of call could be understood as one of the reasons for delays in antibiotic administrations based on the recommendations stated in the FN treatment pathway. The role of nurses in the treatment delays could not be assessed as not part of the study objective. However, increasing staff awareness of FN and access to FN pathway is a starting point among medical officers and nurses to improve care. A development of a standing order for the appropriate antibiotic could reduce the waiting time and patients can be treated immediately. FN algorithms and treatment guidelines need to be made accessible to nursing staff to be aware of their role in caring for FN patients.

**Conflict of interest statement:** The authors have no financial conflicts of interest to declare. Karen Strickland declares she is a member of the editorial board of the Australian Journal of Advanced Nursing however was not involved at any stage in the handling of this manuscript.

**Ethics:** Ethics approval for the study was obtained from the ACT Health Human Research Ethics Committee [2018/ETH00606]. Approved on 30 January 2019 by the ACT Health Human Research Ethics Committee's Low Risk Sub-Committee.

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