Breast research in collaboration with the University of Salford

This series of articles from Peter Hogg et al has outlined a transitional process of change management, revision of strategic research aims, and consequent research outcomes. In this final article the approach to, and significance of, their research in mammography is discussed.

Introduction and background
This is the third and final article in the series of three; this article focuses on one of our two research areas. In some places we have been purposefully vague and this is because we believe we have discovered new information, but as yet, that information has not been reported within the literature. The first part of this article covers the reasons why mammography was selected, it then progresses to an overview of the research.

The research itself has three aspects (Figure 1) and these aspects are used to give structure to the article. With a particular emphasis on the use of compression force for female mammography our central ambitions are to provide new knowledge, clarify existing knowledge and practice, and effect change.

Various factors combined to help develop our mammography research focus. Initially we realised that a robust evidence base for using compression in mammography was limited and available guidelines allowed for considerable variations to occur between practitioners and patients. Anecdote supports this variability, but almost no literature is published to substantiate it. In 2004, Poulos[1] conducted a small scale study and coincidentally detected that huge variations between practitioners can occur *on the same patient*.

Alongside the variability potential, we acknowledged that women are often anxious about mammography and this may affect attendance rates and their experience[2]. Given breast screening directly – ie, the client; or indirectly, eg, their partner/family – affects a huge proportion of the population, then research into this area could have widespread value.

Closely associated with the notion of widespread value we believe this area has a high probability of attracting resource – in the form of grants – to support research. Finally, the University of Salford has had a postgraduate breast programme of study for many years and mammography research would sit very neatly with this.

The chronology of establishing the mammography research programme had three important milestones, each of which helped to clarify our ambitions. Early in 2009, the mammography-focused emotional intelligence (EI) research team was formed and within a year that team had diversified into other mammography practitioner performance measures. Recognising the importance of our ongoing technical research, in mid 2010 a biomedical science mammography focus was established and this resulted in more research teams being formed.

Finally, towards the end of 2010, building upon biomedical science and practitioner performance foci, we realised that some patient-related research needed conducting and by early 2011, a number of research teams had formed in this area. As our interest in compression force evolved, we became more strategic in how we developed. Links with external collaborators have helped us understand more clearly where the worthy research questions resided. Through involving others we could understand better how to approach a particular research question and also how we could extract fuller implications arising from the data.

There are several multi-professional collaborative research teams working with us. These comprise clinical and university staff and students. The nature of each research project varies and qualitative and/or quantitative approaches are used as required. The research is conducted within single or multiple centres. The research has an emphasis on preclinical as well as clinical areas

and extensive use is made of human representations – phantoms.

Figure 1 illustrates facets of the research. Zones 1-7 all have projects within them and some zones have several projects. Figure 2 outlines some of the biomedical research whilst Figure 3 illustrates some of the practitioner performance and patient-related research.

Practitioner performance
Practitioner performance can be evaluated in different ways. Traditional methods of assessing practitioners tend to be associated with training programmes and methods can include consideration of cognitive and psychomotor abilities[3] which would be appropriate to expected course-end requirements. In our research we have focused on measures which have a particular importance to our core research ambitions and these in turn are likely to have significance in routine clinical practice. Two of these areas include: *practitioner variability of compression force* and *psychological constructs*.

As described above we have postulated that variations might exist in the application of compression force between and within practitioners. Our research tests this anecdote and in the longer term aims to explain and address the differences which have been identified. Figure 4 outlines an aspect of the method to achieve this. As seen, the initial approach used a cross sectional design which identified that marked variations exist between and within practitioners (Figure 5[4]).

The Breast Imaging Reporting and Data System (BI-RADS) breast density classification, provides a means of breast pattern density classification and highlights four progressively dense mammographic patterns[5]. Analysis of the compression characteristics within each BI-RADS category from 488 clients[6] was conducted. Figure 5 denotes that for all practitioners included in the study, ANOVA testing found a significant difference in the mean compression values used by different practitioners within each BI-RADS grade, demonstrating that there is a large variation in the amount of compression used by each practitioner.

The data for BI-RADS grade 3

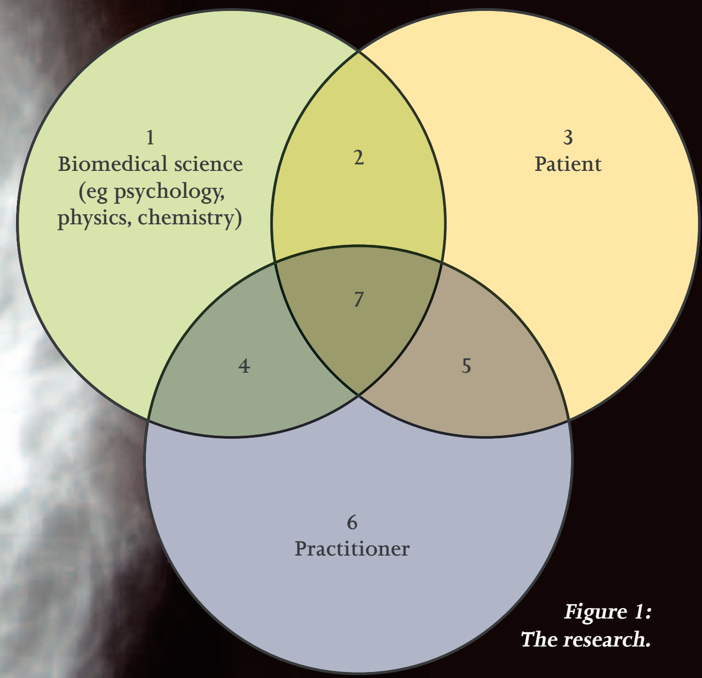

Figure 1: The research.

- Practitioner compression variability
- Compression plate bend and distortion
- Lesion conspicuity (deformable breast phantom)
- In-vivo lesion conspicuity
- Pressure map analysis
- In-vivo breast compression metrics
- Soundscape
- Psychometric scale validation

Figure 2: Biomedical research.

Practitioner performance
- Mammographer Psychological profiles
- Breast compression behaviour scoping
- EI and breast compression

Patient-related research
- Audit
- EI and patient experience in mammography
- Patient experience

Figure 3: Practitioner performance and patient-related research.

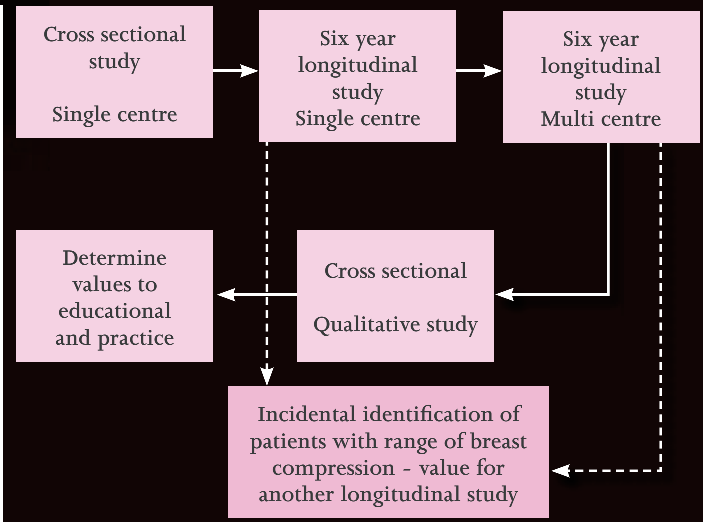

Figure 4: Practitioner variability.

	Low compression group	Medium compression group	High compression group	All practitioners
Number of practitioners	4	7	3	
BI-RADS 1	NS	NS	p<0.0005	p<0.0001
BI-RADS 2	p<0.05	p<0.01	p<0.0001	p<0.0001
BI-RADS 3	NS	NS	NS	p<0.0001
BI-RADS 4	No data	p<0.02	Insufficient data	p<0.0001
All grades	NS	p<0.0001	p<0.0001	p<0.0001

Figure 5: Variations in force (cross sectional study).

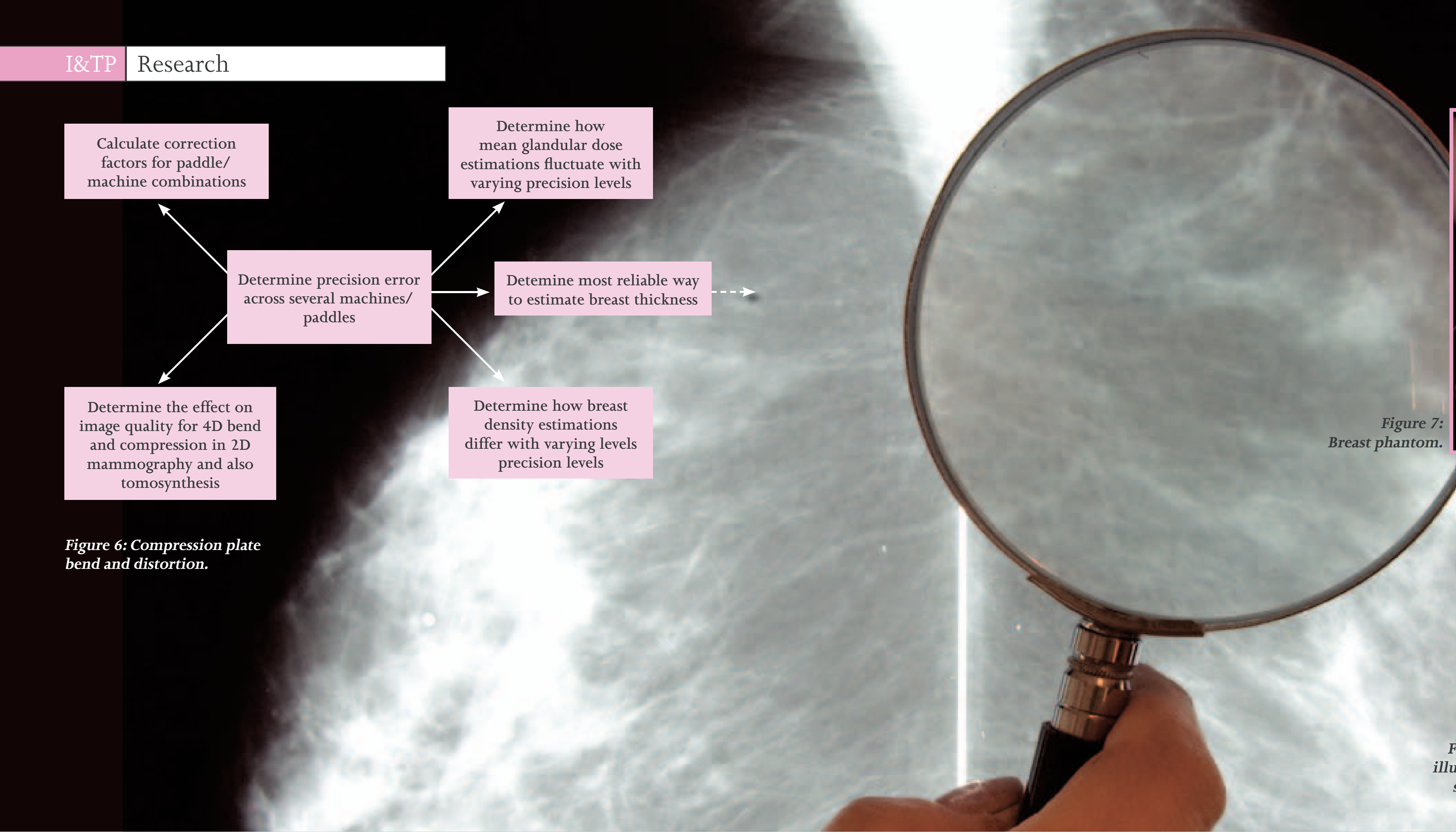

Figure 6: Compression plate bend and distortion.

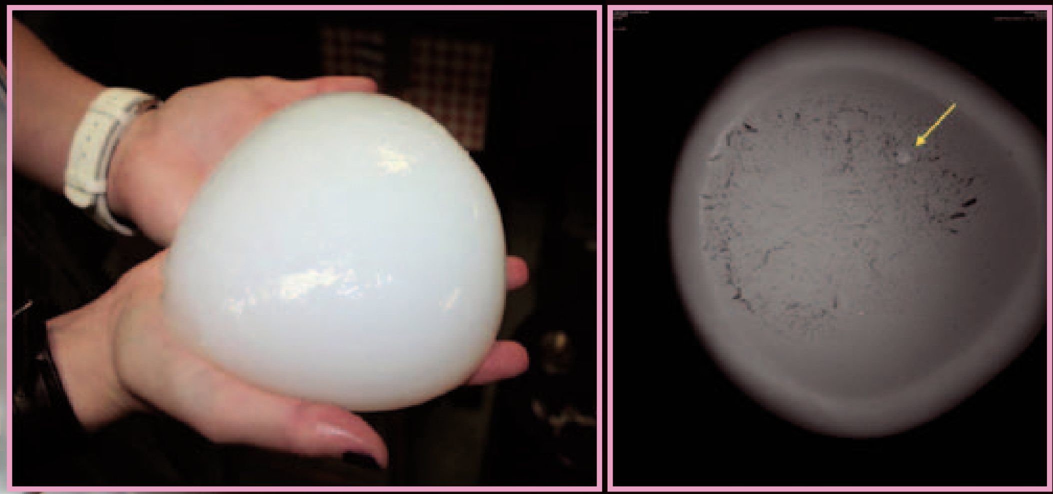

Figure 7: Breast phantom.

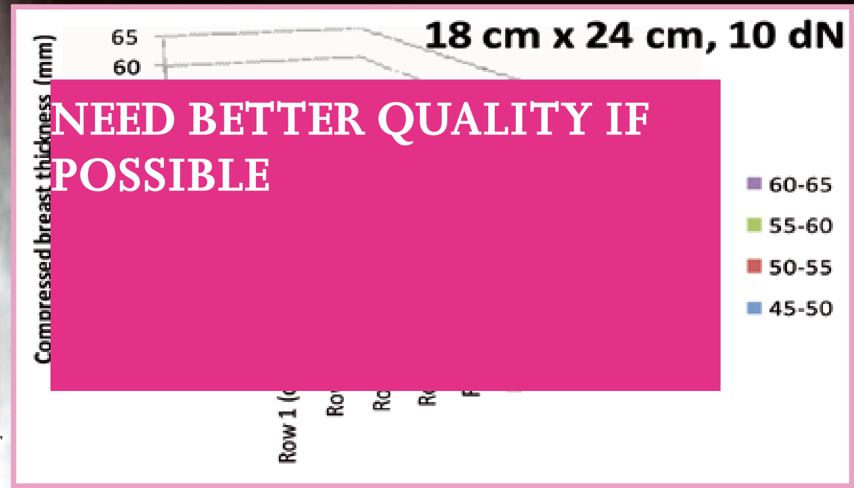

Figure 8: Graphical illustration of paddle surface at 100N of applied pressure.

appeared to separate into three distinct compression ranges and three subgroups of practitioners were defined according to whether they used low, medium or high compression.

The compression data was analysed in each compression group by BI-RADS category to ascertain if each practitioner used the same mean compression as other members of the subgroup. No significant difference was seen in BI-RADS 3 as this was used to define the subgroups. In BI-RADS 1 no significant difference in mean compression for the low and medium compression practitioners was seen. BI-RADS grades 2 and 4 show significant differences for the low and medium compression groups. Only the high compression group of practitioners failed to maintain their consistency in BI-RADS grades 1 and 2.

Building on this work, a single centre longitudinal study was conducted to view the variability from a woman's perspective over time[7]. This confirmed the cross sectional research findings and added further information by illustrating how a woman's experience of pressure can vary considerably over three screening rounds. For example, one woman from our sample experienced the following breast pressure values – 60N (age 50 years), 170N (age 53 years), and 100N (age 56 years). A consequence of this resulted in a multicentre study being designed to determine whether practitioner variability is likely to be widespread – this study is in progress.

Acknowledging that differences exist, a qualitative study seeks to understand 'why'. A different set of related projects seek to establish what the required amount of pressure and breast thickness might be for minimising radiation dose, maximising image quality whilst maintaining a reasonable quality of patient experience. Within Figure 4 you will note dotted lines and a connecting 'box'. This represents the incidental identification of a patient dataset which can be used in other research studies. Such incidental identification of valuable information is not uncommon in other aspects of our research.

The relationship with patients is a key part of a radiographer's role and in some contexts this becomes especially important. Radiographers must be able to 'understand the psychology of illness, anxiety and uncertainty', and 'the likely behaviour of people undergoing diagnostic radiographic imaging procedures, as well as that of their families and carers'[8]. Mammography is a challenging environment to work within, as it is here that people discover if they have a life threatening disease.

In this context, the mammographer needs to be able to gain the compliance of women through effective interaction and perform what can be a technically difficult examination in an emotionally charged situation. In theory, the mammographer would need to be able to recognise the emotion in this situation, respond to the womens' emotional as well as physical needs, manage their own emotions and be able to deliver high quality clinical performance.

This forms the basis of a rationale for one of our research questions: 'does EI affect practitioner performance'? EI can be defined as the extent to which people can recognise, process and utilise emotional information[9]. In health care there is evidence that EI can have a positive impact on the doctor-patient relationship[10] and some have even argued that it is vital to nursing practice[11].

The value of EI to radiography practice has also been highlighted[12,13], especially in interactions with patients and colleagues, management of stress and in leadership. In this research we are investigating the relationship between EI and practitioner performance as determined by the quality of the images they produce, the woman's experience and 'practitioner compression behaviour'.

Biomedical science

A large number of projects are being conducted into this area but only two are illustrated here – 'lesion visibility' and 'compression paddle bend and distortion'. Research into lesion visibility has a number of aspects, each of which tries to elicit a different perspective. Several of these aspects are focused on living human breast tissue – in-vivo – one to cadaver material and several involve the use of our novel deformable breast phantom. Similarly the compression plate bend and distortion research has many facets too, as illustrated in Figure 6.

Theory suggests that objects imaged within small volumes, compared with larger volumes, would be more easily delineated because less scatter is generated. Also, if the object is nearer to the image receptor then it would have less geometric un-sharpness and consequently it should be better delineated[14,15]. These theories combine in mammography[16,17,18,19] to help form a rationale for reducing breast thickness. In respect of these theories, research to date has largely focused on the use of physics test tools. Though inferences have been made from these approaches, the data does not necessarily reflect clinical reality.

Our research attempts to address this by considering lesion visibility from visual and physics standpoints; part of this involves using our novel deformable breast phantom and breast tissue. Within the literature, reside descriptions of how deformable breast phantom material might be created[20,21]. Until now no deformable phantom has been produced which would stand up to the criteria of being clinically realistic.

Using an iterative approach, we have created a deformable breast phantom with cancer lesions in situ; the arrow denotes the cancer lesion shown in Figure 7. The phantom and its lesions have x-ray attenuation coefficients similar to female breast/breast cancer; it has in-vivo compression characteristics similar to female breast[22]. We are introducing additional complexity into its design so that glandular tissue will be mimicked. This will make the phantom more clinically 'real', and will purposefully make lesion visibility more difficult.

Once the design principles have been clarified it will be imaged to determine how lesion visibility varies with different levels of compression and thickness. Objective physics measures and visual perception measures (JAFROC[23]) will be the main approaches used for assessing lesion visibility. The experiments will be conducted on conventional 2D machines and also 3D tomosynthesis machines.

Early on in the biomedical research we recognised that accurate read-out breast thickness values were required from mammography machines. These values would be used in a wide range of pre-clinical and clinical pieces of research we were to conduct. Literature has suggested that these values might be inaccurate due to compression plate bend and distortion[24], consequently there is a need to quantify that error. After analysing our initial multicentre research data into bend and distortion we realised that the error can be considerable and the potential implications of this error could be huge[25]. A consequence of this was that we have proposed several single and multicentre projects (Figure 6).

For the bend and distortion research a clinically representative breast phantom and chest mounting system was designed so that the compression paddle could be bent and distorted in a clinically realistic fashion; Figure 8 illustrates the surface of one compression paddle. As can be seen there is a huge variation across its surface. For this paddle, at 100N, the discrepancy between measured and given thickness was approaching 20%. This error would likely have clinical importance to dosimetry, breast density estimation and image quality – because of auto exposure selection. For aspects of our research this error could mean each machine/paddle combination would need its own calibration factor or that each machine/paddle combination should be treated as 'independent'.

Patient experience

There is a considerable body of literature published about womens' experiences associated with mammography and it was not our intention to repeat that research. Instead we have largely focused this aspect of our research on questions arising from our practitioner performance and biomedical science research. One such aspect is outlined here.

In trying to identify the relationship between practitioner performance and the woman's experience we are working with several clinical partners in the North West of England to explore several different facets of the mammographic practitioner which we believe could have an impact on the woman's experience. Audits of the mammography service in the North West[26] have shown that some of the areas of service weakness identified by the women relate directly to issues that are within the domain of the practitioner, eg, communication and interaction with the women.

The areas we are currently focussing on are EI, personality and tolerance of ambiguity. EI has the potential to enable the mammographer to recognise emotion in both patients and themselves and be able to understand and respond appropriately to emotion to bring about optimum outcomes. There is also a self-control factor within EI which can impact upon stress management.

Personality has been shown to be linked to behaviour and performance and it may be that a certain type of personality profile is more suited to working in the context of mammography practice. We are using the 'big 5'[27] personality traits of conscientiousness, agreeableness, neuroticism, openness to experience and extraversion to profile practitioners, to see if particular traits are linked to a positive patient experience.

Another feature of the make-up of a practitioner is their tolerance of ambiguity[28]. This refers to the way an individual perceives and processes information about ambiguous situations or stimuli when confronted by unfamiliar, complex, or incongruent clues. A person with a low tolerance of ambiguity experiences stress, reacts too quickly, and tries not to have to deal with ambiguous stimuli. By contrast a high scoring person perceives ambiguous situations as desirable, challenging, and interesting. This human feature may have an effect on the way the practitioner reacts to each individual and their circumstances.

The 'patient measures' we are using are quantitative, with a mammography experience questionnaire[29] which explores a range of women's experiences of the service. We have modified this questionnaire to include several domains of the practitioner performance. As the EI of the woman is important and can be affected by the interaction with the practitioner we are also using the psychometric measure of emotion called the positive and negative affect scale (PANAS[30]).

The future

Because this is the final article in the series, this concluding section will take into account this article and the two preceding[31,32]. Two and a half years ago, the Directorate of Radiography within the University of Salford had an eclectic mix of research ambitions and projects. This is no longer the case as it now has two clear and clinically relevant foci – low resolution CT (SPECT-CT) and compression force in mammography.

Since the point of commencing the change process, the Directorate has defined a range of inter-related research questions and formed collaborative multi-disciplinary research teams around those questions. Significant progress has been made in answering the initial research questions and the Directorate has started to submit its initial research to a range of journals and conferences. The attraction of further grant funding has now become a major focus of activity within the Directorate.

Since the University of Salford has required its programmes of study to be more research-led this has led us to make significant changes to the Year I radiography learning experience. This change has come about as a direct consequence of our SPECT-CT dose optimisation research[33]. Building on this, changes to Year II and Year III are planned.

Research findings are also starting to be introduced into our postgraduate pathways of nuclear medicine and mammography. Alongside this, dissertation students are encouraged and supported to engage with furthering the mammography and SPECT-CT research ambitions and the advancement of practice.

By using research and a research-based approach within our curricula we hope to influence clinical practice in a positive fashion. In that context it is worth noting that the College of Radiographers endorses the work of the University of Salford Breast Research Group, the scope of which is consistent with the College's vision for research within the radiography profession.

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The first two articles in this series were: *Transformational leadership in changing a research culture: a personal reflection* (*Synergy I&TP*, April 2011); and *Factors affecting the selection of foci for radiography research* (*Synergy I&TP*, June 2011).

References for this article can be found under 'Synergy resources' at *www.sor.org/members/pubarchive/synergy.htm*

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