NICE advice

The Arrow OnControl powered bone marrow biopsy system for bone marrow aspiration and biopsy

Medtech innovation briefing
Published: 12 February 2015

www.nice.org.uk/guidance/mib19

Summary

The OnControl is a powered bone biopsy system which is intended to be used in place of a standard biopsy needle. It is designed to enable faster access and improved biopsy samples, and to be less painful than manual aspiration techniques. A systematic review of 5 randomised controlled trials showed a statistically significant reduction in pain and increase in biopsy length compared with manual techniques. The OnControl system costs £61.30 per procedure compared with £86 for a manual needle.

Product summary and likely place in therapy	Effectiveness and safety
• The OnControl powered bone biopsy system consists of a battery powered drill which, together with appropriately sized needles, is designed to allow bone marrow aspiration and biopsy. • The OnControl system would be used in place of current manual needle aspiration and biopsy techniques. • The OnControl system is intended for use in secondary care settings by qualified healthcare professionals who are familiar with bone marrow aspiration and biopsy procedures and are specifically trained to use the system.	• 1 systematic review (n=282) included data from 5 randomised controlled trials (n=26, 50, 50, 54 and 102) that met the inclusion criteria. • The systematic review reported a statistically significant reduction in pain experienced by people who had a biopsy using the OnControl system. The mean biopsy length when using the OnControl system was 14.5 mm, a statistically significant increase of 3.6 mm compared with manual biopsy. • Adverse events were higher with the OnControl system at 2.5%, compared with 0% for manual biopsy (p=0.17); none was serious and all resolved.

Technical factors	Cost and resource use
• The OnControl system is the only powered bone marrow biopsy system currently available. The powered driver uses a non-replaceable, non-rechargeable battery providing approximately 200 uses.	• Each OnControl system costs £260; assuming 200 uses, this is equivalent to £1.30 per procedure. A biopsy needle for single use with the OnControl system costs £60 and can be used for a biopsy and aspiration procedures compared with a typical cost of £86 for a manual biopsy needle. • The OnControl system may be able to gather more usable material than manual procedures, so there may be further benefits from avoiding repeat procedures.

Introduction

The bone marrow makes blood cells and platelets. It is a soft fatty tissue found inside the hollow shafts of bones such as the breastbone (sternum), hip bone (pelvis) and thigh bone (femur). Fibrous tissue in the bone marrow forms a sponge-like network that supports the production of stem cells, which produce all types of blood cells.

A number of conditions can affect the structure and function of bone marrow. This in turn can affect the production and function of blood cells and platelets. Bone marrow testing may be used to inform the diagnosis of these conditions, determine the efficacy of treatments, and monitor the recovery process. It is also an essential part of the staging process for people newly diagnosed with certain types of cancer. Bone marrow testing is also used to determine the extent of marrow damage among people who have been exposed to radiation, drugs, chemicals, and other agents that damage bone marrow. Some people will have several bone marrow examinations to help healthcare professionals to monitor and manage disease progression.

In 2012, 29,785 people were newly diagnosed with cancers that needed bone marrow testing (Office for National Statistics 2012). These included:

- 12,412 people with lymphomas

- 7422 people with leukaemias
- 4190 people with myelomas
- 412 people with bone cancers.

These cancers are slightly more common in men (56% of cases), and 52% of all cancers are diagnosed in people aged over 70 years. However, these diseases also impact disproportionately on children and young people, with leukaemia the most common childhood cancer. In total these cancers account for over 50% of all cancers in children and young people aged 14 years and under (593/1170).

Five-year survival rates for adults vary from 37% for people with myeloma, to 83% for people with Hodgkin's lymphoma (Cancer Research UK 2014).

The Hospital Episode Statistics for England (Health and Social Care Information Centre 2014) reported that 44,207 bone marrow tests were performed in 2012/13. The mean age for the procedure is 57 years, with more men than women having tests (59% versus 41%). The tests were performed as follows:

- 29,430 (66.6%) people had tests as day cases
- 11,752 (26.6%) people had tests as inpatients
- 3025 (6.8%) people had tests as outpatients, of which 379 (0.9%) people had the tests on their first attendance.

There are 2 techniques for extracting bone marrow for testing:

- Bone marrow aspiration – a small, hollow needle is used to draw out about 1–20 millilitres of bone marrow. In adults, this is taken from the iliac crest area of the pelvis. For infants and younger children other bones such as the shin bone (tibia) may be used.
- Bone marrow biopsy (trephine) – a small sample of marrow ('core') is extracted from the same bones as for aspiration, but using a needle with a thicker bore.

People usually have both kinds of test, although occasionally only an aspirate sample is needed. The aspirate sample is used for cytological evaluation and the biopsy sample for histological evaluation. Results from the cytological evaluation are usually available in 2 days, but results from the histological evaluation take around 10 days.

Bone marrow extraction can be challenging for the healthcare professional carrying it out. In addition, people can experience varying degrees of pain during the procedure, which may make them reluctant to have repeat tests. Health care professionals usually inject a local anaesthetic into the skin over the pelvis, to numb the area the sample will be taken from. Some hospitals offer adults sedation for repeat tests if they found a previous test painful. Children are usually offered general anaesthesia.

If the volume and quality of the bone marrow removed is not adequate for testing then the extraction will need to be repeated, potentially delaying the diagnosis and increasing the pain experienced by the person having the test. The international guidelines on the standardisation of bone marrow specimens advise that the core length of bone marrow biopsies taken from an adult should be at least 2 cm. The guideline states that a shorter core (for example 1 cm) can sometimes contain enough tissue to make a diagnosis, but that longer cores allow for greater diagnostic accuracy of a larger range of conditions (Lee et al. 2008).

A great deal of pressure has to be applied to the needle in bone marrow aspiration and biopsy, to force it through the outer bone and into the marrow cavity. This can make the procedure difficult to perform, and difficulty in completing the procedure is associated with poorer sample quality (Bishop et al. 1992).

Technology overview

This briefing describes the regulated use of the technology for the indication specified, in the setting described, and with any other specific equipment referred to. It is the responsibility of healthcare professionals to check the regulatory status of any intended use of the technology in other indications and settings.

About the technology

The Arrow OnControl powered bone biopsy system (referred to as the OnControl system) can perform both bone marrow aspiration and bone marrow biopsy. It is a battery-powered driver device that drills through the outer bone to make it easier to reach the bone marrow. A single-needle technique is used to perform either aspiration alone or a combined aspiration and biopsy procedure.

For procedures using the OnControl system, the patient lies prone or on one side with

knees bent up towards the chest. The skin over the pelvis is cleaned with an alcohol solution, and a local anaesthetic is injected. Once the area is numb a small incision is made in the skin above the bone that is to be biopsied. The health care professional performing the procedure attaches a needle set to the powered driver and pierces the soft tissue at an appropriate angle above the target bone. The needle is then driven into the medullary cavity of the posterior or anterior iliac crest.

CE marking

The Arrow OnControl powered bone biopsy system (referred to as the OnControl system), including powered driver, sterile connectors, trays and needle sets, was CE-marked as a class IIa medical device to Vidacare (now part of Teleflex) in April 2005. Current certification is valid until April 2015.

Description

The OnControl system consists of 3 main components:

- A reusable, lithium battery-powered driver similar in appearance to a handheld drill. The battery is non-replaceable and non-rechargeable, with a 10-year shelf life. When pressing the trigger, a battery status indicator lights up solid green when the driver has enough power to perform the procedure, and flashes red when power is down to 10%. Battery life expectancy is approximately 200 uses, dependent on storage, frequency of use and actual usage (including patient bone density and insertion time). A cradle is provided to store the driver when not in use.
- A sterile, single use, disposable connector with integrated sterile sleeve used to fully enclose and seal the powered driver and then couple it to the needle set.
- Single-use, sterile needle sets with depth markings, specifically designed for either bone marrow aspiration alone or combined aspiration and biopsy. Aspiration needles are colour-coded purple and have a 15-gauge (1.83 mm) outside diameter, and are available in lengths of 25, 68 and 90 mm. Biopsy needles capable of taking both aspiration and biopsy samples are colour-coded orange and have a wider 11-gauge (3.05 mm) outside diameter, and are available in lengths of 102 and 152 mm.

Needle sets consist of an inner, bevel-tipped stylet used to penetrate the cortex of the bone, within an outer cannula. The user gently squeezes the trigger on the driver until the needle drills through the bone and reaches the location to be aspirated or biopsied.

A combined bone marrow aspiration and biopsy procedure is performed as follows. To obtain the aspiration sample, the driver is detached, the inner stylet is removed, and a syringe is connected to the outer cannula to aspirate the bone marrow. To obtain the biopsy sample, the driver is reattached and a depth gauge is positioned on the outer cannula to guide the operator. The cannula is then powered into the cavity to the desired depth to obtain the bone marrow core specimen, and then withdrawn. An ejector rod with an alignment guide is then used to push the core biopsy sample from the cannula into a sterile sample container.

All single-use components needed for either procedure can be supplied individually, in multi-packs or in kit form, presented in sterile procedure trays. Comprehensive procedure tray kits are also available, containing additional towel, drape, gauze, dressing, syringe and scalpel components. There are also optional training accessories, including non-sterile aspiration and biopsy needle sets and trays, and laminated blocks and manikins to simulate patients with hard bone cortex.

Training is provided by the manufacturer which provides new users with a detailed explanation and demonstration of the system. The technique is taught on training blocks that resemble the bone cortex and the bone marrow cavity. The blocks must be purchased but the training is provided free. Once the healthcare professional is familiar with the technique and feels comfortable with the system, it can be used on patients. During the first use with a patient, a clinical specialist from Teleflex will provide on-site support for the healthcare professional.

Intended use

The OnControl powered bone biopsy system is intended for bone marrow aspiration and bone marrow biopsy of the iliac crest area of the pelvis for adults. For infants and younger children, use is limited to bone marrow aspiration. The OnControl bone lesion biopsy system is beyond the scope of this briefing.

Setting and intended user

The OnControl system is intended for use in secondary care in day-case, inpatient and outpatient settings. The system is intended for use by qualified clinicians, including oncologists, haematologists, nurses or clinical technologists. Users should be familiar with bone marrow aspiration and biopsy procedures and specifically trained to use the OnControl system.

Current NHS options

Bone marrow biopsy and aspiration is currently done using manual devices only. NICE is not aware of other available powered bone marrow access devices.

Costs and use of the technology

The cost of the powered device and consumables are:

- The Arrow OnControl power driver with cradle: £260.00
- OnControl biopsy:
  - system tray (includes sleeve and connector) and 102 mm or 152 mm single-use needles: £60.00
  - 6-pack of single-use 102 mm or 152 mm needles: £240.00 and £246.00 respectively
  - individual single-use 102 mm or 152 mm needles: £40.00 and £41.00 respectively
- OnControl aspiration:
  - 6-pack of single-use 25 mm, 68 mm or 90 mm needles: £246.00
  - individual single-use 25 mm, 68 mm or 90 mm needles: £41.00
- Individual OnControl connector: £6.00.

The powered driver can be used approximately 200 times. The mean cost per use ranges between £1.04 with 250 uses, £1.30 with 200 uses and £1.73 with 150 uses.

The average costs of the powered driver plus consumables for a biopsy or a combined examination are £61.30 (£60.00 for the system tray plus the usage cost of £1.30), assuming the powered driver is used 200 times. If the driver is only used 150 times before replacement, the costs are £61.73, if the driver is used 250 times the cost is £61.04.

In the UK standard practice manual procedure, a typical single-use biopsy needle (in 10.0 cm, 11.0 cm and 15.0 cm lengths) from Depuy Synthes costs £85.86 (NHS Supply Chain 2014).

When using the OnControl system, centres must also purchase some of the following training accessories:

- non-sterile biopsy training tray: £14.00
- non-sterile aspiration training needle set: £5.00
- non-sterile biopsy training needle set: £9.00
- full pelvis model with carrying case: £95.00
- training blocks: £12.00.

Some hospitals offer sedation to children and young people having bone marrow tests, the cost of which ranges from £156 to £218 (2010 prices; taken from the NICE guideline on sedation in children and young people).

Other costs, for example the cost of alcohol solution to clean the site and pressure dressings for the incision, are assumed to be similar for OnControl and manual needle insertion.

Likely place in therapy

The OnControl system would be used in place of standard manual bone marrow aspiration and biopsy devices.

Specialist commentator comments

One specialist commentator reflected that in his experience there has been a substantial increase in the number of bone marrow biopsies being performed, but a reduction in the quality of the biopsies obtained. They attributed this to an increased number of inexperienced operators performing bone marrow biopsies. In this context, if the powered system is easier to use then it could improve the patient experience and quality of biopsies in general haematology clinical practice.

A second specialist commentator noted that replacing the current method with the OnControl system may improve the efficiency of the procedure.

A third expert noted that in routine practice with the current biopsy process, very few

patients need, or are offered, sedation. They also considered that the length of trephine biopsy usually depends on the operator and may not be related to differences in devices. One expert was concerned that the OnControl system did not feature a guard to limit the depth that the needle can penetrate into the bone.

Equality considerations

NICE is committed to promoting equality and eliminating unlawful discrimination. In producing NICE guidance, NICE aims to comply fully with all legal obligations to:

- promote race and disability equality and equality of opportunity between men and women
- eliminate unlawful discrimination on grounds of race, disability, age, sex, gender reassignment, pregnancy and maternity (including women post-delivery), sexual orientation, and religion or belief (these are protected characteristics under the Equality Act 2010).

One equality consideration was identified with the OnControl system. The system is indicated for use for bone marrow aspiration in children, young people, and adults, but trephine biopsy in young people and adults only, excluding children from the potential benefits of the powered biopsy procedure.

Patient and carer perspective

The patient groups Leukaemia CARE and Myeloma UK gave the following patient perspectives.

Many patients experience severe pain during manual bone marrow biopsy procedures. This degree of pain causes anxiety and fear, which can be particularly problematic for patients who need multiple bone marrow biopsies. The OnControl system would be welcomed by patients if it could reduce the pain and the emotional impact of the procedure without increasing the risk of adverse events.

Patient experience currently varies, and this partly relates to the skill of the person performing the bone marrow biopsy. Introducing a new device such as the OnControl system offers an opportunity to ensure standardisation of care and the sharing of best practice, improving consistency across services.

Using the OnControl system may result in savings from reduced use of sedation. However, patients generally report improved experiences when sedation is used.

Patients highlighted that increased use of the OnControl system could lead to a reduced ability of health care professionals to perform manual bone marrow biopsies when these are still needed, such as in children and young people.

The patient group added that some patients are currently deterred from entering clinical trials that include bone marrow biopsies, because of the pain and anxiety experienced with this procedure. Any device that reduces pain could potentially increase the level of involvement in clinical trials.

Evidence review

Clinical and technical evidence

Regulatory bodies

There have been no Field Safety Notices or Medical Device Alerts issued by the Medicines and Healthcare Products Regulatory Agency (MHRA) for the OnControl system.

A search of the Manufacturer and User Device Facility Experience (MAUDE) database identified 4 adverse event reports that have been submitted to the US Food and Drug Administration (FDA) in relation to the OnControl system. Two events were associated with the breaking of the biopsy needle during the procedure, 1 event was a case of excessive bleeding, and 1 involved inappropriate needle insertion that led to lower quadrant pain, decreased blood pressure and decreased heart rate. It appears that no events had any lasting effect on patient quality of life.

Clinical evidence

The best quality clinical evidence was 1 systematic review and meta-analysis (Voigt et al. 2013), which is summarised in table 1. This review included 5 randomised controlled trials (Berenson et al. 2011, Bucher et al. 2013, Miller et al. 2011, Reed et al. 2011 and Swords et al. 2011) identified from the literature search, and adopted appropriate statistical techniques to synthesise the individual results. Of the 5 studies, 1 was set in

Switzerland (Bucher et al. 2013), 1 in Spain and the USA (Swords et al. 2011), and the others in the USA only. Three studies were of bone marrow biopsy procedures only (Berenson et al. 2011, Bucher et al. 2013 and Miller et al. 2011), and Reed et al. 2011 and Swords et al. 2011 included bone marrow aspirations, together with biopsies. The results from the aspiration procedures were not synthesised.

Table 1 Summary of the Voigt et al. (2013) systematic review and meta-analysis

Study component	Description
Objectives/ hypotheses	To determine whether the OnControl powered bone marrow biopsy system provides significantly different/improved outcomes on the endpoints of pain and sample length.
Study design	Systematic review and meta-analysis.
Inclusion/ exclusion criteria	RCTs comparing the powered system with manual biopsy methods were included. Patients with blood and bone marrow conditions were included.
Primary outcomes	Pain as measured using a VAS 100-point scale. Bone marrow trephine biopsy length (in mm) and volume (in mm^3). Operator satisfaction. Complications or adverse events.
Statistical methods	For continuous data, the mean difference (inverse variance, random or fixed-effects model) was used, and for binary outcomes risk ratios were presented (Mantel–Haenszel, random or fixed-effects model). Each central estimate had corresponding 95% CIs and p values. Statistical heterogeneity was measured using the I^2 statistic; if an I^2 was 60% or less then meta-analysis was deemed appropriate. Funnel plots were used to assess reporting bias.
Participants	Five RCTs met the criteria, with 318 patients (n=160 in powered arm and n=158 in manual arm).

Results: pain at needle insertion, measured as mean VAS score from 0–100 with 100 being maximal pain	Powered: 25.9 (n=101)[a] Manual: 33.8 (n=99) Mean difference 7.9, 95% CI −15.8 to 0.0, p=0.05
Results: overall pain, measured as mean VAS score from 0–100 with 100 being maximal pain	Powered: 32.4 (n=158)[a] Manual: 39.0 (n=156). Mean difference 6.6, 95% CI −12.9 to −0.2, p=0.04
Results: biopsy length (mm)	Powered: 14.5 mm (n=158)[a] Manual: 10.9 mm (n=156) Mean difference 3.6 mm, 95% CI −15.8 to 0.0, p<0.001
Results: biopsy volume (mm^3)	Powered n=77 Manual n=75 Absolute values not reported Mean difference 18.3 mm^3, 95% CI 13.3 to 23.3, p<0.001
Results: operator satisfaction, measured as mean VAS score from 0–10 with 10 being highest satisfaction	Powered n=77 Manual n=75 Absolute values not reported Mean difference 1.4, 95% CI −0.75 to 3.56, p=0.20, I^2=95%

Results: number of adverse events	Powered: 4/160 (2.5%) Manual: 0/158 (0.0%) Risk ratio 3.6, 95% CI 0.6 to 21.4; p=0.17
Conclusions	The results demonstrate statistically significant lower pain scores, improved sample sizes, slightly higher complications and adverse events and a similar level of operator satisfaction for the powered system compared with the manual methods.
Abbreviations: CI, confidence interval; mm, millimetre; RCT, randomised controlled trial; VAS, visual analogue scale. [a] Mean values were not explicitly reported within the article, but were calculated using information presented within forest plots.	

The findings show statistically significant reductions in pain scores and statistically significant increases in biopsy lengths and volumes.

The systematic review did not report data on the adequacy of samples for diagnostic purposes, the duration of procedures or patient satisfaction. The results for each of these end points are discussed below and included by study in table 2.

Three of the randomised controlled trials included in the systematic review reported on the adequacy of samples for diagnostic purposes. Berenson et al. (2011) reported that the overall quality of the biopsy sample was rated adequate for 78% of the powered and 70% of the manual samples (p=1.00). Bucher et al. (2013) also reported no statistically significant difference in biopsy quality, which was rated 'sufficient for diagnosis' in 83% of the powered group and 80% in the manual group (p=0.74). Miller et al. (2011) reported that 79% of samples from powered systems and 33% from manual systems were graded adequate for pathology (p=0.002). No study directly measured whether the OnControl system reduced the number of repeat biopsies needed because of inadequate samples taken in the initial procedure.

Procedure duration was not reported in the systematic review because of high heterogeneity across the studies. Four of the 5 studies reported a statistically significant shorter mean procedure time for the powered group, and Bucher et al.(2013) reported that the procedure time tended to be shorter with the OnControl system. Evidence from a separate prospective study (Tanasale et al. 2011, not presented in the tables) found that procedure duration is correlated positively with pain.

Berenson et al. (2011) and Bucher et al. (2013) reported patient satisfaction. Patients were satisfied with both the OnControl system and manual bone marrow biopsy, scoring 9.4 out of 10 for the OnControl system and 9.3 out of 10 for manual biopsy in the study by Berenson et al. (2011), and a median of 9 for both groups in Bucher et al. (2013). Bucher et al. also reported satisfaction in patients who did not have sedation (n=15). There was a significant difference in this group, with the OnControl system scoring a median of 7 compared with 3 for the manual biopsy (p=0.015). Reed et al. (2011) reported a significant difference in patients willing to have a repeat procedure with the OnControl system compared with the manual biopsy (p<0.03).

Table 2 Summary of end points in the 5 RCTs that were not included in the systematic review and meta-analysis by Voigt et al. (2013)

	OnControl system	Manual biopsy	Analysis
Using a powered bone marrow biopsy system results in shorter procedures, causes less residual pain to adult patients, and yields larger specimens (Berenson et al. 2011)			
Design	Multi-centre (10), randomised, non-blinded, controlled trial		
Randomised (if applicable)	n=52	n=50	
Efficacy	n=52	n=50	
Key end points not used in Voigt et al. (2013)			
Overall quality of core biopsy rated adequate	77.8% (40/52)	70.0% (35/50)	p=1.000
Core acquisition time; mean and SD	102±85 seconds	203±150 seconds	p=0.001
Patient satisfaction (0–10); mean and SD	9.4±1.2	9.3±1.6	p=0.778
Comparison of a powered bone marrow biopsy device with a manual system: results of a prospective randomised controlled trial (Bucher et al. 2013)			

Design	Prospective, single-centre, randomised, non-blinded, controlled trial		
Randomised (if applicable)	n=24	n=26	
Efficacy	n=24	n=26	Note that there were 30 procedures in each group, with 8 patients having 2 procedures and 1 patient having 3.
Key end points not used in Voigt et al. (2013)			
Biopsy quality sufficient for diagnosis	83.3% (25/30)	80.0% (24/30)	p=0.74
Procedure time duration; median (range)	150 (60–720) seconds	180 (80–480) seconds	p=0.95
Median (range) patient satisfaction VAS (0–10, low–high) in all patients	9 (0–10)	9 (3–10)	p=0.69
Median patient satisfaction VAS without sedation	7 (n=9)	3 (n=6)	p=0.015 Range not reported.
Powered bone marrow biopsy procedures produce larger core specimens, with less pain, in less time than with standard manual devices (Miller et al. 2011)			
Design	Single-centre, randomised, non-blinded, controlled trial		
Randomised	n=26	n=26	Each participant had a procedure from each device
Efficacy	n=24	n=24	Two patients were excluded due to inadequacies in the procedure
Key end points not used in Voigt et al. (2013)			

Pathology-graded adequate biopsy core	79.2%	33.3%	p=0.002
Mean time to core acquisition	46.5±15.8 seconds	85.7±31.0 seconds	p<0.001
The OnControl bone marrow biopsy technique is superior to the standard manual technique for haematologists-in-training: a prospective, randomized comparison (Reed et al. 2011)			
Design	Single-centre, randomised, non-blinded, controlled trial (randomisation was of operators not patients)		
Randomised	n=54 patients, 27 in each arm but not randomised; 11 operators were randomised to technique and patient		
Efficacy	n=27	n=27	
Key end points not used in systematic review and meta-analysis Voigt et al. (2013)			
Procedure time, mean and SD	175±105 seconds	292±210 seconds	p=0.007
Patient willingness to have repeat procedure, score 0 to 10 high to low, mean and SD	1.0±2.2	2.9±3.5	p<0.03
A prospective randomised study of a rotary-powered device (OnControl) for bone marrow aspiration and biopsy (Swords et al. 2011)			
Design	Multi-centre (2), randomised, controlled trial		
Randomised	n=25	n=25	
Efficacy	n=25	n=25	
Key end points not used in Voigt et al. (2013)			
Core biopsy usable area, mean and SD	25.4±12.3 mm^2	11.9±5.6 mm^2	p=0.001
Biopsy procedure time, mean and SD	100.0±72.8 seconds	224.1±79.0 seconds	p≤0.001

Abbreviations: SD, standard deviation; VAS, visual analogue scale.

Recent and ongoing studies

One recently completed trial comparing the OnControl system with manual bone marrow examination in children was identified in the preparation of this briefing. This trial compared the use of the OnControl device (n=22) with a manual device (n=22) for bone marrow examination. Results are available on Clinicaltrials.gov (identifier: NCT02159118) and are summarised in table 3.

Table 3 Results from a study comparing manual and powered bone marrow aspiration and biopsy devices in children

	OnControl powered	Manual procedure	Analysis
A study comparing use of manual and power bone marrow aspiration and biopsy devices in children			
Design	Single-centre, randomised controlled trial		
Randomised	n=22	n=22	
Efficacy	n=22	n=22	
Selected outcomes (primary outcome listed first, then secondary outcomes)			
Percentage of hematopoietic tissue present; mean and SD	55.8±19.4	42.5±21.8	p=0.03
Biopsy volume; mean and SD	36.5±16.1 mm^3	23.8±11.5 mm^3	p=0.01
Biopsy length; mean and SD	13.4±4.7 mm	13.9±3.4 mm	p=0.65
Time for procedure; mean and SD	53.2±30.5 seconds	55.0±34.1 seconds	p=0.22
Overall procedure pain score rated from 0–10 with 10 being maximal pain; mean and SD	0.68±1.36	0.27±0.94	p=0.93

Operator satisfaction rated 0–10 with 10 highest; mean and SD	9.2±1.0	9.0±1.0	p=0.51
Abbreviations used: SD, standard deviation.			

This is the only study of the OnControl system in children, and the only one of all the studies reporting a lower pain score and higher sample length with the manual device.

Costs and resource consequences

No published evidence on resource consequences was identified.

The manufacturer states that the OnControl system is currently used in 6 NHS Trusts in England and Wales. No changes to current service organisation or delivery are expected if the OnControl system is adopted in the wider NHS. The manufacturer does not recommend using this system for bone marrow trephine biopsy in children, so they will still need manual biopsies. No additional facilities or technologies are needed alongside the OnControl system.

Clinical evidence suggests some patients may find the OnControl system less painful than a manual device. Should these patients need a second examination then there may be a reduction in requests for sedation and lower costs to the NHS. However, there is no substantial evidence from the studies to support this claim.

In clinical practice, some patients may need a second procedure if the original sample is not good enough for accurate diagnosis. Bucher et al. (2013) aimed to measure if the powered device would produce larger biopsies and therefore help to avoid 'non-diagnostic' biopsies, but found no difference in the diagnostic quality of samples from the OnControl system or manual biopsy. Berenson et al. (2011) did find a non-significant, higher absolute level in the percentage of usable samples with the OnControl system (78% compared with 70%). If this result is replicated in clinical practice then it may be possible to avoid some repeat procedures, improving patient experience and efficiency.

Strengths and limitations of the evidence

The principal evidence source was the systematic review and meta-analysis by Voigt et al. (2013). This was judged to be of high quality. The literature search was rigorous, and study selection and data extraction was done by 2 people acting independently. Clear

inclusion criteria were applied, bias was assessed in each included study, publication bias was checked for and the methods used to synthesise the data were robust. Heterogeneity across the studies was assessed to inform when synthesis was valid, and the results from the random effects models were presented using forest plots.

All 5 studies in the systematic review had similar limitations. In particular, allocation was not adequately concealed and neither patients nor operators were blinded to the choice of intervention during the procedure. However, given the nature of the procedure it is difficult to ensure blinding. The study by Miller et al. (2011) attempted to ensure that the patients were blinded to the intervention, but it is not clear if the technique used was effective. All trials were also at risk of performance bias, because operators were experienced users of the manual device but had minimal experience with the OnControl system. Finally, all of the trials were conducted outside the UK, so it is unclear how generalisable the results are to the NHS.

Strengths of the studies include that all of them were randomised, reducing selection bias. The only differences reported between arms were the devices themselves, with the operators, patient preparation, education and after-care being the same across the groups, reducing other forms of performance bias. All studies had a low rate of attrition, with only 2 patients excluded from the intention-to-treat population. These were in the study by Miller et al. (2011), and a rationale for the exclusions was provided.

The definition and approach to measuring outcomes was reasonably consistent across all studies except for the study by Miller et al. (2011). This study had a potential detection bias in recording pain, as patients in the study re-scored the first procedure for pain after recording the pain associated with the second procedure. This study was conducted with volunteers rather than patients who needed a bone marrow examination for clinical purposes. Because of this, patients may have had a different perception of pain, particularly since they knew they would not need a repeat procedure at a later date. Differences in the populations recruited on other studies included the use of sedation, and 1 study (Bucher et al. 2011) excluded patients with a BMI over 35.

Reed et al. (2011) had a different aim from the other studies. It was set in a teaching hospital and designed to answer whether manual or powered procedures were superior for training haematology students in biopsy practice. Because of this, operators were randomised instead of patients. In addition, the study only used length of sample as a surrogate for biopsy quality, whereas the other studies also considered width or volume of sample.

Bucher et al. (2011) is the only study which was conducted without funding from the manufacturer. None of the authors of this study had any conflicts of interest.

Relevance to NICE guidance programmes

NICE has issued the following guidance that is related to the OnControl System:

- Metastatic malignant disease of unknown primary origin (2010) NICE guideline CG104
- Improving outcomes in haemato-oncology cancer (2003) NICE Cancer service guidance

No related guidance is under development.

References

Berenson JR, Yellin O, Blumenstein B et al. (2011) Using a powered bone marrow biopsy system results in shorter procedures, causes less residual pain to adult patients, and yields larger specimens. Diagnostic Pathology 23(6): 23

Bishop PW, McNally K, Harris M (1992) Audit of bone marrow trephines. Journal of Clinical Pathology 45(12): 1105–08

Bucher CM, Lehmann T, Tichelli A et al. (2013) Comparison of a powered bone marrow biopsy device with a manual system: results of a prospective randomised controlled trial. Journal of Clinical Pathology 66(1): 24–8

Cancer Research UK. Hodgkin lymphoma statistics [online, accessed on 15 October 2014]

Cancer Research UK. Myeloma survival statistics [online, accessed on 15 October 2014]

ClinicalTrials.gov. A Study Comparing Use of Manual and Power Bone Marrow Aspiration and Biopsy Devices in Children [online; accessed 21 October 2014]

Cohen SC, Gore JM (2008) Evaluation of a Powered Intraosseous Device for Bone Marrow Sampling. Anticancer Research 28: 3843–6

FDA. Manufacturer and User Facility Device Experience [online; accessed on

17 October 2014]

Health & Social Care Information Centre. Hospital Episode Statistics [online; accessed 21 October 2014]

Lee E, Erber W, Porwiticsh A et al. (2008) ICSH guidelines for the standardization of bone marrow specimens and reports. International Journal of Laboratory Hematology 30(5): 349–64

Miller LJ, Philbeck TE, Montez DF et al. (2011) Powered bone marrow biopsy procedures produce larger core specimens, with less pain, in less time than with standard manual devices. Hematology Report 3(1): e8

NHS Supply Chain. Online Catalogue [online, accessed 19 October 2014]

National Institute for Health and Clinical Excellence (2010) Sedation in children and young people: costing report. NICE guideline (CG112)

Office for National Statistics. Cancer Registration Statistics, England, 2012 [online, accessed 20 October 2014]

Reed LJ, Raghupathy R, Strakhan M et al. (2011) The OnControl bone marrow biopsy technique is superior to the standard manual technique for hematologists-in-training: a prospective, randomized comparison. Hematology Report 3(3): e21

Swords RT, Anguita J, Higgins RA et al. (2011) A prospective randomised study of a rotary powered device (OnControl) for bone marrow aspiration and biopsy. Journal of Clinical Pathology 64(9): 809–13

Tanasale B, Kits J, Kluin PM, Trip A, Kluin-Nelemans HC (2013) Pain and anxiety during bone marrow biopsy. Pain Management Nursing 14(4): 310–7

Voigt J, Moiser M (2013) A powered bone marrow biopsy system versus manual methods: a systematic review and meta-analysis of randomised trials. Journal of Clinical Pathology 66(9): 792–6

Search strategy and evidence selection

Search strategy

Search strategy

The search strategy was designed to identify evidence on the clinical and cost effectiveness of the Arrow OnControl powered bone biopsy system for bone marrow biopsies and bone marrow aspiration. It comprised 3 concepts: bone marrow biopsy/ aspiration, needles and powered devices. Standalone search lines were added to this structure, designed to capture any records that may have been missed by the 3-concept approach. These included a search by brand name, a focused key term search and a search for the manufacturer name. The strategy excluded non-English language publications and animal studies using a standard algorithm. No additional filters for study design were applied. The results were limited to studies published from 2005 to current; this reflects the date when the OnControl system was CE-marked.

The final strategy for MEDLINE (OvidSP) was peer-reviewed by an independent information specialist.

The following databases were searched:

- Cochrane Central Register of Controlled Trials (Cochrane Library, Wiley)
- Cochrane Database of Systematic Reviews (Cochrane Library, Wiley)
- Database of Abstracts of Reviews of Effect (Cochrane Library, Wiley)
- Embase (Ovid SP)
- Health Technology Assessment Database (Cochrane Library, Wiley)
- MEDLINE and MEDLINE in Process (Ovid SP)
- NHS Economic Evaluation Database (Cochrane Library, Wiley)
- PubMed.

Evidence selection

A total of 723 records were retrieved from the literature search. After de-duplication,

402 records remained. Two reviewers independently sifted these records against the exclusion criteria at title and abstract. By the end of this process the reviewers were in agreement over the papers that should be excluded. In total, 395 papers were removed, based on the following exclusion criteria:

- articles of poor relevance against the search terms
- publication types that are out of the project scope
- non-English language studies
- conference abstracts
- review protocols
- articles in which neither the abstract nor the full text is freely available online.

Full records were retrieved for the remaining 7 papers, and a second sift was done. Papers were excluded at this stage if they were not randomised or did not address the population, intervention, comparator and outcomes needed to inform the review. The second sift was also done independently by 2 reviewers. Following the second sift, 1 paper was excluded (Cohen et al. 2008). This study was a non-randomised, single-arm observational study and so had no comparative information. The remaining 6 papers comprised 1 systematic review and meta-analysis and 5 randomised control trials. Synthesised evidence from the systematic review was used when appropriate, with evidence not reported in the review described on a study-by-study basis.

Changes after publication

October 2015: Minor maintenance

About this briefing

Medtech innovation briefings summarise the published evidence and information available for individual medical technologies. The briefings provide information to aid local decision-making by clinicians, managers, and procurement professionals.

Medtech innovation briefings aim to present information and critically review the strengths and weaknesses of the relevant evidence, but contain no recommendations and **are not**

formal NICE guidance.

Development of this briefing

This briefing was developed for NICE by Newcastle and York External Assessment Centre. The interim process and methods statement sets out the process NICE uses to select topics, and how the briefings are developed, quality assured and approved for publication.

Project team

Newcastle & York External Assessment Centre.

Medical Technologies Evaluation Programme, NICE.

Peer reviewers and contributors

- Joyce Craig, Associate Director, York Health Economics Consortium
- William Green, Research Consultant, York Health Economics Consortium
- Mick Arber, Information Specialist, York Health Economics Consortium
- Derek Bousfield, Senior Clinical Technologist, Newcastle upon Tyne Hospitals NHS Foundation Trust
- Helen Cole, Head of Service – Clinical Scientist, Newcastle upon Tyne Hospitals NHS Foundation Trust
- Iain Willits, Medical Technologies Evaluator, Newcastle upon Tyne Hospitals NHS Foundation Trust.

Specialist commentators

The following specialist commentators provided comments on a draft of this briefing:

- Ms Carol Walsh, Theatre Co-ordinator/Senior Staff Nurse Great Ormond Street Hospital for Children, London
- Dr Vinod Devalia, Consultant Haematologist, Princess of Wales Hospital, Bridgend

- Kevin Gatter, Professor of Pathology, John Radcliffe Hospital, Oxford.

Copyright

ISBN: 978-1-4731-0980-3