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A survey exploring personalised medicine amongst of radiography academics within the United Kingdom.

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Introduction

On its 70th birthday, the National Health Service (NHS) launched a new era in genomic health, whereby people in England will have access to genetic tests. This is a step towards personalised medicine (PM)(1). Health Education England defines PM as "the treatment and care of patients with a particular condition, which uses new approaches to better manage patients' health and target therapies to achieve the best outcomes in the management of a patient's disease or predisposition to disease"(2). Today's conception of PM aims to use a wide range of data, such as molecular imaging, lifestyle, diet and other medical information to holistically look after the health of people (3,4).

A white paper by the research committee of the European Society of Radiology stated that for PM to be successful, medical imaging must play an integral part (5). The white paper called for the radiology workforce to be prepared for this paradigm shift in healthcare and reflect on what it would mean for training, research and practice. This has been echoed in a recent paper by the authors exploring the opportunities and challenges of PM in medical imaging in the contemporary space (6). Similarly, Sloane and Miller (7) recently explored radiology service managers views on the radiography curriculum and points to the need for a curriculum that is responsive to the rapidly changing technological, organisational and social contexts of modern society and healthcare. PM in medical imaging ranges from the adjustment and use of alternative imaging modalities and exposure parameters to suit patient characteristics, and the use of PET imaging to determine tumour response radiotherapy treatment (6,8).

PM use in medical imaging also has potential in the emergence of "companion diagnostics". In order to target therapies to an individual's unique characteristics, patients are tested for biomarkers. A biomarker can be prognostic (a characteristic that has the potential to affect the course or outcome of the disease) or predictive (patient characteristics which can

predict a patient's likelihood of benefiting from a treatment or intervention) (9). Here, genetic and other tests (including medical imaging) are coupled with targeted therapies. This constitutes a good fit for medical imaging through potential expertise in functional and molecular imaging (10).

There is a general consensus that radiology will be greatly impacted by PM (5). The need for increased knowledge and expertise in this area has been mentioned. Notable among these was the lecture by Professor Audrey Paterson at United Kingdom Radiology Conference in 2013, title: "Can radiography survive the next decade?"(11). This has been echoed by Dr Richard Fowler, in his radiology 20/20 presentation (12). These seminal perspectives call for an update in the curriculum to reflect the inevitable change likely to occur in the profession because of PM. In response to the aforementioned, the aim of this study was to investigate the extent to which PM was being taught or incorporated in contemporary radiographic curriculums in higher education institutions (HEIs) offering programmes of study leading to a BSc in Diagnostic Radiography or BSc in ,Radiotherapy and Oncology in the United Kingdom (UK).

Methodology

This study primarily adopted a quantitative approach by utilising an online survey, yet the survey also offered participants an opportunity to provide qualitative comments, which are used as part of the results in order to uncover some feelings and beliefs towards PM in practice. A short questionnaire was designed using SurveyMonkey™ consisting of 7 questions. Due to the limited radiographic literature discussing PM it was decided that the study would be exploratory and keep questions short by exploring how much/or little radiography academics knew about PM and uncover how it was incorporated within the radiography curriculum.

Ethical Approval was sought and approved by the University of Suffolk's Research Ethics Committee. In addition to ethical clearance, it is important to highlight other ethical strategies employed by the authors in order to ensure that a) no harm was done to any survey respondent, and b) no survey respondent was unduly pressured or made to feel obligated to participate. First, participants were fully informed of the intentions of the survey. For instance, potential respondents were informed of the purpose and what would be expected from them, coincided with the expected length of time to complete the survey. Second, it was imperative to acknowledge that the all responses would be kept confidential, thus individual demographics, such as name, email addresses, and location of workplace were omitted from the data collection process in order to elicit better responses.

Key participants were contacted initially and asked to disseminate the survey amongst their peers in order to enhance the response rate. Key participants were identified by the authors. This was achieved through the examination of diagnostic radiography/radiotherapy staff profiles via publicly available HEIs websites. Upon identifying the course leader, he/she remained our primary contact for this study and an aid for disseminating to academic peers. This method of sampling is commonly referred to as 'snowball sampling' whereby study subjects recruit future subjects from among their professional acquaintances. The advantage of this includes the ability for a study to take place if/when participants remain unknown to the researchers.

The questions posed to academics began by asking 'what programme (diagnostic radiography and/or radiotherapy and oncology) they taught on?' Follow up questions then asked participants about their job role, whether they teach PM on their academic programmes and how the subject of PM is delivered. Participants were then asked for the rationale of not teaching PM (if applicable) on their undergraduate degree programme(s), supported with a

question exploring where training could be available to obtain competencies to deliver PM in higher education.

Knapp et al (13) recently evaluated the academic workforce in the UK. Their study offers insight into the number of diagnostic and therapeutic academics currently practicing in HEIs (n = 233). Whilst the study acknowledges that only 18 out of 24 institutions responded in the UK, the value provides an approximation of the total number potential participants that could have taken part in this survey. In response, then, out of a potential 233 participants the initial response rate was low (n = 21) when first distributed to colleagues via email, yet upon a follow-up request to colleagues a significant increase in responses was received (n = 67). The authors felt this sample offered an insight into the concept of PM amongst radiography academics. However, it is important to recognise that the findings presented here should not be generalised, as the approximate sample of 29% remained too low for inferential statistics. Descriptive statistics have been utilised in order to provide some insight into the application of PM in HEIs in the UK.

Results

As identified above, the maximum sample of academics in the UK was limited. Thus, out of an approximate 233 respondents, 67 participants (29%) responded to this survey. These consisted of academics in roles identified as course leader/programme director, module leader, module contributor, academic team manager and admissions tutor. In total, 79% (n = 53) were diagnostic radiography academics while 20% (n = 14) were academics delivering therapeutic radiography. This is consistent with the approximated academic workforce identified previously (13). Figure 1 shows the number of respondents who reported teaching PM on their undergraduate programmes (24%, n = 16), while 30% (n = 20) reported not

teaching PM. The remaining academics (46%, *n* = 31) were either unsure or did not know what PM was.

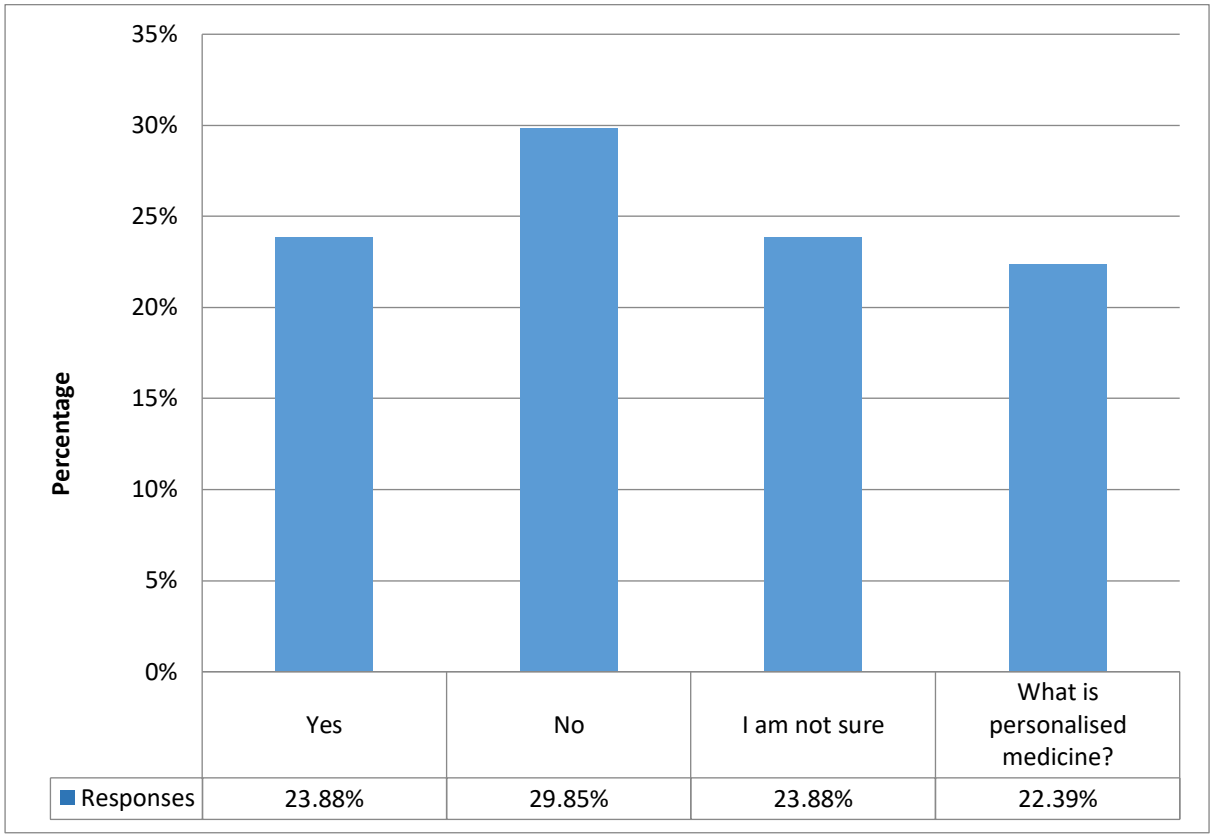
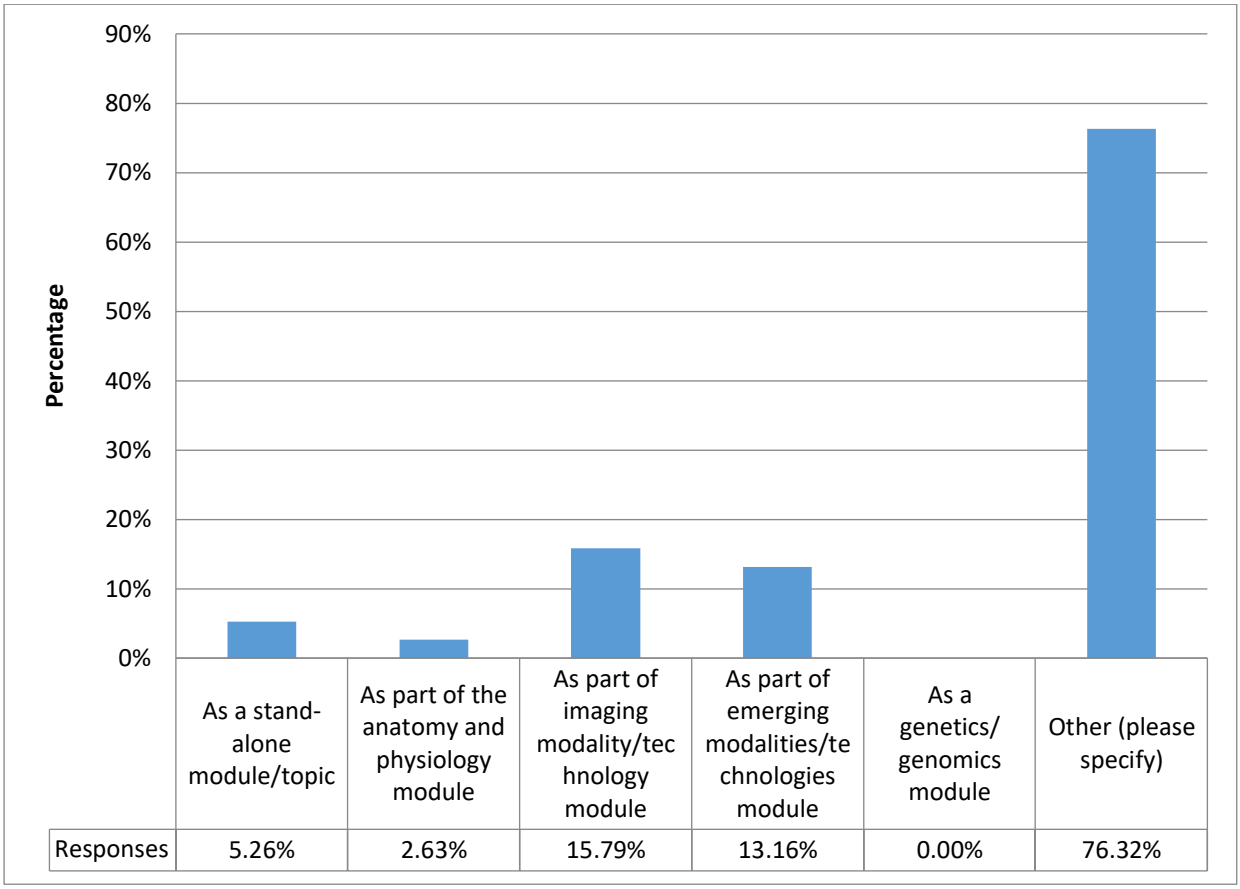


Figure 1: The percentage of academics teaching personalised medicine as indicated by the survey.

It is important to highlight that a relatively large number of academics, 22% (*n* = 15) of respondents, did not know what PM was. There is also a clear distinction in the level of teaching of PM, whereby a larger proportion of therapeutic lecturers taught PM when compared with their diagnostic radiography counterparts. Whilst this finding is relevant, it is not surprising, as Radiotherapy and Oncology in general has arguably been more overtly 'personalised based' depending on patient tumours and personal characteristics(14–16).

The format in which PM was delivered varied considerably among academics. Some cover the topic "as part of imaging modality/technology module" (16%, *n* = 6) or "as part of emerging modalities/technologies module" (13%, *n* = 5).



	As a stand-alone module/topic	As part of the anatomy and physiology module	As part of imaging modality/technology module	As part of emerging modalities/technologies module	As a genetics/ genomics module	Other (please specify)
Responses	5.26%	2.63%	15.79%	13.16%	0.00%	76.32%

Figure 2: Delivery format of personalised medicine in radiography education

Further, this question indicated that PM was not necessarily taught overtly as a discrete concept, but rather incorporated in a variety of ways within the curriculum. This was captured qualitatively by a number of the participants that answered 'other (please specify)' (76%, *n* = 29), above:

> *"I direct students to current literature and we discuss this rather than me actually teaching about it".*
>
> *(Diagnostic academic)*

"Elements of PM are touched upon (in for example, our pathophysiology module and 3rd year UG teaching)".

(Diagnostic academic)

"I think we teach a personalised approach to healthcare, but not this specifically".

(Diagnostic academic)

"We do talk a little bit about this topic in our oncology units, but not explicitly as personalised medicine".

(Therapeutic academic)

"Elements of PM are drawn upon, though not taught specifically".

(Therapeutic academic)

Whilst these narratives acknowledge incorporating PM in undergraduate teaching, one participant remained unsure of the concept of PM and whether, or not, it was linked to value-based radiography, a concept integrated within an undergraduate radiography programme.

"We are incorporating values-based radiography within several modules - mainly within Developing Professional. Whether this counts as personalised medicine, I do not know".

(Diagnostic academic)

The survey identified the rationale for not teaching PM in the radiographic curriculum (figure 3). For example, academics felt they had a 'lack of knowledge' regarding PM (37%, *n* = 17) followed by a 'lack of expertise' (33%, *n* = 15). In addition, 13% (*n* = 6) said that while they were interested in the subject, they felt they did not have the appropriate qualifications nor competencies to teach it as a concept. Whilst 21 respondents chose not answer this question, for those that did, qualitative comments highlight its use for those selecting 'other (please specify)' (31%, *n* = 14):

"I think we touch upon the topic in various modules but it is not embedded fully. We would need to improve our knowledge on the topic in order to introduce it more fully into the programme".

(Diagnostic academic)

"I have introduced very small elements".

(Therapeutic academic)

"I am not sure of how applicable it is in terms of diagnostic imaging".

(Diagnostic academic)

"Potential lack of support".

(Diagnostic academic)

"I would like to know more about what it means for radiography".

(Diagnostic academic)

"Don't know what it means".

(Diagnostic academic)

Together, 15% (n = 7*)* of respondents thought PM was not relevant to clinical practice or to the curriculum. Further, 92% (n = 59) of respondents were unaware of training opportunities in order to gain the necessary competencies to teach PM. Whilst this seemed an impossible question (as stated by one respondent), the aim of the question was to gauge how successfully messages about a course filters into the academic world within a radiography/radiology context because attitudes, emanating from knowledge are a good predictor of future behaviour (17). Figure 3 depicts the rationale for not using PM within undergraduate radiography programmes.

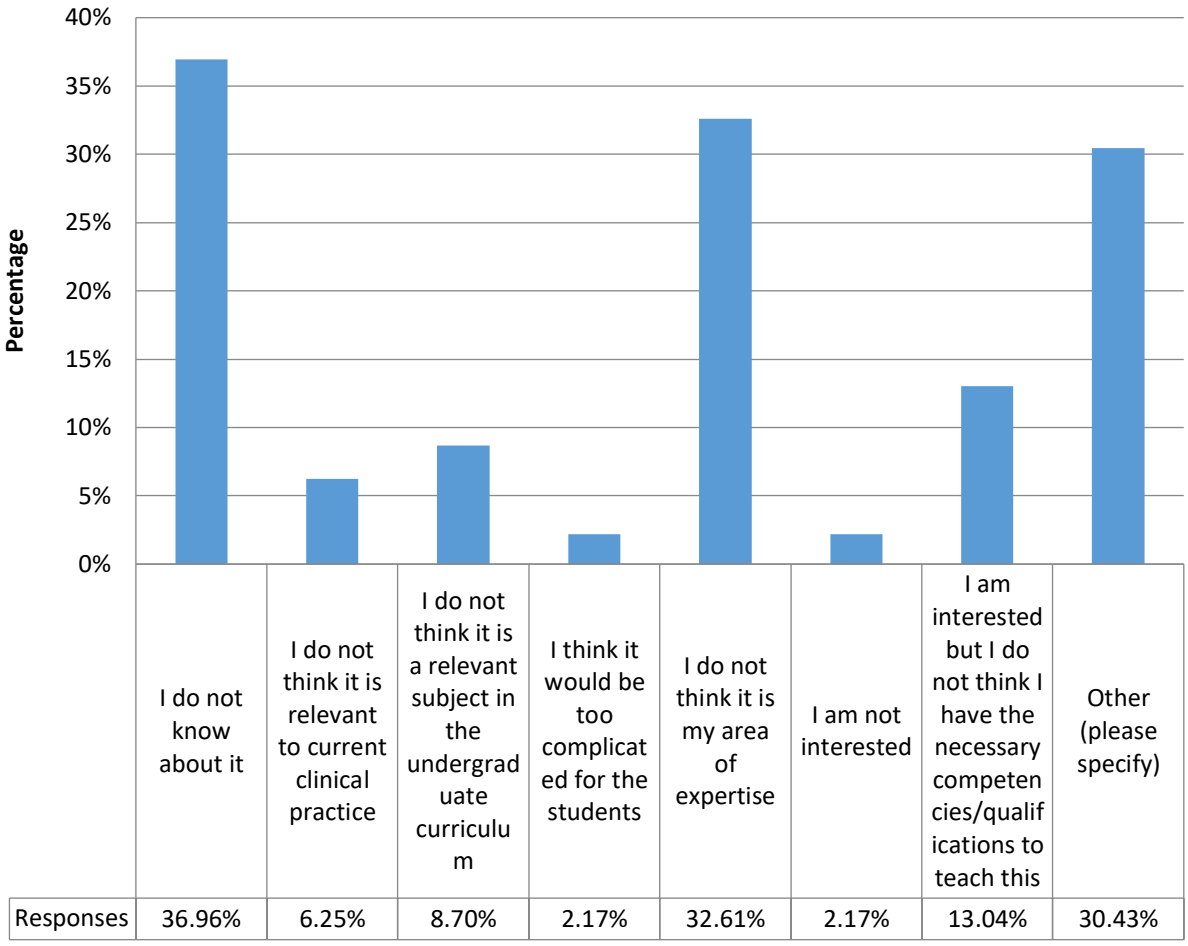


Figure 3: Delivery of PM within the academic curriculum

Some participants in this study expressed their wishes to learn more about PM, in order for them to enhance their academic work, whilst others fully understood its value in the delivery of contemporary education:

> *"I think it is critical that we embrace personalised medicine in the curriculum... Personalised medicine has the potential to completely revolutionise patient care. It is imperative therefore that we become much better informed ourselves so that we might support students' learning and prepare them for a brave new world!"*
>
> *(Therapeutic academic)*

> *"Just to reiterate that in relation to teaching personalized medicine on a therapeutic radiography programme I think we would have to learn*

more about its emerging use in cancer specific pathways and how it links or will link to therapeutic radiography. A study day for lecturers and for clinical educators would be very useful".

(Therapeutic academic)

"I think this is an incredibly important area to be considered within oncology generally and within radiotherapy. As advances are made and technologies improve so will our practice. Therefore we need to provide our students with the most up to date information as they will be the future workforce."

(Therapeutic academic)

The narratives above suggest a clear drive for PM by some academics. They importantly recognise its value in shaping curriculum whereby advances in technology and genomics will continue. In short, it remains imperative that the radiographic community reflects on nuanced areas that will impact on both students and healthcare practitioners in future years.

Discussion

Genomics England was established in 2013 by the Department of Health to deliver the 100,000 genomes project and sequence 100,000 genomes of NHS patients with rare diseases and also patients with common cancers(18). The aim of this project was to lay the foundations for the UK to be a world leader in making such technologies mainstream whilst also ensuring that healthcare remains personalised. To support this project, the Genomics Education program was created to ensure that the NHS had the knowledge, skills and experience to ensure that the NHS remains a world leader in genomic and precision medicine(19). This £20 million education programme involves 10 HEIs and will fund at least 550 Master's in Genomic Medicine programmes and numerous other courses in genomics

and bioinformatics, including doctoral level programmes. Online and self-directed study resources have also been made available for healthcare staff and thus important that healthcare staff are made aware of such opportunities(20).

The findings in this study are consistent with published literature, especially in radiotherapy and oncology, where it is argued that the interplay between a patients' environment, behaviour and genetics have, for a long time, been factored into diagnoses, treatment planning, risk stratification and estimation of drug response(14). The question that arises, here, is whether the concept of PM would benefit from being addressed more overtly in order to facilitate pedagogical and andragogical approaches in undergraduate radiography teaching? The survey highlighted that the term 'PM' may not be widely recognised amongst some radiography academics in HEIs in the UK. This is important to recognise as a discipline if there is to be collegial approach to delivering PM within a learning and teaching context to undergraduate radiography students. This stated lack of awareness of PM and allied fields of genomics is not unique to radiography academics. There is a general lack of awareness and understanding of such concepts in the public sphere and a clear link between awareness and levels of engagement with it (21–23). As identified above, there are funded opportunities for healthcare practitioners to undertake further study in the UK within this growing field, which may help build the knowledge base of radiography academics.

In medical imaging, a person's clinical and personal characteristics are used to ensure that the correct imaging procedure and modality is undertaken for the right patient and to keep potential detrimental effects of ionising radiation to the minimum. Contemporary examples include the use of low dose computed tomography (CT) protocols for the detection of urinary calculi(24); calculating the weight of a patient in determining the quantity of contrast media (25); weight-based isotope injections in radionuclide imaging and the adjustment of exposure parameters based on patient build. In addition, cross-sectional

imaging modalities such as magnetic resonance imaging (MRI) and CT are being combined effectively with quantitative metabolic modalities such as PET and SPECT imaging to better visualise cancers (26,27) while PET/CT is being used to accurately predict tumour recurrence in breast cancer(28). These modalities will continue to be essential imaging practices in the delivery of sound image acquisition and diagnosis, yet only a small number of study participants acknowledged this as PM, as part of an emerging technology module. As outlined, a vast majority of the respondents felt that whilst PM was 'touched upon' it was not specifically discussed in any academic depth. The rationale amongst those who responded in this survey for not incorporating was linked to a lack of knowledge and uncertainty around its application within the radiography curriculum.

PM has been driven by developments in genomic technologies, and has led to enhanced optimism amongst the scientific community in that it holds promise for the future of healthcare. The mapping of the human genome coincided with subsequent initiatives such as the 100,000 genome project (in the UK) has led to an heightened awareness that specific genetic/molecular variations underlie certain diseases and that they can in turn be managed based on these variations (29–31). PM is taking various forms, including the identification of cancer risk, targeted therapy resulting from the identification of biomarkers, prediction of drug response (pharmacogenetics/genomics) and the prediction of the chances of disease recurrence through the analysis of cancerous tissue (32). As a contemporary illustration, a recent finding from the coronavirus outbreak is the variation in susceptibility, presentation and response to the disease (33,34). One of the possible reasons being investigated at the Wellcome Genome Campus in Cambridge (UK) is the link with underlying individual genetics and possible mutation of the virus in individuals (35). This could probably have implications for variations in COVID-19 related imaging.

While the virtues of PM are identified, there was a range of reasons for not incorporating it at undergraduate level. Even though the most common answers were linked to knowledge, understanding, competency and expertise amongst academics, there was also the suggestion that PM was not relevant at an undergraduate level for students. It is important, however, to recognise that some respondents welcomed the introduction of PM in the overarching curriculum, as it would help teaching staff understand the concept more. The variation in attitudes towards PM is not surprising because it has been argued that healthcare has always considered the individual circumstances of patients (36) and that there is the need to reduce the hype of the promise of PM (37). The contemporary conception of PM, by proponents, highlights the potential role of the increased power of digital technologies that have enabled the aggregation and use of patient information from a wide range of sources (38–40).

In short, it could be argued that the concept of PM may not be widely understood amongst radiography academics in the UK. This may also resonate with other academic staff transnationally. The small, but relevant findings in this paper presents an opportunity to discuss the application of PM within an academic context and how PM should be considered as part of overarching radiography curriculum in future years.

Conclusion

This study sought to gauge the extent to which PM is being incorporated in the curricula of programmes offering courses in diagnostic and therapeutic radiography in the UK. A larger proportion of those who taught and understood the concept of PM were those registered as therapeutic radiographers. The survey also found that the foremost reason for not teaching PM was a lack of awareness and understanding from academics. The qualitative

commentary highlights that whilst some recognise the value of PM in both contemporary and future curriculum development, it was evident that more awareness is needed for integration. PM is here, and should remain a topic discussion for academics worldwide in order to better inform the education of students.

Limitations

The response rate of 29% constitutes the most significant limitation of this survey. Due to the snowballing sampling strategy, there was a great reliance on radiography course leaders to disseminate the survey to their colleagues. A common disadvantaged of this sampling method is the difficulty of determining the sampling error and/or whether to make inferences about a population based on this sample. SurveyMonkey™ collects the internet protocol (IP) addresses of workstations completing the survey, thus duplication of IP addresses would have been identified by the researchers if respondents undertook the survey twice for example. The authors also acknowledge that there is always the possibility that course leaders may not have distributed the survey appropriately or could have (themselves) repeated the survey, but it was felt that due to their own professional obligations and codes of ethical practice, this would have been highly unlikely

A more direct and personal approach returned a better response, yet on reflection this could have been improved. The absence of direct academic contact information remained a major constraint for the authors. However, the information received in both quantitative and qualitative data constituted a valuable source of foundational information for larger scaled studies. Finally, whilst attempts were made at the beginning of the survey instrument to explain the concept of PM, it is acknowledged that perhaps a definition and a more detailed explanation of the concept would have assisted in the responses.

Recommendations

In light of the small, but relevant findings, the following recommendations are offered:

- There is an opportunity for continued professional development, reflection and debate amongst radiography academics whereby better understanding of PM may encourage the application of PM within course/subject areas.
- Diagnostic radiographers may need further support and guidance when incorporating PM into their daily academic practices, when compared to their therapeutic counterparts.
- Greater understanding of PM remains central in order to ensure its delivery is sound and impactful within HEIs.
- A more in-depth quantitative and qualitative approach is needed with radiography academics transnationally in order to provide an enhanced generalisation of the topic of PM, accompanied with support mechanisms.

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