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Evaluation of bone marrow examinations performed by an advanced nurse practitioner: an extended role within a haematology service.

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**Key words:** Bone marrow (BM) examination; advanced nurse practitioner (ANP); expanded role.

**Purpose:** Traditionally, medical personnel have undertaken bone marrow (BM) examination. However, specially trained nurses in advanced practice roles are increasingly undertaking this role. This paper presents the findings from an audit of BM examinations undertaken by an advanced nurse practitioner (ANP) at a regional haematology specialist centre.

**Methods:** The audit evaluated the quality of BM examinations performed by the ANP over the past two years (2007-2009). Over the two year period, 324 BM examinations were performed at the centre of which 156 (48.1%) were performed by the ANP. A random sample of 30 BM examinations undertaken by the ANP were analysed by the consultant haematologist

**Results:** All 30 BM examinations undertaken by the ANP were sufficient for diagnosis.

**Conclusions:** The ANP is capable and competent to obtain BM samples which are of a sufficient quality to permit diagnosis.

## Introduction

The aim of this paper is to present findings from an audit undertaken at an Irish regional specialist haematology centre of BM examinations performed by an advanced nurse practitioner (ANP). Traditionally, a medical doctor has performed BM examinations. However, BM examinations are now also performed by nurses in specialist and advanced roles (Lawson et al., 1999; Trewhitt, 2001).

## Bone marrow (BM) examination

BM examination involves the processes of bone marrow aspiration and BM trephine biopsy. BM aspiration is the removal of some bone marrow fluid, which is then spread on slides. A bone marrow trephine biopsy involves the removal of a core from the bone including marrow. Both aspiration and trephine samples are examined in the laboratory.

BM examination is undertaken to assess cellular morphology and to carry out specialised tests on the bone marrow, such as immunophenotypic, cytogenic and molecular analysis (Malempati et al., 2009). Bone marrow (BM) examination is a useful tool in the diagnosis and staging of various hematological diseases, including leukaemia and lymphoma (Zehnder, 2009). Other indications for BM aspiration and biopsy include unexplained anaemia, unexplained thrombocytopenia, pancytopenia and metastatic disease (Trewhitt, 2001). Moreover, BM examination is undertaken to assess disease response to treatments such as chemotherapy or stem cell transplant (Trewhitt, 2001).

Bone marrow examination can be a procedure feared by many patients (Trewhitt, 2001). Many patients reported pain, especially younger patients and those who had past experience of having BM examinations (Johnson et al., 2008). Some patients may require sedation before the procedure, and sedation in the outpatient setting is reported to be as safe as local anaesthesia (Burkle et al., 2004). Intravenous titrated midazolam in conjunction with local anaesthesia has been shown to provide effective pain relief (Chakupurakal et al., 2008). However, use of sedation requires monitoring of the patient's respiratory function during and after the examination (Chakupurakal et al., 2008; Johnson et al., 2008). The use of nitrous oxide 50%/oxygen 50%, is therefore suggested as a more suitable alternative to sedation (Johnson et al., 2008). Also reported to help reduce pain is the use of buffered lidocaine (Ruegg et al., 2009). A recent study reports that the use of oral analgesics (acetaminophen and oxycodone) and minimal sedation with lorazepam versus local anaesthesia alone produced a statistically significant reduction in patients' perception of pain when undergoing BM examination. There was not a clinically significant reduction in patients' pain levels (Talamo et al., 2010).

The patients in this audit received local anaesthesia (unbuffered) without sedation when undergoing BM examination. The prescribing of sedation is not within the ANP's scope of practice. The ANP is accompanied by another nurse when undertaking the BM examination, and through conversation, the patient is distracted. The patient who requires sedation requires careful monitoring which is time consuming. Recently at the centre reported here, a patient being prepared by the doctor for an urgent BM examination by the doctor developed dysphagia which

required prompt medical treatment. This event may have been missed if this patient had been sedated.

**ANP role expansion**

In Ireland, the title of ANP is the only recognised title for advanced practice nurses. Furthermore, those wishing to become ANPs in Ireland must have at least five years experience in their speciality, and also pursue a Master's degree (NCNM, 2008).

Due to an increase in patient caseload, the role of that haematology ANP was recently expanded to include performing BM examination. In addition, it was considered that undertaking BMs as part of the ANP role would enhance the provision of a holistic approach to patient care. Having nurses performing BM examinations not only improves efficiency of services to patients, it also helps provides a comprehensive service to patients (Trewhitt, 2001).

Any discussion on an advanced nurse practitioner undertaking bone marrow examination cannot occur without discussion related to role expansion and role extension and the evolvement of ANP roles. The absence of physicians in some areas, influential changes in medical practice due to technological advances and the transfer of tasks from medicine to nursing (O'Shea, 2008) have influenced the evolution of the ANP role in Ireland. Those favouring role extension for advanced practice nurses view advanced practice as "relating to the emergence of clinical posts at the nurse-medical interface where nurses take on the tasks that were previously considered to be the doctor's domain (p.86)" (Por, 2008). However, fragmentation of nursing care is possible with role extension (Mantzoukas and Watkinson, 2007), and the focus on

role extension raises concerns that a medical focus rather than a nursing focus gains dominance in advanced nursing practice (Arslanian-Engoren et al., 2005). Role expansion evolves when additional skills and responsibilities are integrated into the specialist role in the context of the core elements of nursing practice resulting in more autonomy (Daly and Carnwell, 2003). However, use of the term 'role development' appears more appropriate in current discussions on advanced practice (Daly and Carnwell, 2003). Role development, according to Mundinger et al. (2000) gives added value to the unique contribution of nurse practitioners

## Purpose of the audit

The purpose this audit reported was to evaluate a new role undertaken by the haematology ANP at a regional specialist haematology centre. The audit of BM examinations carried out by the ANP assessed quality of method and ability to make a diagnosis based on the examination.

## Method

### *Planning phase*

The ANP underwent a planned training in BM examination procedure, under the supervision of the Consultant Haematologist. Appropriate training is essential; a wide variation between practitioners undertaking BM examination can occur (Bishop et al., 1992). The model of supervision adopted was one where the ANP assumed progressively increasing responsibility for BM examination. The ANP initially observed more than 20 BM aspirations and biopsies. A sound knowledge of the following was also required:

- Rationale for the procedure is required.
- Anatomy and physiology of the iliac crest.
- Appropriate selection of the site required.
- Appropriate use of local anaesthetic (lidocaine 2%).
- Appropriate sampling technique.

The importance of examining the potential site for evidence of any infection was also addressed in the training as well as accurate location of the site for aspiration.

**Possible complications of BM examination**

Bone marrow examination is easily carried out under local anaesthesia. However, there are complications associated with it, and awareness of this was an aspect of the training. A UK review of morbidity associated with bone marrow aspiration and trephine biopsy for 2004, reported 15 adverse events, which represented 0.07% of all reported examinations (Bain, 2005). The most common and most serious adverse effect was haemorrhage, which occurred in nine patients. One patient with osteoporosis suffered a fracture at the site of biopsy (Bain, 2005). The evidence suggests that patients with a diagnosis of a myeloproliferative disorder are at risk of haemorrhage from BM examination, even when they are not on aspirin therapy (Bain, 2005).

Uncomplicated thrombocytopenia without coagulapathy is not considered a contraindication for BM examination (Malempati et al., 2009). However, with these patients, extended time is allocated to pressure on the site and the patient is monitored for bleeding. Patients are also educated to report immediately any bleeding.

All patients in this audit were assessed for bleeding risk by obtaining a history of any bleeding disorders and ascertaining if they were on anticoagulant therapy. If so, the reason for this was established and the ANP discussed appropriate management with the Consultant Haematologist.

**Supervision and specific standard operating procedures**

Following training, the ANP was supervised undertaking 10 BM aspirations and biopsies. A Jamshidi 11g x 15cm bone marrow biopsy and aspiration needle with non leur lock adaptor is used at our centre. This allows both aspirate and biopsy samples to be taken, with the aspirate sample taken first, and then the trephine. The ANP was then deemed competent by the consultant to perform all aspects of the bone marrow examination including spreading of aspirate slides. Good technique in slide spreading is a skill central to the quality of the sample and nurses require practice to achieve competence (Lawson et al., 1999). To maintain competency, the ANP must undertake more than 10 BM aspirations and biopsies annually.

Specific standard operating procedures (SOP) were also developed. The purpose of the SOP was to standardise the procedure for performing a bone marrow aspirate and trephine on the haematology patient by the ANP within the hospital's day unit. The SOP provides details on training, competency and equipment for the ANP to undertake BM examination, and also guidelines on information for patients undergoing BM.

Patients are provided with verbal and written information about the BM procedure. The leaflet provides details on the following: what is bone marrow, what happens during bone marrow examination, what patients should do in preparation for BM examination and what they should expect after the examination. Combining written and verbal information informs patients better than verbal information alone (Savay and Evcik, 2001).

**Evaluation of BM examinations performed by the ANP**

The audit evaluated the quality of the BM examinations performed by the ANP over the past two years (2007-2009). The number of BM examinations performed by the ANP over the two years totalled 156. A BM examination must be of sufficient quality to permit the Consultant Haematologist make an accurate diagnosis. The audit tool assessed the following criteria: patient identification, indication for BM, aspirate quality, aspirate spread, number of marrow spaces of biopsy, whether a diagnosis was made or not, and any comments. The number of marrow spaces was used as a measure of quality because the Consultant Haematologist favours this method over length of marrow. An adequate trephine biopsy specimen should have at least five or six intertrabecular spaces (Bain et al., 2001). Blood clots and muscle fibres in the trephine biopsy specimen can occur if a very large aspiration is taken which leads to disruption of the tissues (Bain, 2001).

Thirty of the BMs performed by the ANP were then randomly selected (Table 1) by the consultant haematologist and each was analysed for the following:

- Evidence of documented indications for BM

- Number of particles, cellularity and spread of the aspirations (classified as satisfactory or unsatisfactory for morphological interpretation. Satisfactory was further classified as follows: ‘good’: reasonable fragments/spread could be better; ‘very good’: good number of fragments/good spread).
- Quality of trephine biopsies by measuring marrow spaces >6 (classified as satisfactory or unsatisfactory for morphological interpretation)

**Table 1: Documented patient diagnoses for the audited BM samples obtained by the ANP**

| **Haematological condition** | % of BM samples audited | Number of BM samples audited |
|---|---|---|
| Patients with Myeloma | 46.6% | 14 |
| Patients with Chronic Lymphocytic Leukaemia | 10% | 3 |
| Patients with a Myeloproliferative disorder | 10% | 3 |
| Patients with a Myelodysplastic disorder | 13.3% | 4 |
| Patients with a Lymphproliferative disorder | 16.6% | 5 |
| Patients with an Autoimmune disorder | 3.3% | 1 |
| | 100% | 30 |

**Audit results**

Over a two year period, 324 BMs were performed at the centre of which 156 (48.1%) were performed by the ANP. All of the thirty BMs analysed were diagnostic. Aspirate and trephine biopsies were mostly good/very good (Figures 1 and 2). The number of BM examinations performed by the ANP has increased annually from 46 in 2007 and 2008 to 111 in 2009.

**Figure 1**: **Quality of BM aspirate samples**

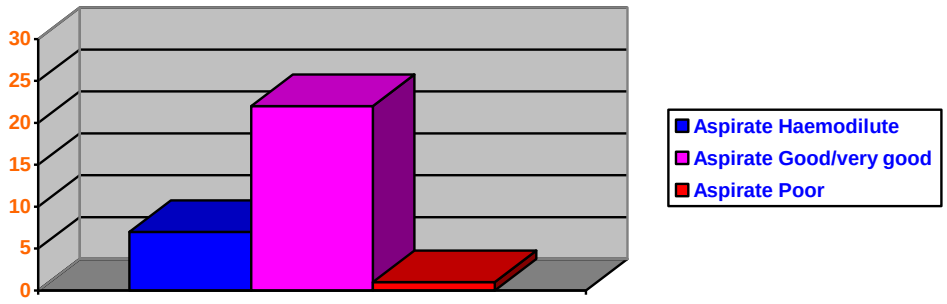
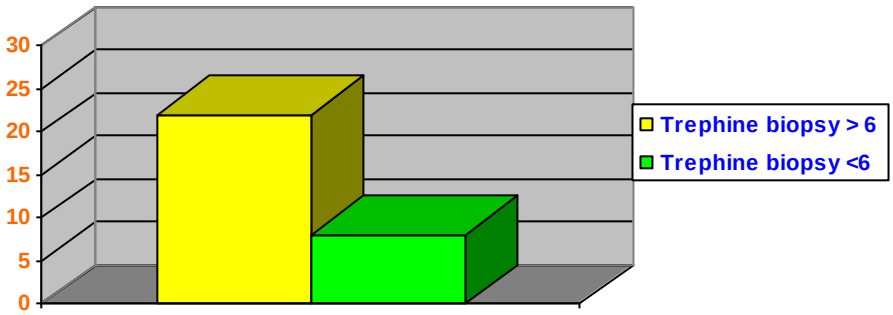



**Figure 2: Quality of BM trephine samples**




**Challenges encountered**

Challenges encountered included the control of BM examination bookings. The problem with bookings was the need to control the number of BM examinations performed on any given day, which would result in extra waiting times. On occasion, five to six patients were booked in for the same morning, which resulted in extra waiting times and increased pressure on the ANP to perform all BM examinations.

Currently booking is restricted to a maximum of two BM examinations per day, which permits factoring in urgent cases.

In addition, the BM examinations are performed over three working days rather than two and each patient is given an allocated time slot, which helps avoid overlap with appointment times. Moreover, the ANP undertakes BM examinations on one day and the medical team undertake them the following day. This ensures that competency in BM examination is maintained and it also prevents the role of the ANP being overly focused on BM examinations. In addition, it allows the team to plan for the patient group attending the day unit each day. Therefore, on the day the ANP is performing BM examinations, the doctor is reviewing patients and visa versa. This also means that waiting times for patients is decreased. Finally, the ANP endeavours to follow through with patients from BM examination to disclosure of results.

## Discussion

The audit revealed that the bone marrows analysed were 100% sufficient for diagnosis. This is an improvement on that reported by Lawson et al. (1999) where 78% of nurse practitioners' BMs were considered technically satisfactory. Not all cases had adequate aspiration and biopsy and development in technique may lead to improvement. However, common difficulties which may influence BM quality include hypocellular and fibrotic marrows, heavily pre-treated and obese patients.

Aspirate and biopsy samples were complementary. Where aspirate sample was poor a trephine biopsy yielded a diagnosis. It is preferable that the aspirate sample is taken first before the trephine (Bain, 2001). The findings of the audit concur with findings of Jamshidi and Swain (1971) where 14-16% of trephine biopsies were diagnostic where diagnosis was not apparent on smear alone. However, in this audit, adequacy of trephine samples were made on marrow spaces alone. In the future, it is planned to evaluate quality using trephine length.

## Conclusion

We conclude that the role development of the Haematology ANP at an Irish regional specialist haematology centre has resulted in the competency of the ANP in performing BM examinations. Similar to the findings reported by Lawson et al. (1999), the performance of BM examination by the ANP has improved the efficiency of services in the haematology department. The ANP is capable and competent to obtain BM samples which are of a sufficient quality to permit diagnosis. It has

resulted in improved efficiency and patients have reduced waiting times although this requires formal evaluation.

The centre plans to re-audit the BM examinations performed by the ANP and compare with those performed by medical staff, incorporating analysis of BM trephine length. In addition, guidelines and SOPs are currently under review and Lee et al's (2008) standards will be incorporated into the new guidelines. Moreover, the views of staff in the Histology department on the reporting and recording of BM examinations by the ANP will also be considered in the updated guidelines.

Plans for this service also include evaluating patients' experiences of BM examinations performed by the ANP. This evaluation will commence at the end of 2010. Many factors influence patients' access to and satisfaction with advanced nursing roles but our understanding of these factors remains limited (Bonsall and Cheater, 2008).

In conclusion, BM examination is a key diagnostic test for patients with various haematological diseases. To enhance continuity of care, the ANP's scope of practice was expanded to include competency in BM examination. Moreover, the addition of the ANP to the team performing BM examinations facilitates the opportunity for reduced waiting times with subsequent early diagnosis and prompt management.

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