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Professional Learning in Sonography

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1. Introduction

The healthcare system is in a state of constant and rapid change as a result of the increase in scientific knowledge and rapid technological advances. To provide the best possible healthcare health practitioners must continue to learn throughout their working life. The notion that professionals must continually update their knowledge is not a new concept (1, 2). For example, Dubin (1 p.486) wrote of professionals:

> *A highly trained person must constantly renew his knowledge. The goal is not merely to keep knowledge already acquired during the period of formal education. Much more than this—for past knowledge may become outdated—the aim is … self-renewal by keeping abreast of new knowledge that is constantly being added to by research and publication.*

The rate of change of knowledge is increasing and this is reflected in the decreasing 'half-life' of knowledge. The term half-life, borrowed from the field of nuclear physics, represents the process of decay of knowledge such that a half-life of five years indicates that after five years only 50 percent of the body of knowledge acquired at a given point remains relevant to the work task (3). The half-life of knowledge continues to decrease, with, for example, the half-life of medical and scientific knowledge estimated to be between 18 months and three years (4, 5). Akin to medical and scientific knowledge having a short half-life, the knowledge of health professionals is also considered to have a short-half life. Professional obsolescence was the term utilised by Dubin (1) to describe the professionals' reduction in competence to meet the demands of their profession with time. Professional obsolescence, Dubin argues is "almost inevitable … without continuous updating … [as] people will carry on their work with increasingly outdated techniques and hypotheses, ignorant of new data, techniques, and principles" (3, p.10). By updating knowledge, professionals grow or appreciate their existing knowledge with new knowledge (3, 6, 7). In essence, to remain competent in their practice, health professionals must advance their knowledge at the same rate as knowledge advances in their field and thus avoid professional obsolescence.

The introduction of CPD requirements within professions formalises the need to update knowledge and counterbalance the effect of professional obsolescence (1, 6). CPD requirements are now common and for many health professionals updating knowledge is now a requirement for practice. The Health Professions Council (HPC) in the United Kingdom regulates 15 health professions and introduced mandatory Continuing Professional Development (CPD) requirements in 2006 (8). The HPC states:

Put simply, CPD is the way health professionals continue to learn and develop throughout their careers so they keep their skills and knowledge up to date and are able to work safely, legally and effectively. (8)

In Australia, CPD linked to registration occurred more recently. For example, the Australian Health Ministerial Council (9) approved the *Continuing professional development registration standard*. This standard took effect from 1 July 2010 for ten health professions and a further four health professionals are to be included from 1 July 2012 (10). Health professions that now have mandated CPD requirements include for example, medicine, medical imaging and nursing and members of these professions perform sonography. With the profound changes in diagnostic ultrasound imaging shown throughout this book, updating knowledge relevant to sonography is an issue of increasing significance for many health professionals. Indeed to provide the best possible sonographic practice, all professionals performing sonography must inform and enhance their individual knowledge with the rapidly changing sonographic discipline knowledge.

2. Professional knowledge

The knowledge base of a profession is composed of the public body of discipline knowledge and the individual knowledge of professionals (11). This distinction between public and individual knowledge is not new. Sir Karl Popper (12) in his writings of the way in which knowledge is created and extended in the scientific community recognised publicly communicated knowledge and the knowledge of the individual. Popper utilised the term objective knowledge to describe publicly shared knowledge artefacts or products and the term subjective knowledge to represent the knowledge of individuals that has not been publicly shared. Other authors (see for example 11, 13-17) have also separated public and individual forms of knowledge. They utilise terms such as explicit, codified or scientific knowledge to describe discipline knowledge that has been communicated, in for example books, journals and conferences. The knowledge of the individual is commonly referred to as tacit knowledge. Higgs and Titchen (17) sub-divide tacit knowledge used by professionals into two categories, professional craft knowledge and personal knowledge. Professional craft knowledge is gained through experience and "embedded in practice" (p.5) and is akin to Schon's (18) 'knowing-in-action' (p.50) and Eraut's (11) process knowledge or 'knowing how' (p.107). Higgs and Titchen (17) contend that through articulation, sharing and critical review, at for example conferences and in journal articles, professional craft knowledge can be transformed from tacit knowledge to public discipline knowledge. According to Higgs and Titchen (17), the second form of tacit knowledge utilised by health professionals, is personal knowledge. This form of knowledge is gained through life experiences, allowing the health professional to "enter the life-world of their patients" (p.6) providing empathic care tailored to the needs of their patient.

Professionals integrate public discipline knowledge and their tacit knowledge in clinical practice (11, 16, 17). As previously noted, public discipline knowledge is communicated through information sources such as books, journals and conferences. With the rapid rate of change of knowledge in diagnostic ultrasound, health professionals must therefore engage in a continuing process of accessing new knowledge disseminated through information sources, internalising it into their tacit knowledge and then utilising it in clinical practice.

3. Learning mediated by information sources

Learning involving the use of information sources is theorised as an activity mediated by tools (19-21). In this mediated learning act, tools such as information sources create a learning environment where higher mental function is achievable than when the learner is left to their own unmediated mental functions (21-23). Learning mediated by tools can be represented by Vygotsky's triangular model. The Vygotskian model of mediated learning has three central elements – subject, tool and object. The *subject* is the learner. *Tools* are utilised by the learner to support the learning process. Tools may be external or internal. External tools are humanly created tools, which support learning such as information sources. Internal tools include processes utilised by individual to support learning such as mnemonic techniques and schemas of events or practice (21, 24). The *object* is the goal or motive (22) of the learning activity. Goals may be set by the individual or by some other such as employer or workplace trainer. In the Vygotskian triad, the learner does not simply react to the external world, a recognised limitation of behaviourist learning theories (24, 25) but is viewed as an active agent purposefully utilising external means or mediating tools to achieve their learning goal (26). The application of the Vygotskian model to health professionals updating their knowledge in diagnostic ultrasound is shown in Figure 1.

Mediating Tool
Information sources containing
new disciplinary knowledge in
diagnostic ultrasound

Subject
Health professional
with their existing
knowledge

Object
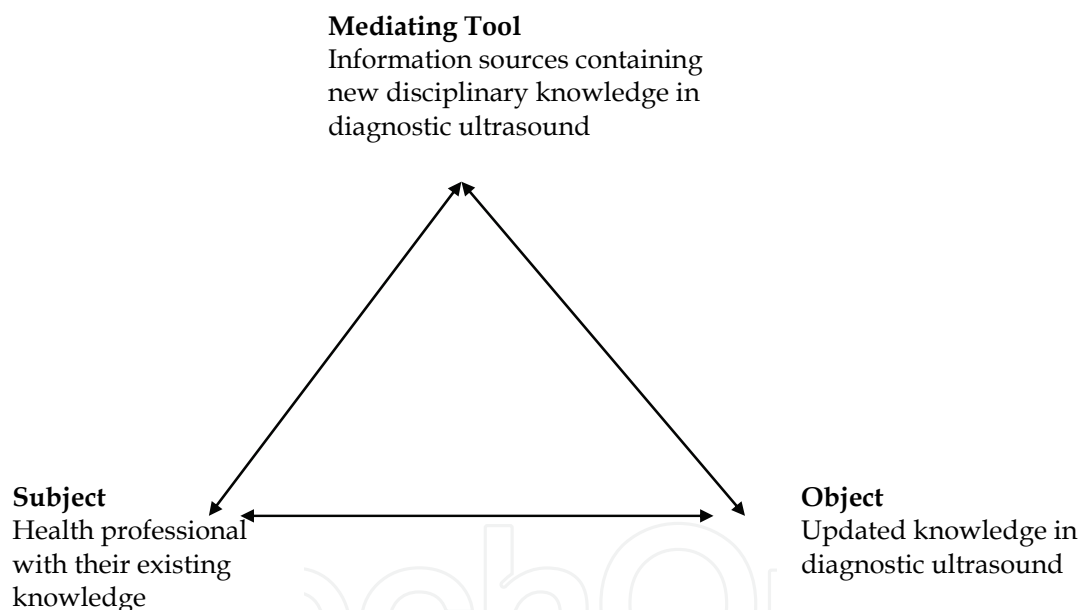Updated knowledge in
diagnostic ultrasound

Fig. 1. Adaptation of Vygotskian model of the health professional utilising information sources as a mediating tool to update their knowledge in diagnostic ultrasound

Consider the case where the subject is a health professional involved in sonographic practice. To avoid professional obsolescence this health professional utilises information sources that contain new disciplinary knowledge as mediating tools to update their knowledge in diagnostic ultrasound. As a consequence of this activity the health professional's clinical sonographic practice is based on the latest disciplinary knowledge providing the patient with the best possible healthcare.

Disciplinary knowledge is made public via information sources through a succession of stages (27-30). For example Garvey and Griffith (28) developed a model of knowledge

dissemination based on the psychology profession. This study identified a succession of stages through which new research findings are communicated within the profession. Initially research findings are disseminated orally through for example seminars and then to larger audiences at state or national meeting of their professional society. Many psychologists then utilise feedback from seminars and conferences to prepare the manuscript for submission to a journal. Finally, Garvey and Griffith contend that new research findings are cited in other journal articles and appear in books and this stage represents the assimilation of new research into the discipline's public knowledge base. Whilst the Garvey-Griffith model was developed from research based on the psychology profession, the succession of stages is similar across many professional fields (27, 29). The Garvey-Griffith model was developed before the Internet and the World Wide Web transformed the scientific communication process. Describing the Garvey-Griffith model as a model of scientific communication for the print era, Hurd (30) adapted the model for the digital era. Whereas the Garvey-Griffith model had professionals disseminating research findings initially through face-to-face seminars and annual conferences and then through print journals, the Hurd model showed the initial phase of research dissemination occurring primarily through Internet-enabled tools such as listservs, web pages and e-conferences.

The Internet is recognised as an important information source for health professional offering immediate access to the most current health and medical information. Web sites of professional, government, education and commercial organisations are utilised by health professionals to access online journals, health and medical databases, practice guidelines, image banks and case studies as well as information on professional development activities (see for example 31, 32-39). Internet based communication tools of e-mail, listservs and discussion forums are used by health professionals to consult with colleagues nationally and internationally (31, 32, 34, 35, 39).

Whilst the Internet offers access to large quantities of information the lack of quality control over information on the Internet means that its use as a major information source for health professionals has been limited (40). To take advantage of the perceived accessibility of electronic information whilst overcoming the disadvantages of variable quality of information, governments in Australia and internationally have developed Electronic Information Portals to provide health professionals with up-to-date information to inform their clinical practice. Examples of these portals include NHS-net (Internet access for the National Health System) in the UK; National electronic Library for Health (NeLH) in the UK; Hospital Authority Library Information Systems (HALIS) in Hong Kong; Clinical Information Access Program (CIAP), New South Wales, Australia, Clinicians Health Channel, Victoria; Australia and Clinicians Knowledge Network, Queensland, Australia. These portals provide health professionals with access to a range of information sources including health and medical databases, e-journals, e-books and clinical guidelines have also been identified by health professionals as an important information source for updating their professional knowledge (41-46).

The Hurd model and the proliferation of electronic media suggests that to update knowledge in the 21st century health professionals would favour and utilise Internet-based tools over both traditional face-to-face conferences and seminars. However, research examining the use of information sources by health professionals does not support this contention. Keppell and colleagues (45) investigated the use of Clinicians Health Channel, a

major online health resource for professionals employed in the public health sector in the Australian state of Victoria. This study (n=233) reported that the four most frequently utilised information sources to refresh knowledge were workshops and seminars (85%), conferences (83%), textbooks (73%) and print journals (72%). When the activity was background research, these health professionals utilise print journals (66%), academic based websites (65%), Internet search engines (61%) and electronic journals (57%). In contrast, when the activity was to assist with clinical diagnosis, the information sources utilised were consultation with colleagues (59%), textbooks (58%), print journals (43%), and academic based websites (36%). Three important aspects of information source use by health professionals at the beginning of the 21st century are demonstrated in this study. First, this study demonstrates that the selection of information sources, or as represented in the Vygotskian model mediating tools, are dependent on purpose of use, or object of activity. Second, seminars and conferences, as identified in the Garvey and Griffth model (28), remain important information sources for updating knowledge. This is evidenced by workshops, seminars and conferences being the top information sources utilised to "refresh knowledge". Third, print journals were, at the time of the study, utilised by a larger number of respondents than electronic journals. Other studies have also demonstrated that health professionals prefer print based information sources such as journals. Davies (47) identified eight studies in which medical practitioners ranked their preference for or identified their use of print and electronic information sources. Each of these studies, published between 2002 and 2005, reported that print-based information sources were preferred or utilised over electronic information sources by medical practitioners. The continued preference for or use of print-based information sources such as journals appears counterintuitive in the digital era where electronic information sources made available through the Internet are considered central to communicating new knowledge (30, 48) and more generally learning (13, 49, 50).

None of the reviewed studies specifically identified health professionals engaged in sonographic practice and so it is not known what information sources they utilise as mediating tools to update their professional knowledge in diagnostic ultrasound. The following section provides research data investigating the use of information sources as mediating tools in professional updating activity by Australian Sonographers.

4. Professional updating activity of Australian Sonographers

The following section discusses research findings from a larger study investigating professional updating activity by Australian Medical Imaging Workers (MIWs). MIWs includes Radiographers, Radiation Therapists, Nuclear Medicine Technologists and Sonographers (51, 52). There were over 10,477 Medical Imaging Workers in Australia in 2006 and of these 2127 were Sonographers. The number of Sonographers increased by 50% between 2001 and 2006 (52) demonstrating one of the most rapid rates of growth of any health profession in Australia. The need to understand how this rapidly growing profession maintains currency of professional knowledge thus is of increasing significance in the 21st century.

4.1 Research study

This study utilised a two-phase sequential exploratory design (53, 54). This two-phase design collected and analysed qualitative data (Phase 1), which was used to inform the

quantitative phase (Phase 2) of data collection and analysis (54-56). In the context of this study, interviews were conducted with 28 Medical Imaging Workers, six of whom specialised in Sonography. Interview data was utilised to develop the four-page questionnaire mailed to a random sample of 1142 practitioners holding registration with an Australian Medical Radiation Technologists Board (MRTB). Surveys were returned from 362 MIWs with analysis demonstrating that the sample was representative for area of specialisation and gender (39). Sixty-one survey respondents specialised in Sonography.

The survey data were entered into SPSS 17.0® and descriptive and inferential statistics were used for analysis. Percentages were used to describe survey findings. The collected data allowed for differences between groups to be examined using chi-square analysis using Fisher's exact test. In particular, this paper examines the value Sonographers (N=67) attribute to information sources as tools for updating professional knowledge, frequency of use of these tools within the context of professional knowledge updating activity and identifies factors that afford or constrain access to these information sources,

4.2 Results and discussion

Table 1 displays the demographic characteristics of Sonographers who participated in the survey component of the study. All age ranges were represented in the respondents with 65% of responding Sonographers aged between 30-49 years. This figure is consistent with data from Australian Health and Community Labour Force statistics where the average age for Sonographers was 39 years (52). Over half (56%) of respondents had professional experience of more than 15 years. The majority of Sonographers were female (72.4%), a finding consistent with gender data from Australian Health and Community Labour Force statistics where females account for 77% of Sonographers. The highest qualification for the majority of responding Sonographers practitioners was at the post-graduate level (86%) with 15% (n=9) of respondents undertaking further study. A majority of Sonographers were employed in metropolitan locations (53%) and in the Private Sector (54%).

Almost all Sonographers (97%, n=59)) held membership with one (38%) or more (59%) professional societies. Of the Sonographers holding membership with an Australian professional society, 85% held membership with the Australian Sonographers Association and 46% with Australian Society of Ultrasound in Medicine. Nine percent (n=5) held membership with an overseas professional society. Ninety-three percent (n=57) of responding Sonographers reported they were enrolled in a CPD program.

Mediating tools in professional updating activity

Survey data was examined to determine use of a range of information sources as mediating tools to update professional knowledge. The results are summarised in Table 2.

Conferences

Ninety-seven percent (n=59) of Sonographers identified that they attend national conferences of professional societies, with 51% attending one (36%) or more (15%) conferences each year. Ten percent (n=6) reported attending international conferences to update their professional knowledge with half (n=3) attending at least every second year. Conferences were valued for the intense nature of learning that they enabled "it was 7 in the morning til - we went to lectures until 6 at night and I found that invaluable going to

something like that but it is a large, it is a constant sort of impact on you in the fact that it's learning day after day".

Characteristic		No. (%)[a]
Employer	Public	26 (46)
	Private	33 (54)
Work environment[b]	Teaching hospital	28 (48)
	Non-teaching hospital	8 (14)
	Clinic	22 (38)
Geographic location	Metropolitan	32 (53)
	Regional	19 (31)
	Rural and remote	10 (16)
Years of professional experience	< 5 years	6 (10)
	5 – 10 years	12 (20)
	11- 15 years	9 (15)
	>15 years	34 (56)
Level of education	Doctorate	0 (0)
	Master	9 (15)
	Graduate Diploma/ Cert	43 (71)
	Bachelor	3 (5)
	Diploma	5 (8)
	Associate Diploma / Cert	1 (2)
Gender	Female	44 (73)
	Male	16 (27)
Age (years)	20 – 29	6 (10)
	30 – 39	19 (31)
	40 – 49	21 (34)
	50 – 60	12 (20)
	>60	3 (5)

[a] Percentages are based upon number of respondents answering each question.
[b] The responses to this organisation factor exclude Sonographers who indicated they worked in more than one type of these environment and those who selected "other"

Table 1. Demographic characteristics of respondent Sonographers (n=61)

Mediating tool	Percent [a] (No.)
National conference of professional society	97 (59)
Journals	95 (58)
Internet search engines	95 (56)
Web pages	95 (56)
Text and reference books	89 (54)
Health and medical databases	84 (48)
Seminars	68 (41)
Government Electronic Health Information Portal eg CHC, CKN	18 (10)
International conference	10 (6)

[a] Percentages are based upon number of respondents answering each question.

Table 2. Information sources utilised by Sonographers to update professional knowledge

Ninety percent (n=55) of respondents reported that their workplace provided them with leave to attend conferences. The financial cost of attending conferences was shared primarily by the Sonographer who self-funded 45% (Mean) of the cost of attendance and the workplace who provided 45% (Mean) of the cost of conference attendance. Financial support was also received from professional societies, (8% Mean). Difference in support by the workplace, through the provision of leave and financial support to attend conference, was not statistically significant (p>.05) across health sector (public, private), geographic location (Metropolitan, regional, rural or remote) or workplace type (teaching hospital, non-teaching hospital, clinic).

Searching for and reading professional literature

The vast majority of Sonographers (98%, n=60) report that they search for and read information on a weekly basis to update professional knowledge. Seventy-four percent (n=45) report reading for one hour or more per week to update their professional knowledge, with 28% (n=17) reading three or more hours per week. Eighty-two percent (n=49) of Sonographers identified that their workplace did not provide dedicated time during work hours to undertake professional reading activities. The greatest variance in the provision of time for professional reading activities by workplaces existed across health sector with 94% (n=30) of Sonographers employed in the private sector not receiving dedicated time for this activity compared to 68% (n=19) of those employed in the public sector, with the difference trending toward statistical significance (Fisher's Exact Test = 6.553, p=.057). Sonographers identified that whilst valuable information sources were available in the workplace they lacked time to use them, stating for example, "No time to access the journals at work".

Time is recognised as a major barrier to updating professional knowledge by health professionals (33, 34, 57-59). In recent studies of Australian health professionals the provision of protected time, that is time during work hours when health professionals are not engaged in clinical or teaching duties, have been reported. For example, 58.1% of Australian and New Zealand Radiation Oncologists reported they had access to 'protected time' for non-clinical or teaching activities such as professional reading (60). Over half (52%) of Australian Radiation Therapists reported that they were provided with 'protected time' for professional reading activity (61), a level quite similar to that reported by Radiation Oncologists. In contrast, a minority (20.6%) of Australian Radiographers were provided with 'protected time' to engage in professional reading activity (62). It is apparent from this study that the provision of 'protected time' to Sonographers is low with just 18% reporting that their workplace provides this support. Whilst variation in support across health sector was evident (6-32%), the level of support for 'protected time' for Sonographers was much lower than their colleagues working in Radiation Oncology and Radiation Therapy. Greater provision of 'protected time' for Sonographers should be investigated.

As displayed in Table 2, Sonographers read journals (95%), Internet web pages (95%) and text and reference books (89%) to update their knowledge and they search for professional information using Internet search engines (95%) and health and medical databases (84%).

Journals

Ninety-five percent (n=58) of Sonographers read journals to update their professional knowledge, with 56% reading journals at least several times a month. The majority of

Sonographers report having access to print (97%, n=58) and electronic journals (93%, n=54) in their workplace. Sonographers also identified that there are a number of journals of relevance to diagnostic ultrasound that they could not currently access but needed access. The journal titles and the percent of respondents were: Journal of Diagnostic Medical Ultrasound (43%), American Journal of Obstetrics & Gynaecology (41%), Ultrasound in Obstetrics & Gynaecology (39%), Journal of Vascular Ultrasound (34%), Journal of Ultrasound in Medicine (33%), Journal of Clinical Ultrasound (32%), Ultrasonic Imaging (29%), Seminars in Ultrasound, CT & MRI (28%), and Obstetric & Gynecology Clinics of North America (27%). It is important that professionals engaging in diagnostic ultrasound have access to disciplinary knowledge disseminated through journals. This study identifies that there is a need to review the journals available in the workplace and determine if journals available are meeting the needs of health professionals performing the range of diagnostic ultrasound procedures undertaken in their practice.

Internet web pages and search engines

The majority of Sonographers (95%, n=56) used web sites to update their professional knowledge. National and international professional organisation web sites were valued by Sonographers as they provided access to needed resources "so you can get every article that has been published on the web if you are a member" and "they have guidelines for particular scans that they update so they give you information about minimum requirements for certain types of scans". In addition Sonographers valued online discussion forums "if anyone has a question you have an open forum where you ask how do you deal with things, has anyone seen this before, those sort of daily information, they put it on the website and its open for discussion". Web sites were also valued for providing access to "very good images" demonstrating normal anatomy and pathology. Internet search engines such as Google (95%) and to a lesser extent Google Scholar (40%, n=21) were also utilised to update knowledge. Search engines were used to obtain information on pathologies "we look up various things on the Internet because very often in daily scanning pathology comes through that we are not familiar with and I find I sit down at the computer and look it up". Sonographers also searched for "examples of pictures of what a particular pathology looks like and more information about that pathology" to inform their clinical practice.

The majority of Sonographers (94%, n=57) indicated that there was access to the Internet in the workplace. Half (51%) of the respondents indicated that the Internet was available on all workplace computers. Two-thirds (66%) of Sonographers who reported Internet access on all workplaces computers undertake Internet searches for professional reasons several times a week. However, in workplaces where the Internet was restricted to Offices (17%), only 22% of respondents undertook Internet searches several times a week. As one Sonographer commented "I do have Internet access here but we, this particular practice we just have the one computer, it's the same one that we use for typing our reports and everything so we don't tend to get on that very often". Workplaces can therefore support professional learning through the universal inclusion of the Internet onto all computers.

Books

Eighty-nine percent (n=54) of Sonographers read text and reference books to update their professional knowledge, with 79% using these books at least several times a month. All responding Sonographers reported that they had access to text and reference books in their

workplace. Sonographers identified there "are still very good textbooks" but were also cautious about using books stating "by the time the text books are out the information is a couple of years old" and "by the time they are printed the images are fairly old".

Health and medical databases

Eighty-four percent of respondents report utilising health and medical databases to update knowledge. The most commonly utilised databases were Medline (70%, n=40), PubMed (62%, n=36), Informit or Meditext (23%, n=11), Cochrane Library (20%, n=11) and CINAHL (Cumulative Index of Nursing and Allied Health, 16%, n=9). Apart from Medline where only 8% of respondents were unaware of the resource, a large number of Sonographers were unaware of other health and medical databases, EMBASE (88%), CINAHL (77%), Cochrane Library (70%) Informit or Meditext (71%) and PubMed (27%).

Eighteen percent of Sonographers reported that they use government provided electronic health information portals such as Clinicians Knowledge Network (CKN) and Clinicians Health Channel (CHC). Amongst respondents, there was a low level of awareness (33%, n=18) of these government portals. Use of these government health information portals was higher amongst Sonographers employed in the public sector (36%, n=9) compared to the private sector (3%, n=1). This finding is not surprising, as these resources are made available to employees in the public sector only.

Given the low level of awareness of health and medical databases and government electronic information portals, there is an immediate need for professional development activities aimed at expanding the knowledge base of health professionals so they can more fully engage with the electronic health information world that is available.

The majority of Sonographers (69%, n=38) were not able to remotely access electronic information resources available in the workplace such as journals and databases from home. Sonographers identified that professionally relevant information sources could be made more available through the facility of remote access to workplace resources. As the vast majority of Sonographers had Internet access at home (97%), remote access to workplace e-resources would be a useful feature providing these professionals with greater flexibility in terms of when and where they can access needed information sources.

Seminars

Sixty-eight percent of Sonographers attended seminars to update their knowledge. Fifty percent (n=30) attended seminars conducted by a professional society, 22% (n=13) attended seminars organised by their workplace and 15% (n=9) attended seminars organised by Vendors. Seminars were valued as they provided information on "applications for their equipment" and also provided Sonographers with access to leaders in their field "people who do cutting edge stuff and that sort of spreads the word … in seminars rather than in publishing, here in Australia"

Importance of information sources

A Friedman Test was conducted on survey data (N=61) to determine an ordered ranking for the importance of information sources for professional updating activity. The results are displayed in Table 3.

	Mean Rank
Importance of seminars	2.97
Importance of conference	3.46
Importance of text and reference books	3.56
Importance of Internet	4.08
Importance of print journals	4.38
Importance of electronic journals	4.73
Importance of databases	4.82

Table 3. Ordered ranking of importance of information sources for professional updating activity

The difference in ranking across information sources was statistically significant $\left(\chi^2 = 47.784,\ df = 6,\ p \leq .001 \right)$. Seminars, conferences and text and reference books were ranked as the top three information sources for professional updating activity, respectively. This top three ranking is in accord with the study by Keppell and colleagues (45) where health professionals ranked the importance of information sources they used to "refresh knowledge". When we consider the traditional model of scientific communication has new knowledge disseminated initially through seminars and conferences and then through journals and books (27-29), the importance Sonographers attribute to seminars and conferences for updating professional knowledge is not then surprising. Despite the 21st century being described as the electronic age, it is important to recognise that non-electronic information sources continue to be highly valued and used by health professionals to update their professional knowledge.

5. Conclusion

The rapidly changing science and technology underpinning diagnostic ultrasound imaging require professionals to engage in a continued process of updating their knowledge. This process utilises information sources as mediating tools in learning. This study identifies that a range of information sources are utilised to update professional knowledge, with seminars and conferences ranked as most important. A number of recommendations were also identified to support professional updating activity. These include: workplaces examine the journals available to determine if they have adequate coverage of diagnostic ultrasound; universal inclusion of Internet access onto workplace computers; provision of remote access to workplace electronic resources such as journals; greater provision of 'protected time' to support professional learning activities; and professional development activities focused on extending knowledge of electronic resources. As this study was conducted in Australia, the results may not have validity in other settings outside of Australia. The author encourages other researchers to build upon this work so that the body of knowledge on professional learning in Sonography is developed.

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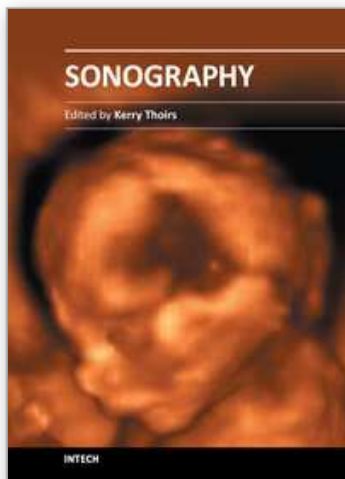
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Medical sonography is a medical imaging modality used across many medical disciplines. Its use is growing, probably due to its relative low cost and easy accessibility. There are now many high quality ultrasound imaging systems available that are easily transportable, making it a diagnostic tool amenable for bedside and office scanning. This book includes applications of sonography that can be used across a number of medical disciplines including radiology, thoracic medicine, urology, rheumatology, obstetrics and fetal medicine and neurology. The book revisits established applications in medical sonography such as biliary, testicular and breast sonography and sonography in early pregnancy, and also outlines some interesting new and advanced applications of sonography.

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