Nursing care, education and support for patients with neutropenia


Summary
Neutropenia is reduced white blood cell count. It is a side effect of cytotoxic chemotherapy for cancer and haematological patients. This article aims to help nursing students and qualified nurses who are novices in caring for neutropenic patients to become familiar with the usual body defences against infection; understand how the body's ability to fight infection is affected by neutropenia; recognise potential sources of infection; and support the patient who is at risk of infection as a result of neutropenia.

Authors
Michael Coughlan is lecturer, School of Nursing and Midwifery Studies, Trinity College Dublin and Colette Healy is clinical facilitator, HOPE Directorate, St James’s Hospital, Dublin, Ireland. Email: michael.coughlan@tcd.ie

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MYELOSUPPRESSION, and in particular neutropenia or reduced white blood cell count, is a major dose-limiting side effect for cancer and haematological patients who are receiving cytotoxic chemotherapy (Tervit and Phillips 2006). Patients with neutropenia have a greater susceptibility to infection than healthy individuals and a reduced ability to fight it. Infection is often not easily identifiable as the reduction or absence of white cells results in a blunting or absence of an inflammatory response (Crawford et al 2004). The result can be a severe chest infection without purulent sputum, a urinary tract infection without dysuria, or painful urination. In many instances, the first and only sign of infection is a rise in temperature (Crawford et al 2004). Neutropenia-associated infections substantially increase morbidity and mortality, and are a burden on the patient and the healthcare system (Kuderer et al 2006).

Natural defences against infection
The skin is the largest body organ and acts as a barrier to infective organisms. Resident bacteria (commensals) that colonise the surface of the skin and prevent the build up of pathogenic organisms assist in this defence. However, if these commensal bacteria gain access to the body through a break in the skin, or to a sterile body cavity such as the bladder, then they can become opportunistic pathogens (Hinchliff et al 1996). Where natural portals of entry to the body exist, other local defence mechanisms restrict microbial access (Box 1).

If pathogenic organisms gain access to the tissues, the first line of defence is an inflammatory response. This involves two groups of white cells. The first group are granulocytes (leukocytes), which consist of neutrophils, basophils and eosinophils. The second group are monocytes, which mature into macrophages (histocytes) (Traynor 2006) (Table 1). The immune system works in tandem with the inflammatory response. The immune system consists of two responses: a cellular response, which involves different groups of T lymphocytes, and a humoral response involving antibodies derived from B lymphocytes (Table 1). All the cells involved in both the inflammatory and immune responses are produced by the bone marrow (Traynor 2006).
White cells and their functions

<table>
<thead>
<tr>
<th>White cells</th>
<th>Functions</th>
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<tbody>
<tr>
<td>Neutrophils</td>
<td>Neutrophils constitute 60% of the total white cell count. They are phagocytes and the granules in their cytoplasm contain lytic enzymes. They are the first white cells to respond to invading organisms. They also induce the inflammatory response.</td>
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<tr>
<td>Basophils</td>
<td>These granulocytes contain histamine and can induce allergic and anaphylactic reactions in response to foreign organisms and proteins.</td>
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<tr>
<td>Eosinophils</td>
<td>These granulocytes are less active than neutrophils, but contain similar enzymes in their cytoplasm. They also assist in protecting against parasites and in controlling the inflammatory response.</td>
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<tr>
<td>Monocytes</td>
<td>These agranulocytes (without granules) share a common stem cell to the neutrophil. They are phagocytic, but respond much more slowly to infections than neutrophils. They are also natural sources of colony-stimulating factors, which promote growth of neutrophils and other monocytes.</td>
</tr>
<tr>
<td>T lymphocytes (T cells)</td>
<td>A number of different T cells are involved in an immune response known as cell-mediated immunity. These include: cytotoxic T cells that destroy foreign material; memory T cells that can recognise foreign organisms encountered previously and destroy them; helper T cells which support the immune response; and suppressor T cells that control and switch off the immune response.</td>
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| B lymphocytes (B cells) | B lymphocytes are involved with humoral immunity, which involves the production of antibodies (immunoglobulins (Ig)). These immunoglobulins are: IgG, IgM, IgA, IgE, and IgD.

Under normal conditions the body’s natural defences offer reasonable protection from everyday infective organisms. However, in patients who are myelosuppressed, some or all of these natural defences may be compromised, leaving these individuals highly susceptible to infection. For patients with neutropenia, infection is a major cause of morbidity and can lead to unplanned hospital admissions and disruptions to treatment schedules and regimens (Crawford et al 2004, Kuderer et al 2006). It is also a leading cause of death (Kuderer et al 2006).

In patients with cancers and haematological malignancies the risk of myelosuppression (and subsequent neutropenia) is increased because of damage to the bone marrow which can result in infection control.
from the disease or treatment (Hart 2005). Depending on the type of malignancy and the stage of treatment, myelosupression may be a side effect of cytotoxic medication, or a planned part of a myeloablative conditioning regimen that aims to prepare patients for bone marrow or stem cell transplant (Tervit and Phillips 2006). The result, from a white cell perspective, is a diminishing or absence of the normal signs and symptoms associated with the inflammatory response and infection. The first and only sign of infection may be a sudden onset of fever (Crawford et al 2004). The immune response is affected by the decrease in the number of T and B lymphocytes. This further increases the risk of infection (Linc et al 2001), and leaves patients susceptible to infections to which they had previously developed resistance.

Management and nursing care

The aim when caring for patients who are neutropenic is to reduce the risk of exposure to pathogens by identifying and eliminating potential sources of infection. In addition it is vital to observe for and recognise the signs and symptoms that may indicate the onset of an infection, and initiate the appropriate treatment. Careful ongoing assessment is essential if these aims are to be achieved. Educating patients and their families about the risks associated with neutropenia and the possible sources of infection can also reduce the likelihood of some of these potential threats becoming actual problems.

White cell counts offer an insight into the level of neutropenia and the potential risk of infection patients may incur. It is therefore essential that nurses caring for neutropenic patients can interpret these blood tests. White cell counts are checked daily and an emphasis is placed on the absolute neutrophil count (Marrs 2006), which identifies the total number of neutrophils in circulation and the degree of risk this poses (Table 2).

Sepsis can develop rapidly in neutropenic patients. It is therefore essential that clinical observations, with a special emphasis on temperature, are recorded at least every four hours and more frequently as necessary. It is vital that patients understand the importance of reporting symptoms such as chills or rigors immediately (Marrs 2006) so that appropriate interventions can be taken. A temperature greater than 38.3°C, or one of 38°C for an hour or more, requires intervention (Marrs 2006). It is important to consider all fevers as an indication of infection until tests show otherwise (Linc et al 2001). A single peripheral blood sample, as well as samples from all lumen of venous access devices, should be taken and sent for culture and sensitivity (Marrs 2006). It is recommended that appropriate prescribed broad-spectrum antibiotics are administered, rather than waiting for sensitivity results from blood tests (Hart 2006). When the sensitivity results are known, specific antibiotics can then be prescribed and administered.

Single room

The benefits of protective isolation for patients who are neutropenic are still under debate. Rooms fitted with laminar airflow or high efficiency particulate air filtration appear to reduce the risk of airborne fungal infections such as Aspergillus fumigatus (Dunleavey 2001, Hahn et al 2002). The latter is an important consideration for patients who are receiving myeloablative chemotherapy for example, or who have prolonged neutropenia. Protective isolation, however, does not shield patients from their own body flora, which are the most common source of infections for myelosuppressed patients (Hart 2005). Mank and van der Leie (2003) found no difference in outcomes when patients were nursed in protective isolation or in open single rooms. However, they state that one advantage of isolation can be that it increases staff and visitors’ awareness of the patient’s risk of infection.

For patients with short-term neutropenia there appear to be conflicting views on whether it is better that those patients with a similar condition be nursed as a cohort in a small ward, or in single rooms (Fenelon 1998, Shelton 2003). Current practice tends to favour a cohort approach with early discharge and outpatient follow up. This approach appears to help reduce the risk of iatrogenic infection and can help to minimise the psychological distress induced by protective isolation (Dunleavey 2001). Fenelon (1998) recommends the use of single rooms for the source isolation of haematological patients who have an infection, as they are likely to infect other immunocompromised patients.

Environmental hygiene

A high standard of cleanliness is essential at all times, irrespective of whether patients are being cared for in protective isolation or not (Linc et al 2001). Rooms should

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**TABLE 2**

Infection risks associated with absolute neutrophil count

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<thead>
<tr>
<th>Absolute neutrophil count</th>
<th>Increased infection risk</th>
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<tbody>
<tr>
<td>1.5–2.0 x 10⁹/l</td>
<td>None</td>
</tr>
<tr>
<td>1.0–1.5 x 10⁹/l</td>
<td>Slight</td>
</tr>
<tr>
<td>0.5–1.0 x 10⁹/l</td>
<td>Moderate</td>
</tr>
<tr>
<td>Less than 0.5 x 10⁹/l</td>
<td>Severe</td>
</tr>
</tbody>
</table>

(Adapted from the National Comprehensive Cancer Network and American Cancer Society 2006)
be free of clutter and unnecessary equipment to allow for more thorough cleaning. Neutropenic patients should avoid exposure to flowers and potted plants which can be sources of water and soil-based opportunistic fungal and bacterial organisms (Shelton 2003).

Preventing cross-infection Good hand hygiene is the single most effective method of reducing cross-infection. All staff and visitors should wash their hands, using an antiseptic hand wash, before and after contact with the neutropenic patient (Hart 2006). Alcohol hand washes are a useful alternative when hands are physically clean and should be available at the patient’s bedside (National Patient Safety Agency 2004). The patient must also be aware of the importance of hand washing after toileting and before eating (Hart 2005, Marrs 2006). Hands that are poorly dried can become a breeding ground for bacteria so patients, staff and visitors need to be advised on the importance of good hand drying (Nirenberg et al 2006a).

All staff caring for or in contact with neutropenic patients must be free from infection. Patients and their relatives require a clear understanding of the dangers of neutropenic sepsis and the potential of cross-infection. It is recommended that family members or friends who have colds, influenza or other contagious conditions do not visit patients with neutropenia (Hart 2006). Individuals who have had recent live or attenuated vaccinations are also advised to avoid contact for at least 48 hours post-vaccination (Fishman and Mrozek-Orlowski 1999). Relatives should be asked to contact a member of the nursing staff if there is any doubt about their fitness to visit.

Protecting the skin The skin is a natural barrier against infection. It is therefore essential to assess pressure sites and the general condition of the skin at least once during each standard shift (Linc et al 2001) and at least twice a day. Education can help patients to avoid activities that are likely to cause skin damage. Bladed razors can nick the skin, therefore the use of an electric razor is recommended (National Comprehensive Cancer Network (NCCN) and American Cancer Society 2006). Keeping nails short and clean is also important (Hart 2006).

It is recommended that invasive procedures, such as the insertion of central catheters, be avoided if possible when the patient is neutropenic and especially at the neutropenic nadir, when the white cell count is at its lowest, which is usually 10-14 days post-treatment (Shelton 2003). If an invasive procedure has to be undertaken then strict aseptic techniques must be used to prevent pathogens gaining access to the tissues (Linc et al 2001). It is important that access sites for intravenous (IV) and central catheters are checked regularly for signs of inflammation and infection. Evidence suggests that IV administration sets and cannulae should be changed every 72 hours (Centers for Disease Control and Prevention 2002). Blood needs to be regularly cultured from central catheters, and if a central catheter is removed due to infection or suspected infection, best practice suggests that the catheter tips should be cultured for bacterial growth (Held-Warmkessel 1998). When administering blood or blood products, it is recommended that giving sets are changed at least every six hours (National Blood Users Group 2004).

A large proportion of infections that occur in patients who are neutropenic are due to resident bacteria becoming opportunistic and invading the tissues (Nirenberg et al 2006a). Daily showers or baths can help to reduce the number of bacteria on patients’ skin and so help reduce the risk of infection (Hart 2006).

Oral care The oral cavity is a common site for infections in patients with neutropenia. Poor dental health, such as decaying teeth and inflamed gums, can result in life-threatening sepsis. Antibiotic therapy can reduce or destroy the normal oral commensals, exposing the patient to the risk of infection (Dickinson and Porter 2006). Cytotoxic drugs can cause xerostomia (dry mouth), which can interfere with usual defences against infection due to reduced or absence of saliva.

Pre-treatment, if time permits, it is advisable that patients have an oral assessment performed by a dentist and if necessary remedial care given before commencement of chemotherapy (Soady 2005). Cawley and Benson (2005) recommend that nurses undertake an oral assessment before the patient starts chemotherapy which will then be used as a baseline. They suggest that following the initial assessment oral assessments are then performed at least twice daily, and patients encouraged, as far as possible, to be active participants in their own assessment and care (Cawley and Benson 2005). Numerous oral assessment tools are available, however no one tool is universally accepted (Cawley and Benson 2005). Dickinson and Porter (2006) state that Eilers et al’s (1988) oral assessment guide has been shown to be useful in practice and appears to have good reliability (Andersson et al 1999).

Patients should understand the importance of brushing their teeth after eating and before going to bed to remove food debris (Dickinson and...
Porter 2006). A soft toothbrush reduces the risk of damage to the oral mucosa and is recommended (Fishman and Mrozek-Orlowski 1999). As long as the platelet count is not low, gentle flossing may be undertaken to remove food debris from areas inaccessible to brushing (Marrs 2006). The routine use of antimicrobial mouthwashes and antifungals is no longer recommended (Nirenberg et al 2006a); however, where patients are at risk of secondary infections their use is considered appropriate (Dickinson and Porter 2006). Where recommended, the evidence suggests that mouthwashes such as chlorhexidine gluconate 0.2% be used after brushing and held in the mouth for approximately one minute before being spat out (Soady 2004). If an antifungal agent is also to be used, Soady (2005) recommends that 30 minutes should be allowed to elapse between the use of the mouthwash and the antifungal agent as the mouthwash can neutralise the antifungal effect.

Mucositis is a common and painful side effect of cytotoxic chemotherapy that can occur anywhere along the gastrointestinal tract including the oral cavity. In the mouth it can make eating difficult and oral care distressing (Honnor and Law 2002). The resulting damage to the mucous membrane can allow microorganisms to gain access to the tissues (Cawley and Benson 2005). The effects of oral mucositis can be minimised by keeping the mouth and lips moist, maintaining a good fluid intake, and avoiding spicy foods, foods that are very hot or cold, alcohol and smoking (Cawley and Benson 2005).

Diet The debate regarding the benefits of a reduced microbial diet for neutropenic patients is ongoing. There appears to be a lack of empirical evidence to support this diet (Rust et al 2000, Shelton 2003, DeMille et al 2006). Rust et al (2000) and Shelton (2003) recommend educating patients and their families about good food hygiene, including washing raw vegetables and fruit before eating and cooking meat and eggs thoroughly. It is advisable that patients avoid drinking milk or beer that has not been pasteurised, or eating yogurts or cheeses made from unpasteurised milk (Rust et al 2000, Marrs 2006). Pre-cooked meats, pre-made sandwiches and cold cooked pies can be sources of infection if poorly stored or unhygienically handled (Rust et al 2000, Shelton 2003), and are best avoided. Visitors bringing in favourite foods to neutropenic patients in hospital should consult with nursing staff about safe foods.

Tap water usually has low microbial levels but can occasionally become contaminated by microorganisms such as coliforms or Pseudomonas aeruginosa, among others. While Shelton (2003) states that bottled water offers a safe alternative to tap water, Hart (2006) argues that controls on the bacterial content of bottled water are less stringent than that of tap water and recommends filtered tap water.

Other gastrointestinal risks The integrity of the anal mucosa can be impaired because of injury and tears resulting from constipation (NCCN and American Cancer Society 2006). Constipation can result from a number of factors such as pain medication, anti-emetics, reduced mobility or cytotoxic drugs such as the vinca alkaloids. Constipation needs to be anticipated and prevented using active measures such as prophylactic stool softeners. Hart (2006) advocates against invasive remedies, such as suppositories or enemas, which can damage the rectal mucosa.

The disease process, cytotoxic medications and superimposed infection resulting from alterations in bowel flora due to antibiotics can all cause diarrhoea (Mehmet 2006). Patients require advice about observing the consistency of their bowel motions and reporting any abnormalities or changes. Stool cultures will be required to exclude infection before the administration of anti-diarrhoeal medication (Held-Warmkessel 1998). Gentle washing of the perineum after bowel motions, cleaning from front to back, and the use of barrier creams can help to reduce the risk of excoriation and genitourinary infection (Held-Warmkessel 1998).

Genitourinary risks Protection of the genitourinary tract from ascending infection and trauma is important in preventing infection. Evidence suggests avoiding invasive procedures, such as urinary catheterisation where possible, especially during the neutropenic nadir. Tampons can cause trauma and are also best avoided (NCCN and American Cancer Society 2006). Sexual intercourse can also cause trauma to the mucous membranes so water-soluble lubricants are recommended (NCCN and American Cancer Society 2006).

Medical prophylaxis The risk of infection and the duration of the neutropenic nadir can be reduced by the use of prophylactic medications (Shelton 2003). However, the routine use of prophylactic antibiotics is no longer recommended. Aspergillus fumigatus and Candida albicans are the two most common fungal pathogens and both can present as systemic infections (Johnson et al 2000). They occur commonly in patients with severe, or prolonged, neutropenia (Nirenberg et al 2006a) (Table 3).
Advice to neutropenic patients on discharge

Depending on treatment regimens, patients receiving cytotoxic chemotherapy may still have low white cell counts or may only become neutropenic after discharge. The advice that patients and their families receive should emphasise that patients with neutropenia are still at risk of infections at home.

It should also reinforce the information that patients received in hospital, for example in relation to hand washing, personal hygiene and diet, and highlight that these measures are still pertinent post-discharge. Other advice is included in Box 2.

### TABLE 3

**Medical prophylaxis**

<table>
<thead>
<tr>
<th>Category</th>
<th>Recommendation</th>
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<tbody>
<tr>
<td>Colony-stimulating factors</td>
<td>- Colony-stimulating factors can be given to stimulate the bone marrow to produce granulocytes and macrophages.</td>
</tr>
<tr>
<td></td>
<td>- They can reduce the risk of infection and duration of the neutropenic nadir.</td>
</tr>
<tr>
<td></td>
<td>- They are recommended where:</td>
</tr>
<tr>
<td></td>
<td>- There has been a previous occurrence of febrile neutropenia.</td>
</tr>
<tr>
<td></td>
<td>- The patient is receiving high-dose chemotherapy (Marrs 2006).</td>
</tr>
<tr>
<td></td>
<td>- There is a risk of febrile neutropenia (Nirenberg et al 2006a).</td>
</tr>
<tr>
<td>Antifungal prophylaxis</td>
<td>- These drugs are recommended for patients who are at risk of severe, or who have prolonged, neutropenia (Nirenberg et al 2006a).</td>
</tr>
<tr>
<td>Prophylactic antibiotics</td>
<td>- Co-trimoxazole is recommended for patients at risk of Pneumocystis carinii pneumonia (Nirenberg et al 2006a).</td>
</tr>
<tr>
<td></td>
<td>- Routine use of prophylactic broad-spectrum antibiotics is no longer recommended because of the risk of bacterial resistance and the lack of empirical evidence to support a reduction in mortality (Crawford et al 2004).</td>
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</tbody>
</table>

### References

Infections in patients with neutropenia are a major cause of morbidity (Crawford et al 2004) and mortality (Kuderer et al 2006). Nurses have an important role in recognising potential sources of infection, reducing the risk of exposure, and educating and supporting neutropenic patients in relation to these.

Infections can arise from activities that healthy individuals take for granted and it can often be difficult for neutropenic patients to accept the lifestyle changes required. However, good nursing care, education and support can promote patients’ understanding and concordance, and ultimately improve treatment outcomes.

**Conclusion**

Patient education and advice in preparation for discharge

**BOX 2**

**Patient education and advice in preparation for discharge**

**Signs and symptoms of infection:**

- Look for signs of infection and be aware that fever may be the first symptom (Hart 2006).
- Check temperature at least once a day or if he or she is feeling unwell (Nirenberg et al 2006a).
- Contact the GP or hospital at the first sign of infection rather than waiting to see if the condition gets worse (Hart 2006).

**Cross-infection:**

- Avoid contact with people who have infections.
- Avoid crowded, smoky environments (Hart 2006).

**Pets:**

- Pets are a potential source of infection.
- Avoid contact with pet faeces, urine and saliva (Hart 2006).
- Do not clean fish tanks as these can expose neutropenic patients to bacterial and fungal infections (National Comprehensive Cancer Network and American Cancer Society 2006).

**Cleaning and gardening:**

- Wear protective gloves for cleaning or for outdoor work, including gardening, to reduce the risk of injury (Shelton 2003).
- Avoid contact with compost heaps as they are a potential source of fungal spores (Johnson et al 2000).

**References**


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