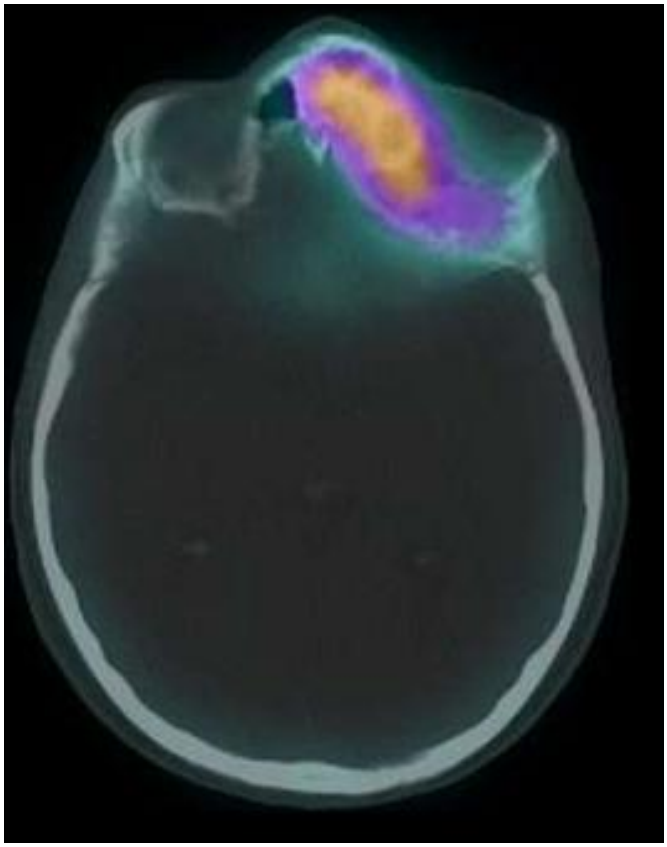
E Pluribus Unum
out of many, one

seasonal rains

RURAL ALLIANCE IN NUCLEAR SCINTIGRAPHY

Volume 4, Number 1 AUTUMN / WINTER EDITION 2010

SPECT/CT Bone Scan Skull



The official quarterly newsletter of the Rural Alliance In Nuclear Scintigraphy

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Introduction

The Australian health care system has been described or defined by the 'inverse care law'; those Australians in the most need of health services receive the least. This might equally reflect life for rural Nuclear Medicine professionals; those with the greatest need for support and representation actually have the least. It is true that the rural Nuclear Medicine professional develops unique skills and capabilities not generally manifest in metropolitan counterparts; an evolutionary adaptation ('survival of the fittest'). Despite these attributes, rural Nuclear Medicine professionals are confronted with professional isolation that fosters a number of inequities:

- Professional representation at state and federal level.
- Accreditation and continuing professional development (CPD).
- Diffusion of innovation, technology and techniques.
- Support for training, leave (illness or recreation) and workload.
- Career development pathways.

RAINS aims to quench the thirst of rural Australia left parched by professional under representation.

RAINS Management Committee

Start Collecting Your 2010 CPD Points With RAINS Now!

President's Report

Welcome to the Autumn edition of *Seasonal RAINS*. I trust that the ANZSNM ASM in New Zealand will provide an opportunity for members and the RAINS Committee to exchange ideas. There are some important announcements in this edition so please read carefully.

I would like to warmly welcome our new members, thank you for your interest and support. We now have 155 associate members and 88 ordinary members. This Newsletter's success in previous years has been based around the contributions of other members. I would like to encourage you all to send in those Interesting Cases or Images we all stumble upon from time to time. It doesn't take much of an effort to email them through for all of your colleagues to appreciate and learn from.

The 2009 Annual CPD conference was held in October last year at Diamond Beach near Forster. By all accounts it was a huge success, with some great contributions from a broad spectrum of our regional bases. It was located slightly off the beaten track, and this assisted us with the decision to base this years conference in Sydney, providing all of our rural and regional members more direct access.

The 2010 conference will be held at the Stamford Grand in North Ryde, adjacent to the new Macquarie University Hospital. This year the theme is Integrative Imaging, and we are sure this will generate a great deal of interest from all facets of Diagnostic Imaging, so don't miss out on the early bird deal. A brochure and registration form has been included in this issue. Please encourage your CT, MRI and ultrasound colleagues to attend.

Easter is upon us already, this first quarter has literally flown! For those of you fortunate enough to have an affluent department, or generous boss, we may see you in New Zealand for the Annual ANZSNM meeting. For the rest of us hard workers, the perfect opportunity to get the CPD points and catch up on the latest with your colleagues from around the country awaits in November with our RAINS conference.

See you all there!

2010 is also an election year for RAINS. This means that members will be asked to nominate committee members soon. Voting will then take place so that the new committee can take charge on 1 July 2010.

Matt Ayers

Purpose of RAINS

The purpose of RAINS is to offer a support network for rural and remote Nuclear Medicine professionals. The support network aims to engage with and develop strategies to overcome the unique professional difficulties encountered in rural and remote Australia.

RAINS does not stand as an alternative to ANZSNM state branch membership, but as an adjunct to it.

RAINS offers a seamless representation of rural and remote Nuclear Medicine professionals. That is, RAINS is a single unified group of individuals with common needs and philosophy. There are neither state borders nor division between the private and public sectors nor delineation based on corporate ownership. RAINS does respect and honour commercial in-confidence and intellectual property rights.

Vision

Equitable provision of representation and professional opportunities for rural and remote Nuclear Medicine professionals. Strategic networking and support to foster professional development, continuing education and collaborative solutions to issues of isolation. Recognition and exploitation of distinctive competencies of rural practitioners.

Building A Future For Rural Nuclear Medicine

RAINS Core Values

- Innovate, adapt, overcome.
- Be committed, meet our commitments.
- Perform beyond industry norms.
- Invest in our work, invest in ourselves.
- Improve, continually. Embrace innovation, embrace challenge.
- Support CPD.
- Demand equity for rural Australia.
- Offer support, ask for support.
- Exploit strengths, overcome weaknesses.

RAINS Mission

- Provide a voice and representation
- Overcome barriers to CPD
- Promote equity of service provision
- Undertake research on rural issues
- Respect issues of commercial in-confidence BUT remove borders on core rural activities
- Highlight and exploit the distinctive competencies of the rural Nuclear Medicine professionals
- Provide a network for support and collaboration
- Integrate student clinical placements
- Lobby professional bodies on rural issues
- Promote Nuclear Medicine services in the rural health sector
- Inform and lobby, where appropriate, legislative and regulatory processes impacting on rural Nuclear Medicine

Membership

Membership to RAINS is open to those Nuclear Medicine professionals sharing the needs and philosophies characteristic of rural Australia; underpinned by "professional, social and cultural isolation". To that end, membership is open to those Nuclear Medicine professionals employed in a Nuclear Medicine practice that satisfies any one of the following criteria:

1. Practice located in a centre that the Federal Government Rural, Regional and Metropolitan Area (RRMA) classification deems either rural or remote.
2. Practice located in a centre that is more than 200 km from the state capital.
3. Practice located in a centre that is more than 100 km from nearest other nuclear medicine practice.

Associate membership to RAINS is open to:

1. Students not actively employed in Nuclear Medicine who are undertaking undergraduate or post graduate studies in Nuclear Medicine at any Australian university and who come from a RRMA classified rural or remote centre.
2. Nuclear Medicine professionals employed in a Nuclear Medicine centre that does not meet the criteria for ordinary membership but who believe issues of professional isolation have a deleterious impact on professional development. Examples of such isolation include, but are not limited to; academics, researchers, company representatives and regional isolation with a small Nuclear Medicine network (e.g. Newcastle, Central Coast, Gold Coast).

Membership entitlements include, but are not limited to:

- Newsletter (electronic)
- Networking (eg. research, problem solving, reduce professional isolation)
- CPD activities (e-journal club, e-grand rounds, conferences)
- Representation
- Support
- Full voting rights (ordinary members only)

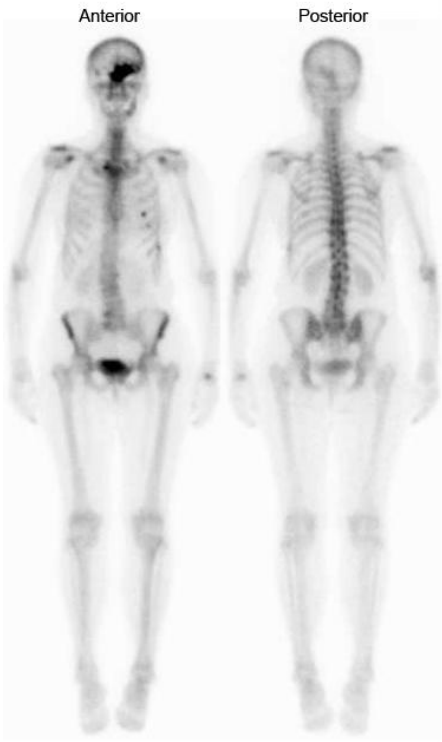
Interesting Image

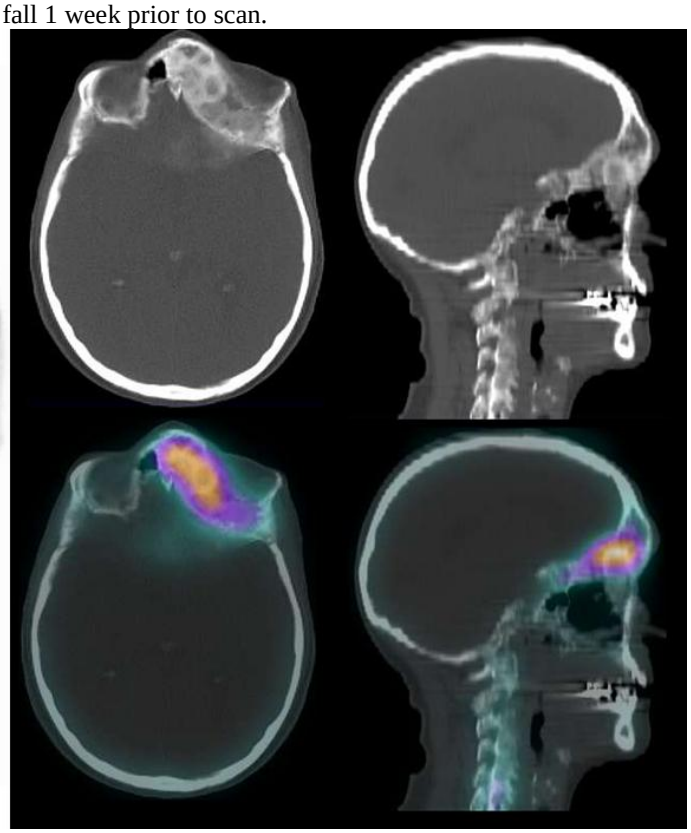
Bone SPECT/CT

Russell Pearce

PRP Diagnostic Imaging, Sydney and Central Coast.

Whole body bone scan on 72 yr old female with suspicious lesions in the cervical spine and possibly T4 on a recent MRI. No history of cancer. Incidental fall 1 week prior to scan.





Result:
1. No evidence of skeletal metastatic disease. No osteoblastic reaction in the cervical spine or T4.
2. Recent fracture involving the left trapezoid.
3. Fibrous dysplasia in the inferior aspect of the left frontal bone (frontal sinus).
4. Subacute fractures in the 4th and 5th left ribs anterolaterally and 8th left rib laterally.

Overview
Fibrous dysplasia is a benign, intramedullary, fibro-osseous lesion of bone that develops during skeletal formation and growth and can be monostotic or polyostotic. Most often diagnosed in adolescents and young adults, fibrous dysplasia accounts for 5%-7% of benign bone tumours. Most patients are asymptomatic and lesions are found incidentally, but patients can present with nonspecific swelling, deformity or pain. Fibrous dysplasia is also associated with several endocrine and non-endocrine disorders.

Clinical
Fibrous dysplasia is monostotic in 70% of patients, with a predilection for long bones such as the femur, tibia, humerus, and rib. Most of these lesions are found incidentally. Polyostotic fibrous dysplasia may be extensive and frequently involves the femur (91%), tibia (81%), pelvis (78%), ribs, skull, facial bones (50%), and less often the upper extremities, lumbar spine, clavicle and cervical spine.

Monostotic fibrous dysplasia is craniofacial in 10%-25% of patients but occurs in 50% with the polyostotic disease. In the skull, the frontal, sphenoid, maxillary, and ethmoidal bones are involved more often than the occipital and temporal bones. Deformities include hypertelorism, cranial asymmetry, facial deformity, visual impairment, exophthalmos, and blindness due to orbital and peri orbital bone lesions. Sphenoid wing and temporal bone lesions may result in vestibular dysfunction, tinnitus and hearing loss.

The risk of malignant transformation is low (0.4%-4.0%), but is more common in the polyostotic form.

Imaging

X-Ray

The typical radiographic appearance of fibrous dysplasia consists of a medullary-based, minimally expansile lesion with "ground-glass" opacity and irregular but well-defined borders. In long bones, the location usually is diaphyseal or diametaphyseal, and the epicentre is centric or eccentric. More expansile lesions cause endosteal scalloping and thinning that weakens the cortex. Lesional radiopacity is variable depending on the ratio of fibrous and osseous tissue. Homogeneous, featureless grey opacity is the classic "ground-glass" appearance of fibrous dysplasia, a term borrowed from the appearance of frosted or ground window glass that is uniformly opaque. Lesions are less commonly homogeneously lucent or sclerotic. Chronic changes secondary to bone weakness may lead to bowing of weight-bearing structures, fracture, and remodelling.

Computed Tomography

Computed tomography is not required for diagnosis but can be valuable in evaluating the extent of disease in complex anatomic locations such as the facial bones, pelvis, and spine. Attenuation of the characteristic ground-glass portions is 70-130 Hounsfield units (HU), in contrast to normal trabecular bone that is >250 HU. Lesions may expand bone. The mixed density of these lesions has been described as "whorls and swirls." Computed tomography can show compromise of the spinal canal and evaluate neural foraminal compromise in the skull. In addition, signs of malignant transformation, including extraosseous soft-tissue mass and aggressive bone destruction, can be shown.

Bone Scan

Fibrous dysplasia in general appears as an area of markedly increased uptake on bone scintigraphy, however uptake may be normal or decreased. Barely increased bone uptake in fibrous dysplasia may be associated with decreased vascularity and osteoblastic activity of the lesion as a result of concurrent bone infarction. Bone scans are not helpful in diagnosing these lesions but can be useful in identifying asymptomatic lesions.

Do you have an interesting image to share? Email the image and brief overview with author details to seasonal@rains.asn.au

Do you have a book review in mind or in progress? Email the final draft with author details to seasonal@rains.asn.au and collect 2 CPD points.

Do you have a journal article review in mind or in progress? Email the final draft with author details to seasonal@rains.asn.au and collect 2 CPD points.

Continuing Professional Development

Brown Adipose Tissue and ^{18}F-FDG PET.

Annah Skillen

Nuclear Medicine and PET, Hunter New England Imaging, Newcastle.

INTRODUCTION

The use of Fluorine-18 fluoro-2-deoxy-D-glucose (^{18}F-FDG) in Positron Emission Tomography (PET) is now considered to be routine practice in oncology as a tool for diagnosis, staging and assessment of treatment response. ^{18}F-FDG is used to assess the function of active tumour cells through their uncontrolled glucose metabolism (Evans, Tulloss, & Hall, 2007). Whilst ^{18}F-FDG PET has a high sensitivity for this purpose but specificity can be problematic due to accumulation within several normal cells that also metabolise glucose, along with inflammatory and infective processes (Evans, et al., 2007). The appearance of the brain and myocardial cells on ^{18}F-FDG PET is accepted, as a result of their glucose energy demands. Also not uncommon is the visualisation of skeletal muscle, gastrointestinal tract, genitourinary tract, bone marrow, and lymphoid tissue for the same reasons (Evans, et al., 2007). Nuclear Physicians have also noted areas of ^{18}F-FDG accumulation within the supraclavicular and mediastinal areas that is not identified to corresponded to any areas of abnormal tissue on correlative imaging (Yeung, Grewal, Gonen, Schoder, & Larson, 2003). This specific pattern was initially described to correspond to muscular uptake in anxious patients, as the administration of oral diazepam; a muscle relaxant, and a repeat PET scan resulted in the reduction of this uptake (Yeung, et al., 2003). Although considered normal variants, ^{18}F-FDG uptake in these areas described can cause false-positive findings (Williams & Kolodny, 2008) on PET imaging.

The introduction of PET/CT (Computed Tomography) has allowed the fusion of PET and CT images, allowing superior accuracy in the localisation of abnormalities found on PET imaging – a technique that cannot be achieved with such accuracy when PET and CT scans are undertaken individually (Yeung, et al., 2003). Since PET/CTs advent in 2001, several studies have been undertaken to accurately localise the increased ^{18}F-FDG accumulation within the supraclavicular and mediastinal areas described above (Cohade, Osman, Pannu, & Wahl, 2003; Paidisetty & Blodgett, 2009; Yeung, et al., 2003). This accumulation has been reported to correspond to areas of adipose tissue, specifically hypermetabolic brown adipose tissue (BAT); as opposed to the previous conclusions that the accumulation is the result of anxiety induced muscular tension (Nedergaard, Bengtsson, & Cannon, 2007). The presence of BAT in these areas has recently been confirmed histologically by Virtanen, et al. (2009) (Virtanen, et al., 2009).

BAT has been proven to exist in rodents throughout life and in human infants and young children (Cypess, et al., 2009). However, it was a long held belief that in adult humans BAT was relatively non-existent with no physiological significance (Cypess, et al., 2009). As a direct consequence of the emergence of PET/CT technology, this belief was determined to be no-longer valid. In fact, Cohade, et al. (2003) documented the appearance of BAT on PET/CT confirming its presence within adult humans, coinciding with the findings of other studies (Cypess, et al., 2009; van Marken Lichtenbelt, et al., 2009; Virtanen, et al., 2009). Five common areas of BAT have been identified (Nedergaard, et al., 2007) to be within the neck and supraclavicular areas (more common) and the mediastinal (para-aortic), paravertebral, and suprarenal areas (less common) (Nedergaard, et al., 2007). Hypermetabolic BAT within these areas can affect the overall accuracy of ^{18}F-FDG PET in the investigation of lymphoma, oesophageal, stomach and lung cancers and also metastatic lymph node involvement within the neck and mediastinum (Cohade, Osman, et al., 2003).

Hypermetabolic BAT is manageable and there is potential to eliminate the appearance on PET imaging, but the nature and appearance BAT must be well understood.

Non-Shivering Thermogenesis

Two types of adipose tissue exist; white adipose tissue and brown adipose tissue (BAT), with two types differing on a cellular level and also in their functionality (Cypess, et al., 2009). The primary purpose of white adipose tissue is the storage of energy, whilst also providing insulation and cushioning (Cypess, et al., 2009). On the other hand, the primary function of BAT is to provide warmth through non-shivering thermogenesis (Cypess, et al., 2009). Microscopically, BAT is uniquely characterised by abundant mitochondria and high vascularisation (giving the tissue its brown appearance), and the presence of uncoupling protein 1 (UCP1) (Agrawal, Nair, & Baghel, 2009).
Non-shivering thermogenesis is the process by which newborn infants and hibernating mammals maintain normal body temperature through the

production of heat (Virtanen, et al., 2009; Weber, 2004). The identification of BAT on PET has proven that adults also have the potential to maintain their body temperature through this process.

Adenosine triphosphate (ATP) is used an energy transporter between cells (Weber, 2004). In cells other BAT, a proton gradient is observed across the mitochondrial membrane within the cell (Weber, 2004). Energy derived from the flow of protons across this membrane allows adenosine diphosphate (ADP) to undergo oxidative phosphorylation and form ATP (Weber, 2004). In BAT cells, the presence of UCP1 allows protons to move along the protein gradient without causing ATP synthesis (Weber, 2004). This process uncouples oxidative phosphorylation and energy is converted to heat, rather than being used for ATP synthesis (Celi, 2009; Weber, 2004).

Weber (2004) reports that non-shivering thermogenesis is triggered by the sympathetic nervous system, in response to cold temperatures. Norepinephrine is released and binds to the β_3-adrenergic receptors on the BAT cell surface causing enzyme action, which in turn begins the heat production process. Glucose transport is also initiated by the release norepinephrine. Glucose transporter 1 (GLUT1) and glucose transporter 4 (GLUT4) are primarily involved and it is the activation of these glucose transporters by which ^{18}F-FDG uptake into BAT is mediated (Nedergaard, et al., 2007; Weber, 2004).

Brown Adipose Tissue on ^{18}F-FDG PET

PET/CT imaging has been used extensively to correctly localise areas of normal ^{18}F-FDG accumulation to anatomical structures. Several analyses have been performed, all supporting the claim that areas of increased BAT accumulation are due to hypermetabolic BAT. Hany, et al. (2002) performed an investigation of 638 consecutive patients who underwent PET/CT and reported increased symmetrical ^{18}F-FDG accumulation within the shoulder area in 17 patients (2.5%). PET/CT localised this accumulation to the fatty tissue of the shoulders in all patients. Two distinct patterns of accumulation were noted: The first within the shoulder area (supraclavicular) and the second within the neck, shoulder and thoracic spine areas (neck, supraclavicular and paravertebral). Interestingly, the latter pattern was demonstrated within 7 female patients. Investigators also note a probable link between body mass index (BMI) and the appearance of BAT, although no statistical testing was performed. In four out of the seven patients that demonstrated the latter pattern of uptake the BMI was within the underweight range (<18.5), with the average BMI of all other patients being 22.7 (Normal range was defined as 18.5-24.9).

The patterns of ^{18}F-FDG uptake in BAT have been further defined (Yeung, et al., 2003) through an analysis of 863 PET/CT examinations. This investigation determined four distinct areas of uptake related to BAT, which was also described during other investigations (Nedergaard, et al., 2007). 32 patients were found to have hypermetabolic BAT (3.7%), which is a similar proportion of patients compared to previous investigations (Yeung, et al., 2003). Of significance is that 26 of these patients were paediatric, which can be expected given that it is known that BAT is present within the younger population (Cypess, et al., 2009). This investigation demonstrated a tendency towards female patients demonstrating higher BAT accumulation than males (P<0.01) and no significant relation was found between BMI and the appearance of BAT. Standard Uptake Value's (SUV) were calculated in patients demonstrating neck accumulation that was localised to BAT (SUV_{max} average = 7.7), and compared to a small proportion of patients demonstrating muscular uptake (SUV_{max} average = 5.8) within the same region. These similar figures indicate that it may be difficult to assess the difference between ^{18}F-FDG accumulation in BAT and muscle and further emphasise the benefit of anatomical localisation provided by PET/CT.

In a similar analysis, of the 359 patients who underwent PET/CT, 49 patients (14.1%) were found to have abnormal ^{18}F-FDG accumulation within the supraclavicular area (Cohade, Osman, et al., 2003). Abnormal tracer accumulation was compared to corresponding tissue on the CT images with the CT tissue densities used to delineate between fat, muscle and lymph tissue (Fat density -75.9 ± 24 HU, Muscle 31.9 ± 14 HU and lymph tissue 29.8±12 HU (Cohade, Osman, et al., 2003)). Results demonstrated 14 patients with BAT accumulation. No statistically significant difference was found between the BMI or the age of patients that demonstrated hypermetabolic BAT when compared to those that demonstrated muscular or lymph tissue uptake. A comparison was made between the SUV_{max} for BAT, muscle and lymph tissue. The SUV_{max} of muscle was significantly lower than that of lymph tissue and BAT (Cohade, Osman, et al., 2003). These findings are comparable with the SUV measurements gained in other investigations (Yeung, et al., 2003).

In the investigation of 845 performed by Truong, et al. (2004), similar appearances of abnormal ^{18}F-FDG uptake was found in 25 patients that correlated to hypermetabolic BAT. Interestingly, the results indicated that there is a female predominance for the presence of BAT (Truong, et al., 2004), a finding that has not been demonstrated by other investigators (Cohade, Osman, et al., 2003; Hany, et al., 2002; Yeung, et al., 2003). However, other investigations into the appearance of BAT in rodents have also suggested a female predominance (Nedergaard, et al., 2007).

Investigators have identified and described five typical areas of increased ^{18}F-FDG accumulation that can be localised to BAT through the use of PET/CT. Of these five areas, it appears more common to find hypermetabolic BAT within the supraclavicular and neck areas, when compared to the mediastinal, paravertebral and suprarenal areas. There is evidence to suggest that female patients are more likely to demonstrate hypermetabolic BAT, when compared to their male counterpart. As it is known that younger members of the population have BAT, it is not surprising that investigations show that hypermetabolic BAT is of a higher proportion within the paediatric population, compared with adults. Only limited evidence exists that the appearance of hypermetabolic BAT is related to BMI, with some investigations suggesting that patients with a lower BMI are more likely to demonstrate BAT. Similar SUVs have been obtained for BAT, muscle and lymph tissue, which places emphasis on the importance of PET/CT anatomical localisation to delineate between the three tissue types.

In addition to sex and age, the two main causes of hypermetabolic BAT on PET/CT are environmental temperature and diet (Nedergaard, et al., 2007). Of the investigations studied, it is unlikely that diet has had any effect on the activation of BAT. All patients were fasted for a period between four and six hours prior to the administration of ^{18}F-FDG. In trusting that all patients had fully complied with preparation instructions, this effectively eliminates patient diet as a probable cause for hypermetabolic BAT. It is more likely that the environmental temperature of the patients prior to administration and during the uptake period of ^{18}F-FDG has resulted in BAT appearance.

The effect of cold exposure on FDG distribution

Cohade, Mourtzikos,et al. (Cohade, Mourtzikos, & Wahl, 2003) performed a retrospective analysis of 1017 PET/CT scans and compared those that demonstrated BAT with the outdoor temperature. BAT was identified in 68 patients (6.7%), with 11 being male and 52 being female. The incidence of the appearance of BAT was compared with the outdoor temperature during the month of the patients scan, and one, two and three months prior to the month of the scan. Cohade, Mourtzikos, et al. (2003) deduced that the occurrence of BAT is more likely to occur in the month's directly succeeding the onset of winter (February and March: Study completed in Northern Hemisphere), (Cohade, Mourtzikos, et al., 2003). In turn, it may be possible that the appearance of hypermetabolic BAT on ^{18}F-FDG is due to the activation of BAT due to prolonged cold exposure, rather than as a consequence of direct cold exposure. Additionally, Cohade, Mourtzikos, et al.'s investigation further emphasised that BAT appearance is more likely to be encountered in the paediatric population. An incidence rate of 23.8% in patients less than 18 years of age was demonstrated, compared to 5.9% in patients over the age of 18.

A similar investigation by Kim, et al. (Kim, Krynyckyi, Machac, & Kim, 2008) analysed 1495 PET scans that were performed in 1159 patients (566 men, 593 women and 22 patients less than 18 years of age). 42 scans were found to be positive for hypermetabolic BAT. A higher incidence was once again demonstrated within patients less than 18 years of age, with an incidence of 13.6% compared to that of the adult population at 2.8%. A comparison was made between the incidence of hypermetabolic BAT to the outdoor temperature on the day of PET imaging, and 2, 3, 7, 14, 30 and 60 days prior to imaging. BAT appearance was found to be more common when the outdoor temperature was lower on the day of the scan and up to a week prior. Incidences were more common during the winter months. There was no significant relationship demonstrated between the appearance of BAT and the temperature 14, 30 and 60 days prior to the PET scan. Kim, et al. (2008) concluded that the appearance of BAT was more likely as a consequence of exposure to acute cold conditions, rather than as a result of prolonged cold exposure as proposed by Cohade, Mourtzikos, et al. (2003). As CT localisation was not available during this investigation, Kim, et al. relied upon the knowledge that BAT is found in several common locations to interpret and assess their PET scans. Whilst this method cannot be regarded as accurate as Cohade, Mourtzikos, et al.'s (2003) for the determination of BAT appearance, and consequently, the influence that outdoor temperature has on BAT; the findings of the study are considerable.

Despite the evidence from Cohade, Mourtzikos, et al. (2003) and Kim, et al. (2008) that cold exposure, whether it be acute or prolonged, can cause BAT appearance of ^{18}F-FDG PET there is limited literature on the topic. The most probable cause for the lack of investigations are the ethical considerations surrounding humans undergoing PET for research purposes only, and it is difficult to justify their unnecessary radiation exposure. Two groups of investigators have conducted studies using simulated cold environments in attempt to reproduce the appearance of hypermetabolic BAT.

Baba, et al. (Baba, Engles, Huso, Ishimori, & Wahl, 2007) conducted an investigation to assess the appearance of multiple radiotracers in BAT at room temperature and cold environments, using rats at their subject. ^{18}F-FDG was injected intravenously into two groups of rats, the first group exposed to 22.5°C for four hours prior to injection, and the second exposed to 4°C for the same time. One hour post injection, the rats were sacrificed; interscapular BAT extracted, assessed under microscope and measured for the presence of ^{18}F-FDG. Baba et al.

(2007) determined that there was a statistically significant increase (26 times greater; $P < 0.01$) in the presence ^{18}F-FDG in BAT for the cold exposed rats, when compared to the control group. This study effectively demonstrates that acute cold exposure can induce ^{18}F-FDG presence in BAT. Despite this, the conditions represented within the investigation can be considered 'extreme', and it is unlikely that patients would encounter similar conditions prior to routine PET scanning.
The most relevant investigation into the effect of cold exposure on the appearance of ^{18}F-FDG in BAT has been conducted by van Marken Lichtenbelt, et al. (van Marken Lichtenbelt, et al., 2009). 24 healthy male patients were investigated (10 with a BMI <25 and 14 with a BMI ≥ 25) with ^{18}F-FDG during exposure to mild cold (16°C). Prior to PET/CT imaging, all subjects were fasted for the same duration and wore standardised clothing. The subjects were placed in a climate chamber for 1 hour at 22°C and were then exposed to cold conditions at 16°C for a further two hours. After the first hour of cold exposure the subjects were administered 74MBq of ^{18}F-FDG intravenously. PET/CT scanning occurred after the second hour. Three of the subjects were then re-evaluated using a constant temperature of 22°C. 23 patients were confirmed to have hypermetabolic BAT on PET/CT to varying degrees with the exception being one subject with a BMI of 38.7 - the highest BMI of all subjects. A higher amount of BAT was demonstrated in subjects with a lower BMI in keeping with the findings of previous investigations (Hany, et al., 2002), although no statistically significance difference was reported. There was no BAT observed within the patients that underwent re-evaluation at 22°C. The investigation by van Marken Lichtenbelt, et al. (2009) depicts similar conditions that may be encountered during routine PET scanning when compared to that of Baba, et al. (2007). Although there is this discrepancy, the conclusions of both investigations are similar and both demonstrate the effect that cold exposure has on 18F-FDG imaging and confirm the presence of hypermetabolic BAT.

Reduction of BAT on ^{18}F-FDG PET

Recently, the majority of investigators have focused on the administration of pharmaceuticals with the attempt of reducing the appearance of BAT on ^{18}FDG PET. These pharmaceuticals include propranolol; a β-blocker and diazepam; a benzodiazepine and fentanyl; an opiate. Other methods reported have included controlling the environmental temperature of the patient and controlling the diet of the patient. All techniques have varying reports of success in reducing the appearance of BAT.

Diazepam was the first pharmaceutical to show effectiveness in reducing BAT appearance - an occurrence which initially led researchers to believe that what we now understand to be BAT, to be muscle uptake in anxious patients (Yeung, et al., 2003). Despite this, there has been limited success using diazepam for this purpose. Gelfand, et al (Gelfand, O'Hara, Curtwright, & MacLean, 2005) performed 118 PET scans in 69 paediatric patients (average age was 12.9 years of age, 76 male and 42 female). In 88 studies, premedication was administered. 44 patients received intravenous fentanyl (dose 0.75-1 μg/kg), 34 received oral diazepam at a dose of 0.06mg/kg and 9 received 0.10mg/kg. 29.4% of patients who received low dose diazepam demonstrated BAT and of the patients that received fentanyl only 6.7% demonstrated BAT. Of the patients that received no premedication, 26.1% demonstrated BAT. None of the patients that received moderate dose diazepam demonstrated BAT, but it is likely that the result may be skewed due to a small sample size. No difference was reported between male and female patients and those that received low dose oral diazepam and those that received no premedication. Although Gelfand, et al. (2005) demonstrated that the administration of fentanyl was able to reduce the incidence of BAT they did not report complete effectiveness.

Jacobsson (Jacobsson, Bruzelius, & Larsson, 2005) reported the use of propranolol was successful in reducing the appearance of BAT. A male patient who underwent a PET examination was reported to have extensive BAT that could not be distinguished from actual disease. The patient underwent a repeat examination 3 weeks later following the oral administration of 80mg of propranolol. Jacobsson, et al. (2005) reported a compete resolution of the hypermetabolic BAT. Following Jasobsson, et al.'s (2005) revelation several groups of investigators have conducted studies into the use of propranolol as an effective means of preventing hypermetabolic BAT on ^{18}F-FDG PET.

Soderlund (Soderlund, Larsson, & Jacobsson, 2007) investigated 11 patients that were reported to have BAT on their PET scans by performing a second examination 5 days post the first PET study. Prior to the administrated of ^{18}F-FDG the patients were given 80mg of propranolol orally. All patients showed a complete or almost complete disappearance of BAT on the second PET examination ($P< 0.001$) (Soderlund, et al., 2007). Disease that was present with some of the patients on their first PET scan remained unchanged, suggesting that the oral administration of propranolol prior ^{18}F-FDG does not alter the biodistribution within tumours. Soderlund, et al. (2007) also reported that propranolol had the ability to reduce cardiac uptake of ^{18}F-FDG, although the difference was not significant. Agrawel (Agrawal, et al., 2009) reported a similar success rate in the reduction of hypermetabolic BAT following the administration of propranolol. 40

patients (14 females and 26 males) who demonstrated BAT on an initial PET scan were re-examined following the oral administration of 40mg of propranolol. The repeat PET scan was repeated 48 hours post the initial scan, and the propranolol was administered 60 minutes prior to ^{18}F-FDG. Patients taking β-blockers were excluded from the study. 90% of patients demonstrated a complete clearance of ^{18}F-FDG from BAT on their second PET scan. Agrawel, et al. (2009) suggest that the BAT observed in 10% of patients may have been due to the external influences on hypermetabolic BAT such as anxiety level, temperature and blood glucose level; as these factors were not controlled during the investigation.

Parysow (Parysow, et al., 2007) also investigated the effectiveness of oral propranolol and reported a similar success rate as Agrawel, et al. (2009) and Soderlund, et al. (2007). 26 patients that had been previously identified at having hypermetabolic BAT on PET were administered 20mg of oral propranolol 60mins prior to ^{18}F-FDG. 24 patients (92.3%) demonstrated no BAT after being administered with the propranolol. The remaining 7.69% of patients still demonstrated BAT, although the distribution and SUV_{max} was reduced, but not significantly.

Tatsumi (Tatsumi, et al., 2004) conducted an extensive investigation using rats, similar to that of Baba, et al. (2007). Three groups of rats were anaesthetised and each of the groups were administered propranolol, diazepam or reserpine (an antihypertensive) intraperitoneally post anaesthesia. The dose administered were 5mg/kg of propranolol 20mins prior to ^{18}F-FDG, 4mg/kg of reserpine 4 h prior to ^{18}F-FDG, and 2.5mg/kg of diazepam 30min prior to ^{18}F-FDG. A control group was also included and received no medication prior to ^{18}F-FDG. 60 minutes following ^{18}F-FDG injection, the rats were sacrificed, interscapular BAT removed and examined under microscope and measured for the presence of ^{18}F-FDG. Tatsumi, et al. (2004) demonstrated propranolol to be the most effective medication in reducing the ^{18}F-FDG uptake in BAT, reducing it to just 16% of the control value.

Reserpine was also effective, reducing BAT activity to 28% of the control. Diazepam was also effective in reducing the ^{18}F-FDG uptake in BAT, but the result was not statistically significant, achieving only a 64% reduction when compared to the control. The administration of propranolol one hour prior to the administration of ^{18}F-FDG has been demonstrated at the most effective pharmaceutical in reducing the incidence of hypermetabolic BAT on PET. The reported success rate is approximately 90% (Agrawal, et al., 2009; Parysow, et al., 2007; Soderlund, et al., 2007; Tatsumi, et al., 2004). Given the evidence that there is a strong relationship between temperature exposure and BAT appearance (Cohade, Mourtzikos, et al., 2003; Kim, et al., 2008) the effectiveness of controlling the temperature of the patients environment prior to ^{18}F-FDG administration has been under investigated.

Christensen, et al. (Christensen, Clark, & Morton, 2006) proved that by attempting to control the patients environmental temperature prior to ^{18}F-FDG injection, hypermetabolic BAT could be reduced just as effectively as with the administration of propranolol. During the investigation, 10 patients were selected that had previously demonstrated BAT on their PET scan. 3 patients were provided with warm blankets from a blanket oven during the uptake period, 4 patients were instructed to stay in a warm environment for 48 hours prior to their scan and 3 patients were instructed to stay in a warm environment for 48 hours prior to their scan and given 5mg of oral diazepam at the time of ^{18}F-FDG injection ((Christensen, et al., 2006). Patients underwent PET/CT at 60mins following injection. All but one patient (90%) showed complete resolution of hypermetabolic BAT on their second scan. This success rate in the reduction of BAT is comparable with that achieved using propranolol, although the sample size within this study is small. In a similar sized study Garcia, et al. (Garcia, et al., 2006) re-evaluated 10 patients who were reported to have hypermetabolic BAT on an initial PET scan. Patients were instructed to wear warm winter-type clothing prior to their scan and during transit from home to the PET centre and pre-warm their car's interior to room temperature. Upon arrival to the PET centre, patients were placed in a temperature controlled room and provided with warm blankets. Warm blankets were also provided during the uptake period. Four observers assessed the PET scans for any presence of hypermetabolic BAT and reported no BAT visualisation in 70-90% of patients (allowing for inter-observer variability).

Both Christensen, et al. (2006) and Garcia, et al. (2006) have reported a high level of success (70-90%) in reducing hypermetabolic BAT on ^{18}F-FDG PET through simply attempting to control the patients environmental temperature prior to their scan. These figures are despite small sample sizes and are comparable with that achieved using pharmaceuticals such as propranolol. Surprisingly, despite a similar success rate there have been limited investigations into the use of warming techniques.

Conclusion

Hypermetabolic BAT, when present, has the potential to reduce the accuracy of ^{18}F-FDG PET. Whenever possible, an attempt must be made to reduce its appearance. Hypermetabolic BAT has been visualised in all types of patients but a higher incidence has been observed in female patients, the paediatric population and those patients with a low BMI. The appearance of BAT appears to be as a consequence of the environmental temperature of the patient prior to their PET scan. Pharmaceutical

intervention has proven to be successful in reducing the appearance, with oral propranolol proving the most successful. Several small studies into environmental temperature control prior to scanning have demonstrated a similar success. Although highly effective, the administration of propranolol to patients does not come without risks or the need to manage outpatients following administration. The use of warming techniques comes with relative ease when compared to pharmaceutical intervention and there is a need to conduct further investigations to emphasise their effectiveness.

REFERENCES

Agrawal, A., Nair, N., & Baghel, N. S. (2009). A novel approach for reduction of brown fat uptake on FDG PET. [Journal Article]. *The British Journal of Radiology, 82*, 626-631.

Baba, S., Engles, J. M., Huso, D. L., Ishimori, T., & Wahl, R. L. (2007). Comparison of Uptake of Multiple Clinical Radiotracers into Brown Adipose Tissue under Cold-Simulated and Nonsimulated Conditions. [Journal Article]. *J Nuclear Medicine, 48*, 1715-1723.

Celi, F. (2009). Brown Adipose Tissue - When it Pays to Be Inefficient. [Journal Article]. *New England Journal of Medicine, 306*(15), 1553-1556.

Christensen, C. R., Clark, P. B., & Morton, K. A. (2006). Reversal of Hypermetabolic Brown Adipsoe Tissue in F-18 FDG PET Imaging. *Clinical Nuclear Medicine, 31*(4), 193-196.

Cohade, C., Mourtzikos, K. A., & Wahl, R. L. (2003). "USA-Fat": Prevalence Is Related to Ambient Outdoor Temperature - Evaluation with ^{18}F-FDG PET/CT. [Journal Article]. *J Nuclear Medicine, 44*, 1267-1270.

Cohade, C., Osman, M., Pannu, H. K., & Wahl, R. L. (2003). Uptake in Supraclavicular Area Fat ("USA-Fat"): Description on ^{18}F-FDG PET/CT. [Journal Article]. *J Nuclear Medicine, 44*, 170-176.

Cypess, A. M., Lehman, S., Williams, G., Tal, I., Rodman, D., Goldfine, A. B., et al. (2009). Indentification and Importance of Brown Adipose Tissue in Adult Humans. *New England Journal of Medicine, 360*(15), 1509-1517.

Evans, K. D., Tulloss, T. A., & Hall, N. (2007). ^{18}FDG Uptake in Brown Fat: Potential for False Positives. [Journal Article]. *Radiologic Technology, 78*(5), 361-366.

Garcia, C. A., Nostrand, D. V., Acio, A. E., Bulter, C., Esposito, G., Kulkarni, K., et al. (2006). Reduction of Brown Fat 2-Deoxy-2-[F-18] fluoro-D-glucose Uptake by Controlling Environmental Temperature Prior to Positron Emission Tomography Scan. *Molecular Imaging and Biology, 8*, 24-29.

Gelfand, M. J., O'Hara, S. M., Curtwright, L. A., & MacLean, J. R. (2005). Pre-medication to block [^{18}F]FDG uptake in the brown adipose tissue of pediatric and adolescent patients. *Pediatric Radiol, 35*, 984-990.

Hany, T. F., Gharehpapagh, E., Kamel, E. M., Buck, A., Himms-Hagen, J., & von Schulthess, G. K. (2002). Brown adipose tissue: a factor to consider in symmetrical tracer uptake in the neck and upper chest region. *European Journal of Nuclear Medicine, 29*(10), 1393-1398.

Jacobsson, H., Bruzelius, M., & Larsson, S. A. (2005). Reduction of FDG upatke in brown adipose tissue by propranolol. *Eur J Nucl Med Mol Imaging, 32*, 1130.

Kim, S., Krynyckyi, B. R., Machac, J., & Kim, C. K. (2008). Temporal relation between temperature change and FDG uptake in brown adipose tissue. *Eur J Nucl Med Mol Imaging, 35*, 984-989.

Nedergaard, J., Bengtsson, T., & Cannon, B. (2007). Unexpected evidence for active brown adipose tissue in adult humans. *Am J Physiol Endocrinol Metab, 293*, E444-E452.

Paidisetty, S., & Blodgett, T. M. (2009). Brown Fat: Atypical Locations and Appearances Encountered in PET/CT. *AJR, 193*, 359-366.

Parysow, O., Mollerach, A. M., Jager, V., Racioppi, S., Roman, J. S., & Gerbaudo, V. H. (2007). Low-Dose Oral Propranolol Could Reduce Brown Adipose Tissue F-18 FDG Uptake in Pateints Undergoing PET Scans. *Clinical Nuclear Medicine, 32*, 351-357.

Soderlund, V., Larsson, S. A., & Jacobsson, H. (2007). Reduction of FDG Uptake in brown adipose tissue in clinical patients by a single dose of propranolol. *Eur J Nucl Med Mol Imaging, 34*, 1018-1022.

Tatsumi, M., Engles, J. M., Ishimori, T., Nicely, O., Cohade, C., & Wahl, R. L. (2004). Intense ^{18}F-FDG Uptake in Brown Fat Can Be Reduced Pharmacologically. *J Nuclear Medicine, 45*, 1189-1193.

Truong, M. T., Erasmus, J. J., Munden, R. F., Marom, E. M., Sabloff, B. S., Gladish, G. W., et al. (2004). Focal FDG Uptake in Mediastinal Brown Fat Mimicking Malignancy: A Potential Pitfall Resolved on PET/CT. *AJR, 183*, 1127-1132.

van Marken Lichtenbelt, W. D., Vanhommerig, J. W., Smulders, N. M., Drossaerts, J. M. A. F. L., Kemerink, G. J., Bouvy, N. D., et al. (2009). Cold-Activated Brown Adipsoe Tissue in Healthy Men. *New England Journal of Medicine, 360*(15), 1500-1508.

Virtanen, K. A., Lidell, M. E., Orava, J., Heglind, M., Westergren, R., Niemi, T., et al. (2009). Functional Brown Adipose Tissue in Healthy Adults. *New England Journal of Medicine, 360*(15), 1518-1525.

Weber, W. A. (2004). Brown Adipose Tissue and Nuclear Medicine Imaging. *J Nuclear Medicine, 45*(7), 1101-1103.

Williams, G., & Kolodny, G. M. (2008). Method for Decreasing Uptake of ^{18}FDG by Hypermetabolic Brown Adipose Tissue on PET. *AJR, 190*, 1406-1409.

Yeung, H. W., Grewal, R. K., Gonen, M., Schoder, H., & Larson, S. M. (2003). Patterns of ^{18}F-FDG Uptake in Adipose Tissue and Muscle: A Potential Source of False-Positives for PET. *J Nuclear Medicine, 44*, 1789-1796.

Continuing Professional Development – Question and Answer Sheet

Article title: Brown Adipose Tissue and ^{18}F-FDG PET.

Your name: _____

RAINS Member Number: _____

Answer the following questions and return the completed sheet before the middle of the month to: RAINS
PO Box U102 or
Charles Sturt University seasonal@rains.asn.au
Wagga Wagga NSW 2678

1). Initially, the appearance of BAT was thought to be what?

2). What are the five common locations of BAT?

3). What are the unique characteristics of BAT?

4). How does 18F-FDG localise in BAT?

5). Describe some characteristic s of a patient that may be more likely to have activated BAT on 18F-FDG PET.

6). Describe the relationship between temperature and the incidence of BAT.

7). What is the proposed action by which the administration of propranolol appears to block the appearance of BAT on 18F-FDG PET?

8). Soderlund, et al. (2007) administered 80mg of propranolol to patients prior to their PET scan. What was their success rate in reducing the appearance of BAT?

9). What effective technique that can be utilised in the reduction of BAT on 18F-FDG PET has been under-investigated?

Crossword Puzzles

The ANZSNM is now accepting a broader variety of CPD activities. Crossword puzzles now attract 1 CPD point when completed. You are not required to submit them for marking. The CPD requirements of the ANZSNM simply require that you record in your CPD diary that a CPD activity was undertaken. This has been confirmed in writing by the ANZSNM. So complete the crosswords below (and other CPD activities) and record these activities in your diary as proof in the event that you are audited.

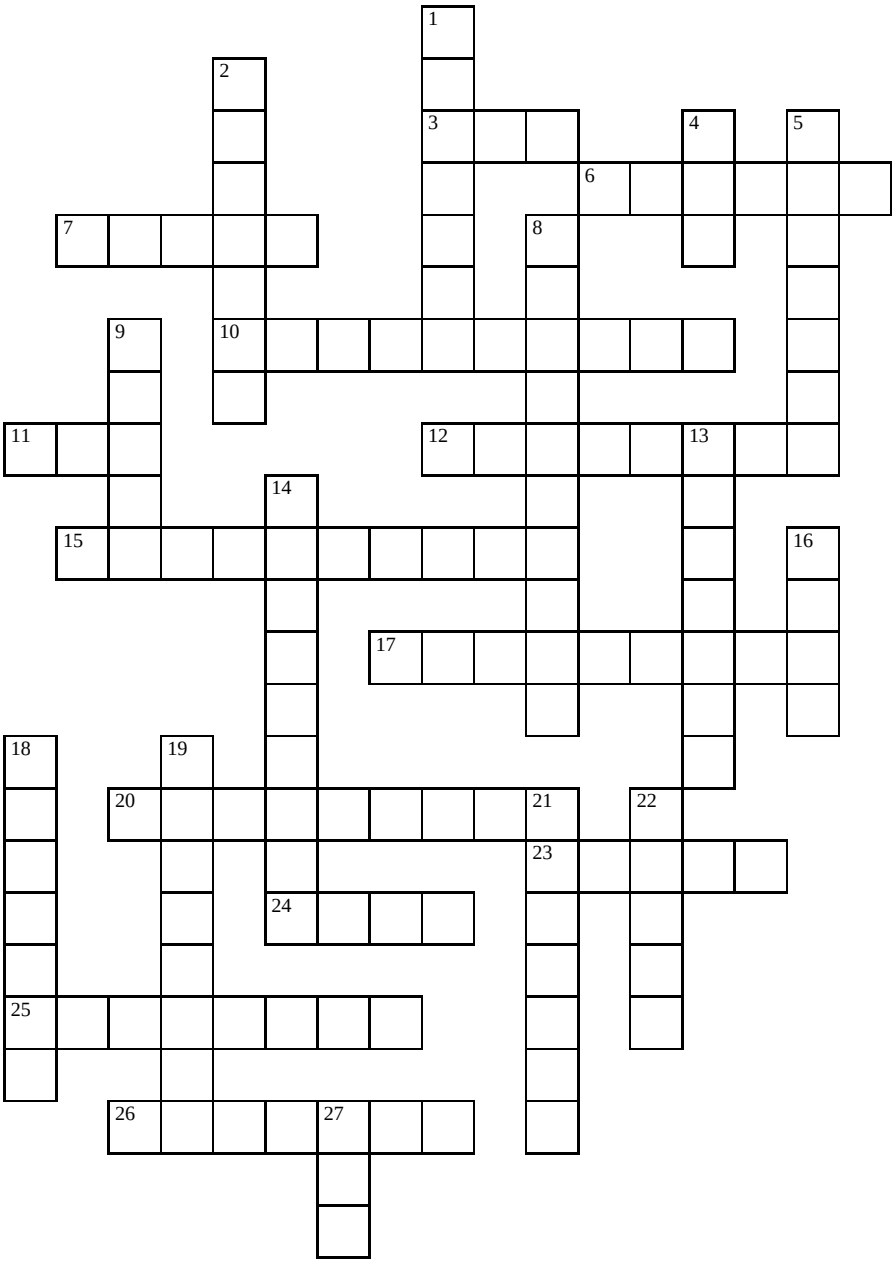
Submit your crossword. You can use the free puzzle maker at http://www.puzzle-maker.com/CW/

Save the puzzle and solutions as a webpage and send to seasonal@rains.asn.au

Radiopharmacy

Geoff Currie

Charles Sturt University.



Radiopharmacy Clues

ACROSS

3 Approximate half life of 99Tc _____ hours
6 Approximate half life of 11C _____ minutes
7 Principle of radiation safety
10 Transition metal that is element 43 on periodic table
11 Half lives required to decay to 'background'
12 'D' in TDS
15 18F based dopamine receptor tracer
17 201Tl produced in a _____
20 'S' in TDS
23 Decay constant
24 'T' in TDS
25 Generator based PET blood flow agent 82-_____
26 Where 99Mo is produced

DOWN

1 How 99Mo is produced
2 67Ga radiochemical gallium _____
4 Approximate half life of 13N _____ minutes
5 Method of disposal of 99mTc waste; decay by _____
8 The 'm' in 99mTc
9 System imaged using mertiatide
13 How 89Sr is produced _____ activation
14 Type of equilibrium for the Mo/Tc generator
16 Imaged with medronate
18 System imaged with 99mTc disofenin
19 201Tl radiochemical thallous _____
21 'G' in FDG
22 More common abbreviated name fro exametazime
27 Approximate half life of 15O _____ minutes

Acronym Clues

ACROSS

1 Positron emission tomography
3 Magnetic resonance imaging
7 ECG
8 Diethylenetriamine pentaacetic acid
9 Not for resusitation
12 Rural alliance in nuclear scintigraphy
17 MAG3
18 Hydroxymethan diphosphonate
20 EEG
25 Roentgen absorbed dose
27 Prospective investigation of pulmonary embolism diagnosis
28 3,4-dihydroxy-6-[18F]fluoro-phenylalanine
30 Pulomonary embolism
31 Methylene diphosphonate
32 Dimercaptosuccinic acid
33 Radiology information system
35 Gastrointestinal tract
37 MBq
38 Chronic obstructive pulmonary disease
40 Heart rate
41 Fluorine-18 2-fluoro-deoxyglucose
43 Myocardial infarction
46 Ethyl cysteinate dimer
47 Statim (immediately)
48 Monoclonal antibody
49 IV

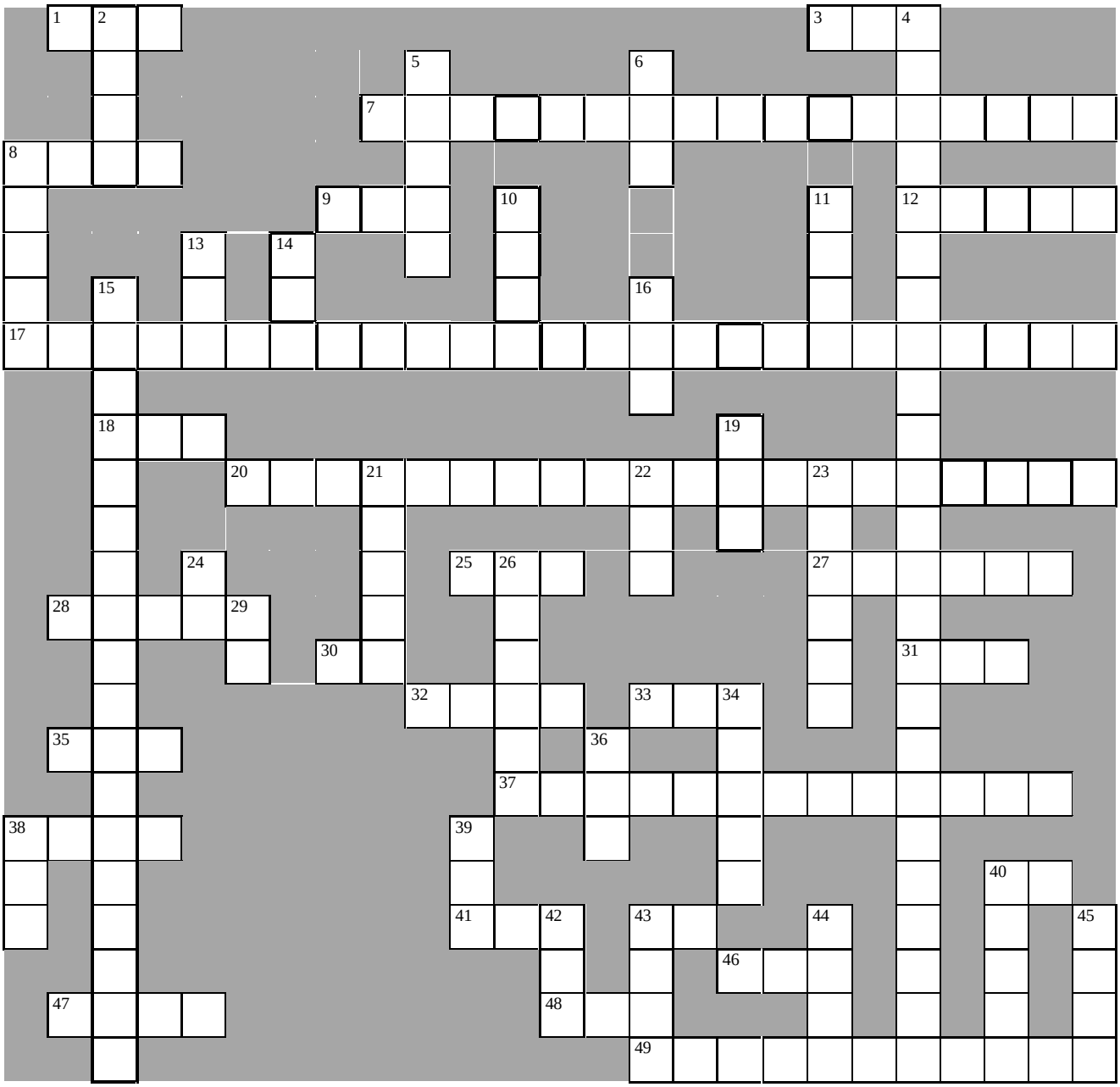
DOWN

2 Ethane-1-hydroxy-1, 1-diphosphonate
4 IMP
5 As low as reasonably achievable
6 Region of interest
8 Digital imaging and communications in medicine
10 Mini-mental state examination
11 Meta-iodobenzylguanidine
13 Carcinoembryonic antigen
14 O-(2-[18F]fluoroethyl)-L-tyrosine
15 OIH
16 [18]F-3'-deoxy-3'-fluorothymidine
19 Counts per minute
21 Ci
22 Coronary artery disease
23 Amp
24 Blood pressure
26 Australian and New Zealand society of nuclear medicine
29 Alzeimer's disease
34 Single photon emission computed tomography
36 Bismuth germinate
38 Cerberal blood flow
39 Neck of femur
40 Hexamethylpropyleneamine oxime
42 Glioblastoma multiforme
43 Methoxy isobutyl isonitrile
44 Ethylene-diamine-tetra-acetic acid
45 Picture archiving and communication system

Acronyms

Geoff Currie

Charles Sturt University.



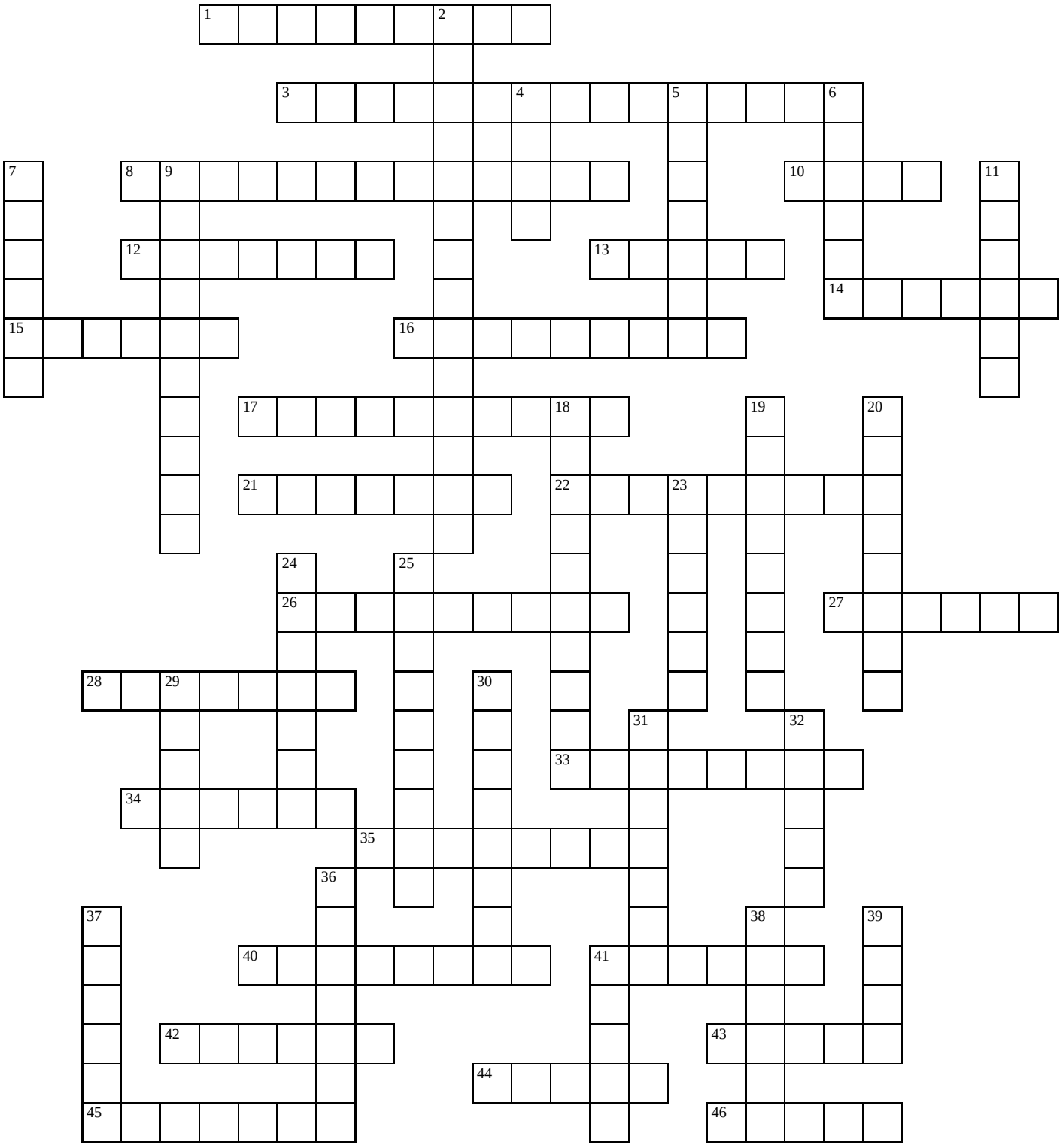
Submit your crossword. You can use the free puzzle maker at http://www.puzzle-maker.com/CW/

Save the puzzle and solutions as a webpage and send to seasonal@rains.asn.au

Musculoskeletal Gross Anatomy

Geoff Currie

Charles Sturt University.



Musculoskeletal Gross Anatomy Clues

ACROSS

1 Finger and toes
3 Abdominal muscle (6,9)
8 Calf muscle
10 Forearm bone
12 Shoulder muscle
13 C1 spine
14 Pelvic based section of spine
15 Spine region of rib attachment
16 Midfoot bone
17 Thigh muscle
21 Upper arm bone
22 Heel bone
26 Irregular midfoot bones
27 Tip of spine
28 Upper arm muscle
33 Carpal bone (s_____)
34 Lower non fused spine region
35 Carpal bone (c_____)
40 Collar bone
41 Bones of the ankle
42 Midfoot bone
43 Bone of the hind foot
44 Midline pelvic bone
45 Breast bone
46 Upper leg bone

DOWN

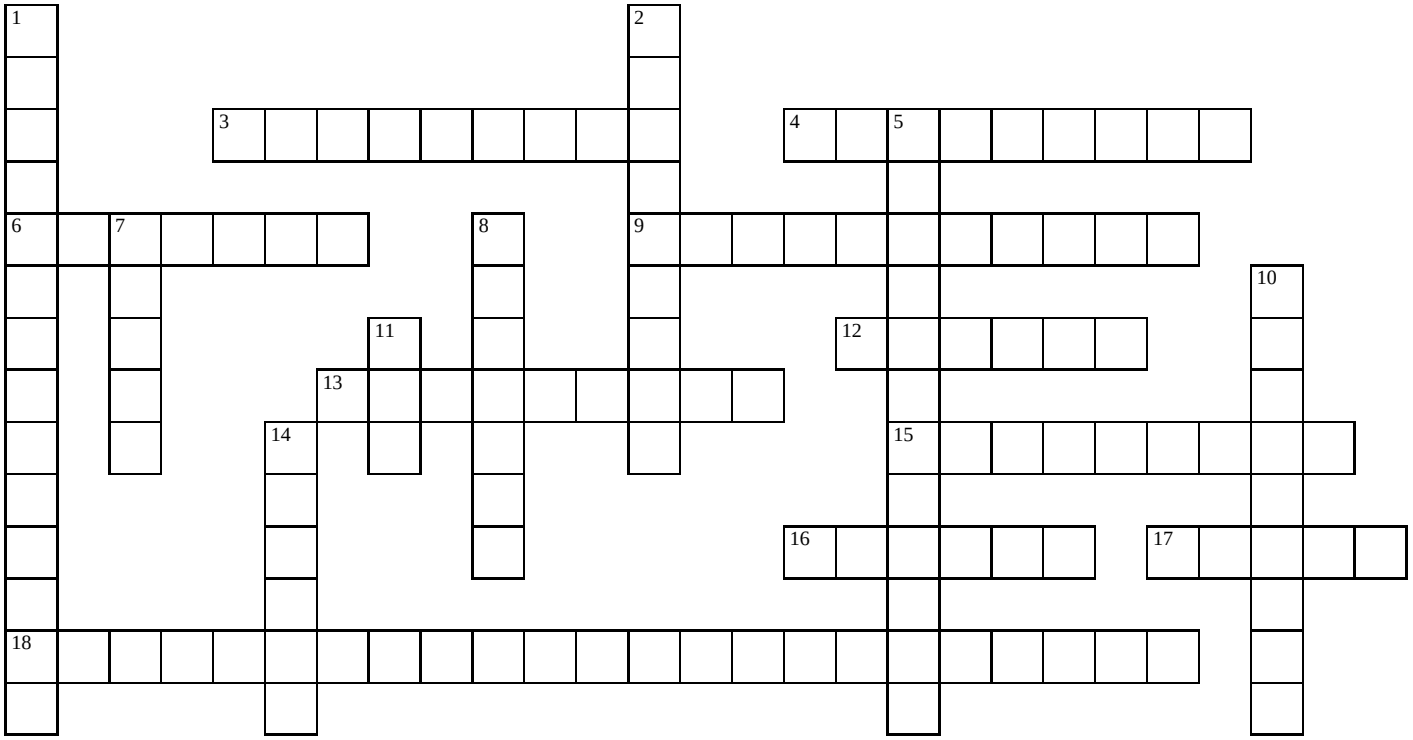
2 Bum muscle (7,7)
4 C2 spine
5 Upper jaw
6 Lower leg muscle
7 Carpal bone (l_____)
9 Hip bone
11 Lower leg bone
18 Chest muscle
19 Lower jaw
20 Carpal bone (p_____)
23 Bones of the wrist
24 Shoulder girdle
25 Sub unit of spine
29 Pelvic bone
30 Region of upper spine
31 Knee bone
32 Upper arm muscle
36 Skull bones
37 Forearm bone
38 Carpal bone (h_____)
39 Bones protecting the chest contents
41 Lower leg bone

Crossword Puzzle Challenge

The crossword puzzle offers a very efficient tool for gaining CPD points. It does not take long to create. The puzzles below were team efforts from the respective departments and the authors (and their departments) issue a challenge to other nuclear medicine departments to form a team and create a better crossword puzzle for the next newsletter. There should, however, be some ground rules. Firstly, the crossword needs to be on a specific theme (eg. PET, GIT imaging, SPECT/CT etc) not just general nuclear medicine. Secondly, the puzzle needs to contain between 30-40 clues. Submit your department crossword for the next edition of the newsletter.

PRP Crossword

PRP Diagnostic Imaging Team Effort



ACROSS

3 The bone of insertion of the Achilles tendon.
4 Pathology indicated if myocardial perfusion at rest is normal while the stress shows an area of decreased perfusion.
6 Type of ultrasound used to diagnose DVT.
9 Liver mass detected on a Tc-RBC scan.
12 Most likely cause of fractures.
13 Isotope used for bone palliation.
15 Likely pathology demonstrated on Bone scan as hot spots in the ribs which appear to be in a straight line.
16 Increased alkaline phosphate is an indicator for which common bone pathology.
17 Interventional drug commonly used in renal imaging for PUJ obstruction.
18 MIBG.

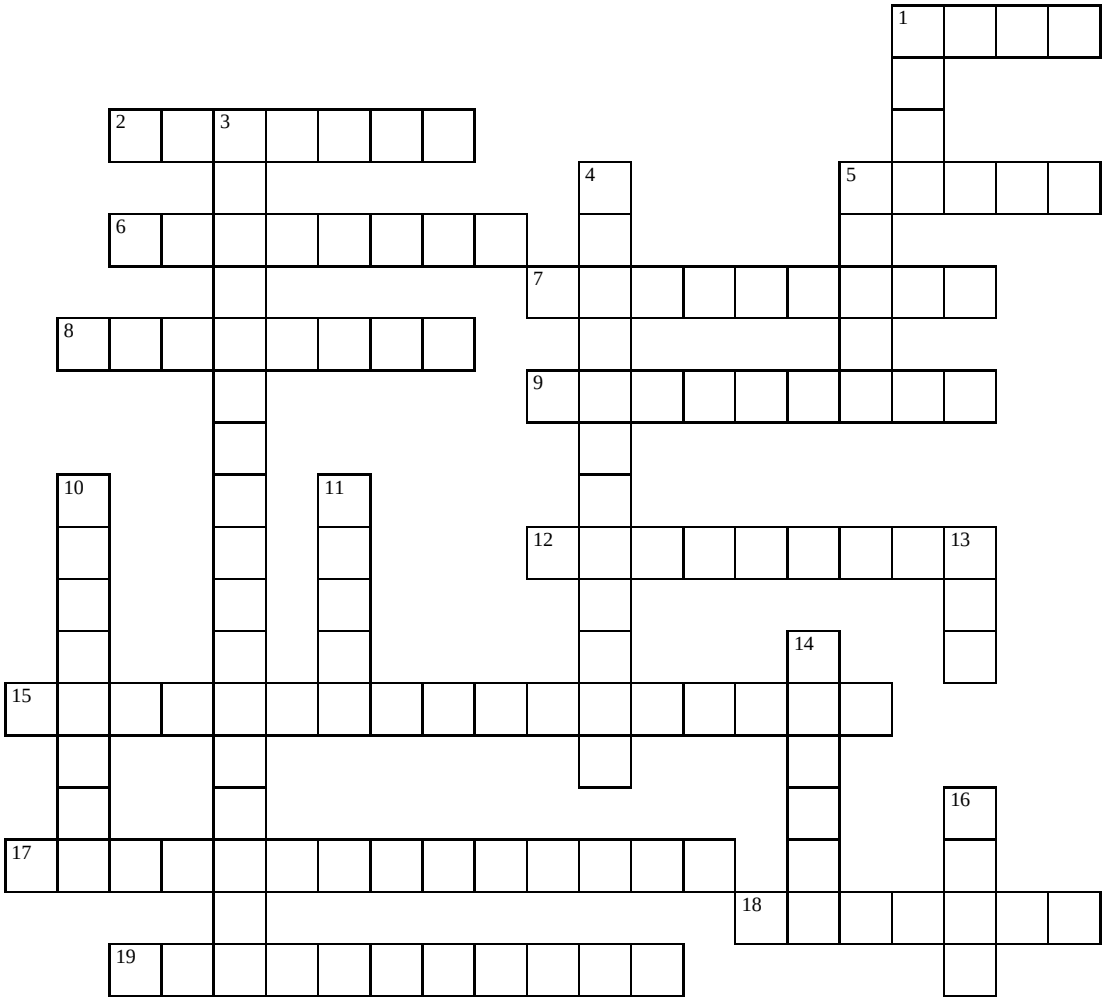
DOWN

1 Primary malignant tumour of bone whose cells produce hyaline cartilage resulting in abnormal cartilage and - or bone.
2 The medical term for the symptom of difficulty in swallowing.
5 Process of separating blood.
7 _____ imaging: A technique used in myocardial perfusion imaging to correct for diaphragmatic attenuation.
8 What does the E stand for in VEB in relation to stress testing.
10 Term used to describe a WB bone scan showing diffusely increased bony uptake with absent or near complete absence of soft tissue, renal, and bladder tracer activity.
11 Initials for the agent used in lymphoscintigraphy.
14 Pharmaceutical used in evaluating loss of or decrease blood supply in cerebral perfusion studies.

Nuclear Medicine

Michael Crook

Toowoomba Nuclear Imaging.



ACROSS

1 Nuc med techs always work _____?
2 Haemangiomas are deficient in these cells
5 Spinal joint
6 Needed to reduce pertechnetate prior to tagging a chelate.
7 Mechanism of lung perfusion radiopharmaceutical localisation. _____ blockade
8 PET pharmaceutical
9 Conceived the tracer principle
12 Early bone imaging agent
15 Treated with P32
17 Imaged with MIBG
18 Pelvic bone
19 Required in Gallium localisation

DOWN

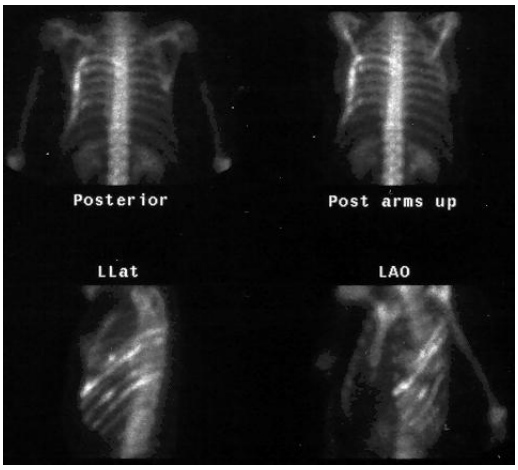
1 Antibody response
3 Neural crest tumour
4 Liver-spleen mechanism of uptake
5 A response which occurs following Metastron therapy
10 Tl-201 is a potassium _____?
11 Time magazines year 2000 invention of the year
13 Bone scan agent
14 Autoimmune condition
16 DMSA (dimercaptosuccinid _____)

What The ……. ?

Geoff Currie

Charles Sturt University.

Chest statics from a wholebody bone scan. Solution in the next issue.



Send your 'What The …… ?' image, solution and author details to seasonal@rains.asn.au

What The …..? Solution For Last Edition

Monostotic Paget's disease of the heel

RAINS CPD Initiatives.

The following initiatives have been developed by RAINS to facilitate achievement of the 30 CPD points for RAINS members. These are proposed activities that mirror activities approved by the ANZSNM with some modification for more ready use in the rural environment.

Activity	Description	CPD Points
E-Grand Rounds	RAINS members can submit a power point presentation of one or more clinical cases. Content should include patient history, scan methodology, other imaging procedures, relevant technical information, final report and patient outcomes of 20-30 minutes View, read and submit review questions (80% pass mark).	2 presenter points 1 attendee point
Continuing Education Articles and Tests	Each issue of Seasonal RAINS will contain 1 or more continuing education articles with tests. Completion of the tests and submission back to RAINS with an 80% pass mark will attract CPD points.	2 per test
Writing CPD articles/tests	RAINS members are encouraged to write fully referenced and scientific continuing education articles accompanied by 10 'test' questions and submit for distribution in Seasonal RAINS.	3 per article published
Short Courses and workshops	CSU in conjunction with RAINS and the ACT Branch of the ANZSNM organise an annual 2 day CE workshop in Wagga.	4 points
In-service Education	Provide 30 minute power point presentation with narration for inclusion on CPD CD, including written question). View, read and submit review questions (80% pass mark).	2 presenter 1 attendee
Book / journal review	Write a considered book review (nuclear medicine) or journal article review for inclusion in Seasonal RAINS (1 page).	2 points
Professional Development Plan	RAINS will develop and circulated a professional development plan template for members wishing to use it.	1 point pa
Crosswords	Complete the crossword and make a notation in your CPD diary.	1 point per

The Doctor of Health Science

Introduction
The Doctor of Health Science (DHlthSc) at CSU is a professional doctorate that allows candidates to pursue a research higher degree of the same standard as the PhD but within a structure that is aimed at improving professional practice. Specifically, it offers a research based approach for provision of solutions relevant to the professions and industry.

Professional doctorates aim to provide a tool for advanced research enabling candidates to contribute in a significant way to the knowledge and practice in their profession or discipline area. Consequently, candidates enrolled in professional doctorates tend to be more intrinsically motivated aiming to improve professional practice and enhance job satisfaction.

Course Structure
The DHlthSc is offered by part-time distance education mode and is composed of coursework and an applied research/professional component. Student's progress through the research/professional component of the DHlthSc is monitored by the requirement that students complete subjects in sequence thus meeting pre-defined milestones. The applied research/investigation allows students to develop a research question or topic for investigation by conducting an intensive literature review, critique and reflecting on their professional practices.

The DHlthSc culminates in a professional portfolio (including an exegesis), which integrates the research/investigation within their professional practice. The professional portfolio incorporates reports, papers and publications prepared throughout the course with an exegesis to link the results back to the profession and professional practice, and original question on which the research or investigation is based. The professional portfolio with exegesis is subjected to external examination in accordance with University regulations.

The duration of the DHlthSc is the equivalent of 4.5 years part time enrolment.

Enrolment Pattern
HSC700 Research Critique and Publication
HSC701 Reflective Practice in Health Science
HSC702 Proposal For Applied Research
HSC703 Research Project and Report 64 Points
HSC704 Health Science Portfolio / Exegesis

CHARLES STURT
UNIVERSITY

Admission Requirements
For admission to the DHlthSc applicants would need to demonstrate that they:

- are working in an appropriate field within, or relevant to, the Health Professions and can demonstrate they have the opportunity and facilities to complete the applied research/investigation components of the course; and
- have had a minimum of 3 years of relevant professional and/or vocational experience (with relevance being determined by the DHlthSc Course Coordinator in conjunction with the proposed principal supervisor); and
- normally hold a Masters degree or equivalent (by coursework) in an approved area of Health Sciences, with credit grades or above in all subjects undertaken.

Course Aims and Objectives
The DHlthSc promotes an advanced, critical reflection on professional practice in the health sciences and aims to:

- provide opportunity for the candidates to continue lifelong learning in keeping with the university's mission statement;
- satisfy the educational needs of professionals working in or aspiring to work in the most senior tiers of the health sciences and related sectors;
- promote the acquisition of advanced analytical and problem solving skills and conceptual insights that enhance the capacity of the candidate to undertake positions of significant responsibility in the health sciences;
- encourage excellence in scholarship and focused research within the candidates discipline area.

Course Coordinator
Dr Janelle Wheat
Senior Lecturer, Faculty of Science
Telephone: 61 2 69332750
Email: jwheat@csu.edu.au

For all inquiries please contact info.csu on:
Telephone: 1800 334 733 (free call within Australia)
Telephone: 61 2 6338 6077 (outside Australia)
Email: inquiry@csu.edu.au
Web inquiry: www.csu.edu.au/student/contact

Guidelines for Submissions to Seasonal RAINS

Seasonal RAINS will accept a number of types of submissions. All work must be written in English and submitted in Microsoft Word. All submission must be accompanied by a cover letter (email is sufficient) indicating the type of submission, details of authors and departments, contact details of the corresponding author and a statement indicating that the submission is not subject to copyright elsewhere.

All submissions will be reviewed for appropriateness and accuracy (where relevant). Inclusion in Seasonal RAINS remains the discretion of the editorial board. Preference will be given to submissions consistent with the philosophy and purpose of RAINS.

All submissions should be sent by email to: seasonal@rains.asn.au

Letter To Editor

300-500 word limit.

Interesting Image

1 JPG image and 300 word limit case presentation.

What The … ?

1 JPG image and 100 word limit solution.

News and Events

Summary of recent or upcoming events. Update RAINS member achievements; publication, conference presentation or scholarship.

Book or Journal Article(s) Review

Review of a recently released nuclear medicine text or journal article(s) related to nuclear medicine. Minimum of 1 page.

E-Journal Club

20-30 minute power point presentation of a relevant journal article in Nuclear Medicine. Submissions should include written text and discussion for each slide plus 10 test questions.

E-Grand Rounds

Submit a 20-30 minute review summary and presentation (power point) of one or more clinical cases. Content should include patient history, scan methodology, other imaging procedures, relevant technical information, final report and patient outcomes. Submissions should include written text and discussion for each slide plus 10 test questions.

In-Service Education

Seminars should be submitted as power point presentations with audio narration. Audio recordings should be embedded in the power point presentation (not linked) using a radio quality setting (22kHz, 16 bit, mono). Ensure sound quality is suitable for circulation. Valuable presentation might only be included if narration is re-recorded. Accepted presentations will be included on the RAINS CPD in-service CD. All presentations should be accompanied by 10 review questions. Presentations should be sent by mail to: The Editor, PO Box U102, CSU, Wagga Wagga, 2678.

CPD Articles

Submissions should provide an educational review of an area of interest. The reviews should be well researched and present all valid perspectives. CPD articles may be accepted after review by the editorial board. Alternatively, the submission may be accepted with some suggested revision or deemed not suitable for the purpose intended (CPD). All submission must adhere to the guidelines provided by the *Journal of Nuclear Medicine Technology*; available on the SNM web site (www.snm.org).

CPD articles should be made available for publication without copyright authority elsewhere. Submitting authors accept responsibility for ensuring manuscripts do not breach copyright laws. Seasonal RAINS does not, however, ask that you transfer copyright to RAINS. Thus authors are free to re-publish manuscripts in whole or in part in subsequent journals.

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Advertisement of activities, products or events consistent with the philosophy and purpose of RAINS will occur without charge (including positions vacant).

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THE AUSTRALIAN SCHOOL OF ADVANCED MEDICINE

E Pluribus Unum
out of many, one

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RURAL ALLIANCE IN NUCLEAR SCINTIGRAPHY

CENTRE FOR RESEARCH IN COMPLEX SYSTEMS

CHARLES STURT UNIVERSITY

Integrative Imaging Symposium

7th Annual CPD/CME Conference: IIS2010

Stamford Grand, North Ryde

(Adjacent to Macquarie University, Sydney)

Saturday 13th & Sunday 14th November, 2010

GE Healthcare

cyclopharm

ALFRED HEALTH SOLUTIONS

Making Excellence the Standard

The scientific program is aimed at a trans-disciplinary approach to major health care issues. Integrative imaging explores the synergies between diagnostic imaging modalities with a focus on the modalities comprising molecular imaging:

- PET and PET/CT
- SPECT and SPECT/CT
- CT
- MRI
- Ultrasound
- DR and CR

There is a growing demand for a more comprehensive understanding of the entire patient journey through diagnosis, treatment and follow-up. The blurred boundaries between physiological and anatomical imaging demand a thorough understanding of the steps before and after a patient enters our departments.

Each session in the scientific program will explore the pathophysiology, the roles of relevant diagnostic imaging modalities, current best practice and treatment options for specific pathologies. The program is aimed at technical and nursing staff working in SPECT, PET, CT, MRI, ultrasound and CR/DR although other discipline staff (physicists, physicians) are welcome to attend. The program will comprise 15-20 key note speakers; prominent and established nuclear physicians, radiologists, specialists and scientists from all over Australia.

If you are a Nuclear Medicine Scientist/Technologist, Radiographer, Sonographer or Radiation Therapist, this will be the conference you'll remember in years to come!

Provisional Scientific Program

Time	Saturday	Sunday
9-1030am	CT and PET in diagnosis and management of cancer	Transition from SPECT to PET
11am-1230pm	Novel peptides in cancer therapy; the role of imaging	Medical oncology PET or Endocrine imaging
130-3pm	Imaging advances	Coronary artery disease or Musculoskeletal imaging
330-5pm	PACS/RIS, ECG Tutorial or Cross sectional workshops	PE/DVT or PET and MRI in dementia
6-7pm	Pre-dinner drinks	
7pm	Conference dinner	

Morning tea from 1030am-11am
Lunch from 1230pm-130pm
Afternoon tea from 3pm-330pm

Scientific Program Registration

Registration fee includes:
- All scientific program sessions
- Morning tea Saturday and Sunday
- Buffet lunch Saturday and Sunday
- Afternoon tea Saturday and Sunday

Conference dinner:
- 3 course buffet meal at the Stamford Grand
- 3 hours of superior beverage service during dinner
- 1 hour of superior beverage service at pre-dinner drinks

Early Bird Registration!

Note:
- Day registration includes morning tea, lunch and afternoon tea on the day of registration.
- Early bird registration discounts apply before the end of the financial year.
- CE and CPD point applications pending.
- Book accommodation directly with Stamford Grand , North Ryde using the conference discount rates of $170 for a superior room (02 9888 1077). Executive and family suites are also available.
- Alternative accommodation can be organised at the Travelodge at Macquarie University.
- Send a RAINS membership application (free) with this form and receive the member discount (www.rains.asn.au).

Check Appropriate Box	Scientific Program	Elective Activities
RAINS Member before 1/7/10	$100 ☐	**Preferred Saturday workshop:**
Non Member before 1/7/10	$125 ☐	RIS/PACS ☐
RAINS Member	$125 ☐	ECG ☐
Non Member	$150 ☐	Cross sectional ☐
Saturday Only*	$80 ☐	
Sunday Only*	$80 ☐	
Conference Dinner (Saturday night)	$75 delegate ☐ $100 guest ☐	

Please return this form with payment (cheque or money order made payable to 'RAINS') **to:**

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PO Box U102, CSU, Wagga Wagga 2678.

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Please send completed registration form ASAP after direct deposit, and provide the date of direct deposit and amount.

Date of deposit:
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Organisation: _____

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Please circle an appropriate descriptor: Medical Technical Nursing Scientist Other: _____

Please circle appropriate expertise: SPECT PET CT MRI US Therapy Other: _____

Please check this box if you do not want your details made available to sponsors: ☐

2009 Conference Report
B2B09: Back to Basics CPD Conference

Matt Ayers, RAINS President.

On the weekend of the 10/11 October, Charles Sturt University and RAINS co-hosted the annual CPD conference. The 'Back to Basics' theme aimed to discuss and disseminate knowledge and skills transferable to actual clinical practice. The venue was ideal at the Diamond Beach Resort near Forster, although the weather was disappointing.

Based on delegate, sponsor and committee feedback, the weekend was an enormous success; surpassing both plenary and social program expectations.

Welcome drinks on Friday night were largely prohibitive of most attending the Saturday morning beach Tai Chi although most managed to find their way to the buffet breakfast. The Saturday sessions commenced with Professor Hosen Kiat, who regaled delegates with some wonderful anecdotes before taking us on a journey from our cardiac imaging roots to the latest in cardiac molecular imaging; painting an optimistic picture of the evolving role of myocardial perfusion imaging. Professor Doug Howarth reminded delegates of the role and power of oesophageal transit studies and GIT bleeding scintigraphy.

Morning tea freshened the palate for an insightful examination of bone scintigraphy and the role of SPECT/CT by Dr Shane Morony. Dr Emlyn Jones followed with a captivating presentation of the importance of parathyroid imaging. Ian Turner from ARI/PETNET (our major sponsors) rounded out the session with an overview of the changing world of Mo-99 and a comparative situation analysis between Australia and our international colleagues.

Lunch and an afternoon of social activities (tennis, volleyball, dayspa, beach) afforded an opportunity to digest and discuss delivered content. InMed kindly provided pre-dinner drinks to lubricate the evenings festivities. The social dinner was a culinary delight in the award winning resort restaurant 'surpassed' only by the unsolicited entertainment of a number of delegates who will remain unnamed (singing, dancing and instrument playing). Despite the social activities, for many, extending into the early hours of Sunday morning, delegates faced Sunday breakfast and session three with vigour.

Prof Doug Howarth provided an enlightening analysis of lung scintigraphy and encouragement to all to "get off the PIOPED fence". Dr Emlyn Jones mediated discussion on renovascular hypertension which was absorbing. Llewelyn Clack and Melissa Earl presented stimulating interesting case studies.

The final session saw a riveting presentation from Nathan Cassidy on breast lymphoscintigraphy and sentinel node biopsy followed by an insight into making the transition from NMT to MRI technologist from Coralea Kaaser and finishing with Dr Geoff Currie presenting the pharmacological basis of interventional nuclear cardiology. A scrumptious BBQ lunch followed the RAINS AGM before delegates departed well informed, well fed, and not so well rested.

The enthusiasm of attendees and the robust discussion generated by each of the speakers highlighted the importance and relevance of the topics to current clinical practice.

The organising committee would like to extend a warm thank you to presenters, delegates and our sponsors (ARI,PetNet, InMed, GMS, Cyclomedica, RAINS, Siemens, GE Healthcare, Insight and Charles Sturt University,) without whom the program could not have been achieved. We invite all ANZSNM members and colleagues to participate in 2010.

Rural Alliance In Nuclear Scintigraphy - (RAINS)

APPLICATION FOR MEMBERSHIP

There are no membership fees for RAINS in 2008.

Please send complete forms to:
RAINS
PO Box U102
Charles Sturt University
NSW 2678

Or email to:
membership@rains.asn.au

I wish to apply for membership to RAINS and, if accepted as a member, I undertake to comply with the RAINS Charter.

See membership guidelines (please tick):

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Professional Category (please tick):

Technologist/Scientist ……. ☐ Physician ……... ☐
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Nurse …… ☐ Registrar …… ☐
Radiopharmacist ……. ☐ Student Technologist (specify uni) ☐
Other (please specify) ……..... ☐ ……..…

Are you a member of (please tick):

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I agree to have my telephone number and email address included on the RAINS database and circulated amongst RAINS members.

Signature: _____ Date: _____

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