Pharmacy Education, 2003 Vol. 3 (1), pp. 35–52

A Large Group Hybrid Lecture and Problem-based Learning Approach to Teach Central Nervous System Pharmacology within the Third Year of an Integrated Masters Level Pharmacy Degree Course

ALISON M. BRATT*

School of Pharmacy and Biomolecular Sciences, University of Brighton, Cockroft Building, Moulsecoomb, Brighton BN7 4GJ, UK

(Received 4 October 2002; In final form 15 January 2003)

This study developed a hybrid lecture and problem-based learning (PBL) methodology to teach a large group of third-year undergraduate pharmacy students, the topic of Alzheimer's disease and its pharmacological treatment. A combination of two introductory lectures and a structured medical case history PBL task, with guided study, were used as learning materials. At the completion of the PBL task, a lecturer-chaired whole group interactive discussion summarized the task outcomes. Qualitative and quantitative evaluations of the student's experiences with the PBL task, as compared to traditional lecture style information delivery, were then collected by means of a nine-item questionnaire. Most students made favorable comments concerning the PBL task, ranking it highly in terms of its ability to improve overall learning, and aid retention by providing a relevant learning context. Statistical analysis of age effects on task perceptions, demonstrated that mature students (>26 years), far preferred this mode of teaching to traditional lecture delivery, as compared to younger (20–25 years) students.

Keywords: Problem-based learning; Self-directed learning; Pharmacy; Pharmacology; Clinical case study; Alzheimer's disease

INTRODUCTION

Problem-based learning (PBL) is a teaching methodology, which utilizes pertinent "real-life" situations as examples of problems to be solved within the realms of any particular academic specialty (Barrows and Tamblyn, 1980; Birch, 1986; Walton and Matthews, 1989; Margetson, 1991; Barrows, 1993; Woods, 1993a,c; Sadlo, 1995; Mierson, 1998; Norman, 1998). The "problems" form structured learning tasks, around which students formulate learning strategies, attempting to solve the set problems, through a combination of relevant research, information retrieval and abstraction of knowledge, which may be crucial to the solution.

PBL was first used to deliver part of the medical curriculum at McMaster University in Canada in the 1960s, and since then its use has spread throughout University education worldwide, including UK medical schools, (O'Neill *et al.*, 1999). PBL aims to place more responsibility for effective self-directed learning on the students, whilst simultaneously providing a working context within which information, for example, covering medical concepts, may be more readily understood, applied and retained for use in similar practical situations in the future.

Learning appears to be a highly individualized process, such that, throughout our lives, we all may learn by different means at different rates (Barlow, 1997). This study aimed additionally to study the impact of age on student appreciation of the PBL approach. Despite varied styles of learning, two principle factors tend to drive learning forward, these being relevance and interest. PBL specifically aims to introduce information in such a way as to directly relate to the needs or experiences of the learner, in a context of practical usage. In many academic areas of

*Address: Pharmacology Department, Organon Laboratories Ltd., Newhouse, Lanarkshire ML1 5SH, Scotland.
E-mail: ambratt@yahoo.com

ISSN 1560-2214 print
DOI: 10.1080/1560221031000089444

study, learning which is centered around, and applied to a pertinent structured "problem" or issue, may hence combine the necessary elements of interest and practical consideration, which may facilitate and cement learning. Many positive claims have been made in favor of the use of PBL, for example, that it creates the appropriate context in which students can develop critical thinking and problem-solving skills (Norman, 1988; Sinnot, 1988; Resnik, 1989) by making the student feel closer to, and more intimately involved with the topic at hand (Albanese and Mitchell, 1993). PBL also fosters the sense of ownership of learning, in a more self-directed way, and also may instill more confidence in the student, enabling them to feel that they can handle "real-world" problems, (Berkson, 1993; Vernon and Blake, 1993). This is crucial in the teaching methods for the pharmacy course, as such types of clinical scenarios pave the way for the actual day-to-day experiences that pharmacists encounter when practicing in the community.

PBL techniques appear to comprise elements of the learning experience, which are completely congruous with Kolb's learning cycle (Kolb, 1984). Kolb proposed that all learning experiences are acquired through sequential processes of concrete experience, reflective observation, active conceptualization and active experimentation. In order to be fully versatile as a learner, one must master all stages in Kolb's cycle. As an effective lecturer we must strive to provide learning experiences that cater for the range of learning styles represented between our students. To give a presentation, followed by an activity, a designated period for student reflection and a final concluding joint session to draw out concepts underlying the bulk of the learned material, does potentially allow for maximized learning according to the schema of Kolb's cycle. The use of the clinical application also fits with Bloom's taxonomy of learning (Bloom, 1956) in which knowledge comprehension is applied and synthesized, promoting the abstraction of knowledge.

Therefore, a decision was made to present the background information relevant to this section of the module over two lecture periods, to encourage student engagement with the topic. During this time, the etiology, pathology, symptomology and diagnosis of Alzheimer's disease were covered, and a traditional didactic style of information delivery was employed. Students then spent a total of three lecture sessions (equivalent to 6 h total study) in active and individual completion of the assigned clinical scenario. The information that students held at hand included the previous lecture notes, extensive intranet notes, a list of specific guided study, two hand-out information work packs and a number of web site links which could be accessed via the Pharmacy student intranet.

The use of PBL in this context aimed to increase effective knowledge and to enhance student's personal study skills and learning strategies. In terms of knowledge accrual, the PBL task adopted here was designed to:

(1) Create interest in the topic;
(2) Facilitate the integration of theoretical and practical knowledge;
(3) Enhance medical inquisitiveness and "hypothetico-deductive reasoning" (i.e. logical diagnostic thought patterns); and
(4) To strengthen relational links between clinical and pharmacological knowledge bases.

Considering students' study skills and effective learning strategies, it is known that the way in which teaching is managed could have a directed impact to encourage the desired study approach by students (Prosser and Trigwell, 1999). The desired approach in this module was to advocate a deep learning approach (Marton and Salijo, 1976; Entwhistle, 1981; Morgan, 1993) to allow the students to make decisions for themselves relating to the nature and extent of self-directed learning. This aimed to empower the student to take full control of their learning outcomes, and to enhance student's time investment in study. The initial grounding lectures were provided to stir enthusiasm for the subject, and were considered an important element of the hybrid lecture and PBL approach to ensure that the students felt prepared to tackle the clinical scenario. The package of lecture information, plus the structured PBL exercise specifically provided contextual relevance to Pharmacy practice, thereby promoting and developing critical skills and powers of reasoning related to the abstraction of utilizable knowledge.

To interrelate pharmacological concepts with clinical concepts, the PBL exercise developed the ideas that patients have certain pathologies and require specific drugs with specific mechanisms of action to cure illnesses, following the concept of patient health care outlined by Donabedian (1966). It was hoped that by the use of this combination of student focused teaching styles, all of this learned information would be acquired in an interconnected layering fashion, often referred to as a learning "spiral" (Barlow, 1997). By allowing students sufficient time to spend on task-focused guided study, they may not only instinctively adopt a more actively reflective learning approach in the future under similar learning conditions (Schon, 1983; Sinnot, 1988; Resnik, 1989) but they may also keep returning to topics to gain deeper and deeper meaning, with enhanced reflection and integration in an ever-growing construction of a knowledge base (Barlow, 1997).

A few previous research studies have highlighted some potential negative aspects related with the use of PBL. Negative findings have stated that this method of teaching may lead to a relative poverty of background foundation knowledge compared to students taught by a traditional means (i.e. lectures) (Norman and Schmidt, 1992; 1993; Albanese and Mitchell, 1993); that PBL curricula may be stressful for both faculty and students alike (Berkson, 1993), that they do not in fact teach problem solving skills *per se* (Norman and Schmidt, 1992), and that they are too costly and difficult to apply with large groups (Albanese and Mitchell, 1993; Woods, 1993b).

The current study aimed to test out the value of implementing a hybrid lecture and PBL approach to teach the topic of Alzheimer's disease and the pharmacology of its treatment to third year students studying for an integrated Masters degree course in Pharmacy. More specifically, 3 h of traditional lecture style delivery of information were replaced with the use of a patient focused PBL clinical scenario, once background information had been relayed by means of two grounding lectures. The individual PBL exercise took the form of a medical case, according to the "case-format" developed by Christensen (1981). Students were provided with a set of patient medical notes, with guided study questions; through which the student worked, and reflected upon, individually, and outside of the classroom. The period of individual study was followed by a group-debriefing seminar, in which the entire group discussed issues arising from the exercise. Student perceptions of and satisfaction with the experience of, the PBL exercise compared to that of traditional lectures were assayed by use of a questionnaire.

METHOD

Formulation and Implementation of the Hybrid Lecture/PBL Exercise

Some examples of specific PBL exercises (Mierson, 1998; Kudjdych, 1999) were consulted as potential templates around which to structure the desired exercise to teach Alzheimer's disease and its treatment. The information contained in the case study was specifically constructed to guide the learning of the symptomology, diagnosis and drug treatment strategies related to Alzheimer's disease.

In compiling the task, notice was taken of previous criticisms in the literature of the possible lack of the teacher's subject specialism if PBL exercises bridge subject gaps (Walton and Matthews, 1989). In order to preserve continuity between the areas of pharmacology and clinical pharmacy, I liased with Dr Marcus Allen, a senior lecturer in clinical pharmacy within the School of Pharmacy and Biomolecular Sciences, who read and critiqued drafts of all PBL-related literature I had compiled for this module.

Prior to running the PBL task the students were informed that a different method of information delivery would be used for part of this central nervous system pharmacology module, and presented with written statements covering the learning objectives of the PBL exercise (modified from Barrows and Tamblyn, 1980).

The students initially attended two background lectures, introducing the whole topic of Alzheimer's disease. The issues covered included Alzheimer's disease symptomology, diagnostic criteria, pathology and its possible etiology and drug treatment. The initial lectures were held to present an overview of the area of study, and a framework pinpointing areas around which self-directed study should be focused. During the second lecture, the PBL clinical scenario task (Appendix 1), was disseminated, in combination with two handout information dossiers, entitled Introduction to Alzheimer's disease, and Alzheimer's disease pharmacotherapy. The students worked through the PBL exercise outside of the classroom, with the aid of extensive intranet notes, and useful web-links, over a period of three weeks, and the equivalent of three lecture slots (6 h of total study) were used for PBL guided study. At the completion of the PBL task, a whole group seminar style session was held. The post-task debriefing seminar was held to allow open discussion of all questions arising from the task, at the end of which a detailed written summary of the essential facts was presented to the students (Appendix 2). The medical scenario aimed to promote self-learning concerning not only the disease itself, but also the most up to date and appropriate treatments.

Information on sources of information for guided study were provided, and the students were urged to use all available sources of information (intranet lecture notes, handouts, library, internet and British National Formulary (BNF) in order to deduce answers to the questions posed.

Following completion of the PBL task, a group seminar was held in which the lecturer chaired a discussion of the questions posed in the task. At the end of the debrief the students were informed that the use of the PBL task was part of an educational research study, and were asked to complete a questionnaire (Fig. 1), that aimed to review their perceptions of the effectiveness and suitability of many aspects of the self-directed learning task. Questions were posed to assess whether the PBL approach achieved its learning outcomes, and whether the students preferred this style of task to that of traditional lecture style delivery. The questionnaire required students to rank their agreement or disagreement with any question on a 1–5 scale. Sections of the questionnaire were also

PY325: Central Nervous System Pharmacology: Drug Use and Abuse.

Dr. A. Bratt. Student Assessment of Problem Based Learning (PBL) Exercises:

The purpose of this questionnaire is to gather information about your experience of the PBL exercises used in the section of the module covering Alzheime r's disease and its treatment. Please indicate your response by placing a tick in the appropriate box. The information is anonymous.

Gender: Male ☐ Female ☐

Age Group: 20-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-50 ☐

1). How easy / difficult did you find this exercise?

Easy 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Difficult

2). Did you find that you spent the right amount of time in data collection to enable you to work through the set "problem" effectively?

Too Little 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Too Much

3). How helpful did you find the associated information provided as handouts?

Poor 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Good

4). Has the exercise helped your overall learning of the topic?

No 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Yes

5). Did you find that by focussing on a particular problem in context helped you to retain information more readily?

No 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Yes

6). Has the ability to take control of your quality of learning through this exercise enhanced your own self-confidence of your knowledge base in this subject?

No 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Yes

7). OVERALL, do you prefer this method of delivery of module content to that of more traditional didactic teaching ie: lecture style of delivery.?

No 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Yes

Rank 3 statements about this method of learning and teaching that you considered **POSITIVE**?

1).

2).

3).

Rank 3 statements about this method of learning and teaching that you considered **NEGATIVE**?

1).

2).

3).

Please add any ideas you have by which I can improve this method of teaching.

Please be as candid and constructive as possible.

Thank you for taking the time to give me your responses!

Dr. A. Bratt.

FIGURE 1 Nine-item questionnaire to assess student experiences with, and perceptions of, the hybrid lecture/PBL task.

provided for written comments regarding student-held perceptions of both positive and negative issues arising from the new teaching methodology.

Statistical Data Analysis

Data were collected for each of the seven discrete questions ranking perceptions of the PBL task and placed into a spreadsheet. These data were analyzed using the Mann–Whitney U rank sum test (SigmaStat, SPSS), and the impact of student age on response ranking was explored. Similar analyses were completed on the number of both positive and negative descriptive written comments concerning the hybrid lecture and PBL task.

RESULTS

The Student Cohort

The third year student class comprised 104 students total, 84 female (80.77%) and 20 male (19.23%). On the day of the PBL discussion, a total of 71 students took part constituting 68.3% of total group attendance. There is no compulsory attendance of lectures within this module. Of the group present, 11 (15.5%) were male and 60 (84.5%) were female. In the age bands of students attending the PBL debrief, 87.3% of respondents were aged between 20–25; 2.82% were aged between 26–30; 2.82% between 31–35; and 7.04% aged between 36–40. This group therefore comprised 87.3% "college-aged" students, and 12.7% mature students.

Whole Group Perceptions of the PBL Task

Questionnaire data were gathered and expressed as the overall frequency of group responses. The exercise in general appeared to be presented at a suitable level for this third year class; 59.72% expressed neutral thoughts on its level of difficulty, and 33.33% expressed that they found it hard (responded 4–5), as opposed to 6.95% who found it easy (responded 1–2).

The exercise was perceived to be somewhat time-consuming, with 44.5% of respondents feeling that they had probably spent less time on it than they should have to work through the "set-problem" effectively, and 43.1% of respondents feeling that they spent about the right amount of study time on the task.

The quality and usefulness of the handouts and intranet notes for use in conjunction with this PBL exercise were rated quite highly, with 62.5% of students finding them helpful, and only 19.4% of students rating them as not too helpful.

Students definitely indicated that this PBL exercise may have aided their depth of learning in the field of Alzheimer's disease and its treatment; 59.72% registered that it helped overall learning, 16.67% expressed neutral views, whereas 23.61% felt that the task had not helped their overall learning.

The majority of students agreed that by focusing on a particular problem in context this aided information retention more readily, with 54.2% indicating that the format of the exercise did aid information retention; 25% gave a neutral response; and 20.83% felt that it did not help information retention at all.

The PBL exercise failed to instill confidence to the degree which was intended, 43.0% of students reported that they did not feel that the exercise had improved self-confidence, 26.4% expressed neutral feelings, whereas only 29.2% rated the exercise as confidence boosting.

A small majority of the overall student cohort (51.4%) expressed that they preferred traditional didactic lectures to the PBL teaching style; 26.4% expressed no preference, whereas 22.2% favored PBL above traditional lectures.

Qualitative Evaluation of Added Written Comments

When the sections asking for ranked responses to positive and negative factors related to the PBL exercise were surveyed it was found that 90.3% of students had taken time to make additional written comments. Out of this number, 74.7% made a combination of positive and negative comments, 19.7% made positive comments only, whereas only 5.6% made negative comments only. Analyzing the entire written component, a total of 124 positive comments were made, as opposed to 76 total negative comments, generally conveying that the students had received the task favorably.

The positive comments focused on many aspects of the task, including the interest it generated, the benefits of self-directed learning, the fact that learning in context boosts understanding and retention, and an investment of time and effort promotes reflection on principle concepts.

Of the total group, 45.83% of the students had made comments demonstrating that guided individual research had enhanced proactive learning. Actual comments like "encourages self-reliance", "encourages responsibility for learning", "helps control own depth of knowledge", "encourages independent learning", "gives incentive to read around the topic", "gives more flexibility for self-study" and "having to think for myself", were made in a positive light.

The usefulness of the information pack, compiled by the lecturer, an appreciation of the effectiveness of

the clinical case approach to integrate pharmacology and clinical science and the level of immediate interactive feedback were all commented upon favorably. Another area of positive comment covered the addition of relevance and interest through the use of a case study. Actual comments on this point were, "good real-world relevance", "real-life set of symptoms improves understanding and gives better insight", "Thought provoking", "reflection on the problem is useful", "Helps pick out gaps in knowledge and apply knowledge" and "a chance to apply lecture material to actual questions". Most students appreciated the provision of extensive notes on the Pharmacy student intranet.

Negative qualitative comments appeared to focus on three major themes, these being:

(1) A lack of confidence in the breadth and depth of the personal knowledge base attained through the exercise,
(2) The amount of time investment and level of motivation required to complete the task and
(3) A resistance to deviate from traditional lecture based learning.

Concerning confidence levels, comments such as "don't feel I know the basics before I begin", and "not confident I am making the right judgments, with nobody to ask until the exercise debrief session" and "not sure about the answers" were quite prevalent. This indicated an anxiety within certain students that they had covered the right information in the right amount of detail to "know what is needed for the exam", and "hard to relate to an exam context", as other students stated. Another anxiety was that these students had very little experience with this type of case presentation, and they would have benefited from some practice or tutoring before embarking on the task. Comments which indicated this included "task too daunting and too difficult to do alone", "difficulty prioritizing learning", "self-motivation was a big problem" and "have to be dedicated to put the effort into doing this".

The major complaint was a feeling that this type of teaching style was different from that which has been previously experienced, and that the students preferred lecture style delivery. This was indicated by comments such as, "No dictation of notes like proper lectures" and "prefer structured lectures" were made.

The Effects of Age on Qualitative and Quantitative Responses to the PBL Questionnaire

The group was separated according to age, into "college-age" students (20–25 years), and mature students (>26 years). The Figs. 2 and 3 depict data from these analyses. Responses have been collapsed together as 1–2, 3 and 4–5, to clarify figures. There was found to be no statistical difference between the groups with respect to perceived task difficulty, (Fig. 1A; $t = 396.5$; $p = 0.213$, Mann–Whitney U rank sum test), or confidence levels in the self-directed learning achieved, (Fig. 2B; $t = 398$; $p = 0.204$, Mann–Whitney U rank sum test).

Mature students were statistically much more enthusiastic about the use of PBL in this module. One hundred percent of mature students ranked the PBL accompanying literature as highly useful, as opposed to only 48.4% of younger students (Fig. 1C, $t = 463.5$, $p = 0.016$, Mann–Whitney U rank sum test). A greater number of mature students (88.9%) rated that the task aided overall learning, as opposed to 56.4% of young students (Fig. 1D, $t = 438$, $p < 0.05$, Mann–Whitney U rank sum test). All mature students (100%) rated that the context of PBL aided information retention, as opposed to 58% of younger students (Fig. 2A, $t = 463.5$, $p = 0.016$, Mann–Whitney U rank sum test). A larger number of mature students (44.4%) than younger students (25.8%), showed a strong statistically significant preference for PBL over traditional lecture style teaching (Fig. 2C, $t = 474$, $p = 0.01$, Mann–Whitney U rank sum test).

Mature and younger students made the same number of negative descriptive comments per student, however, mature students made more positive qualitative written comments (2.77 comments/student), than younger age bracket students (1.72 comments/student), indicating their relative preference for PBL. The number of positive comments were significantly higher ($p < 0.05$, Mann–Whitney U rank sum test) for mature than younger students. The natures of the comments were also qualitatively different. The mature students really appeared to appreciate and thrive on independent study, with comments such as, "working myself rather than passive" and "Having time to source our own information and reflect on the problem" highlighting this.

DISCUSSION

This study intercalated a hybrid lecture and PBL mode of teaching for the first time with the module PY325: central nervous system drug action, to teach third year pharmacy students at the University of Brighton. Students found the approach novel, and overall made more positive comments highlighting the perceived attributes of the teaching style than negative comments. It is interesting to address both sets of comments, to understand what drives students to derive benefit from such a learning technology, as well as gaining useful information

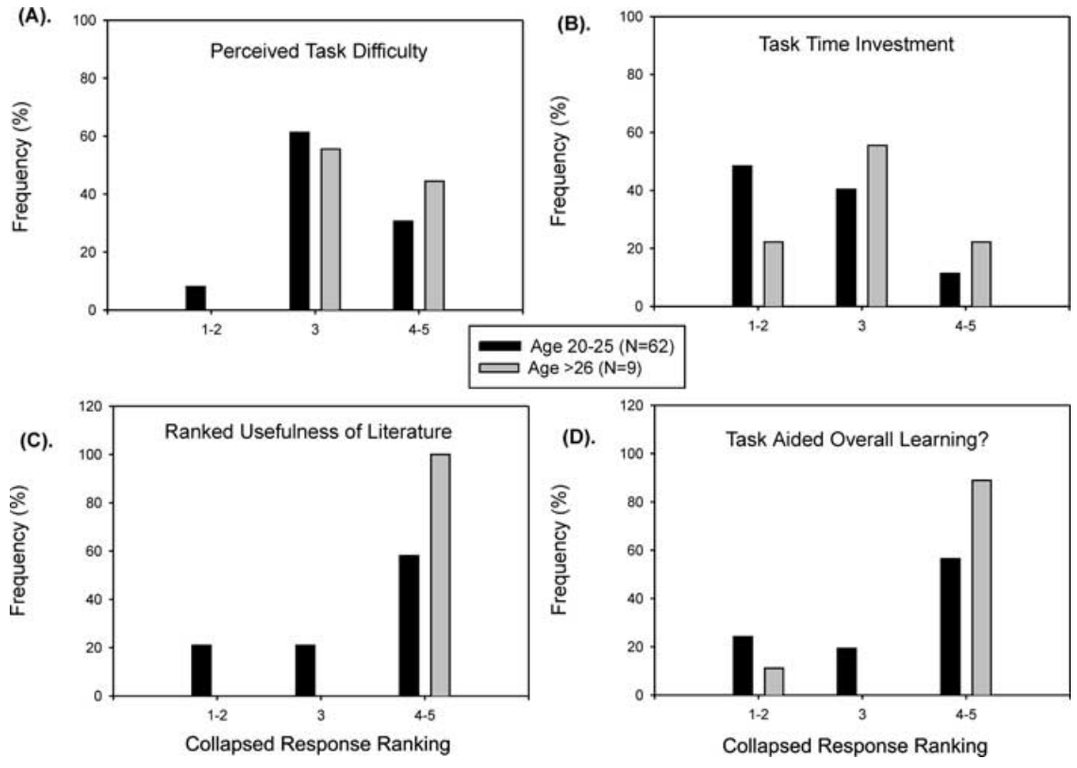

FIGURE 2 The effects of age on responses to the questionnaire relating to the hybrid lecture/PBL task made by the third year pharmacy student cohort. The data depicted are the frequency (% of respondents) selecting responses 1–2, 3, and 4–5 (collapsed ranking) on a Likert scale. The dark bars of the histograms depict responses made by "college-aged" (20–25 years) University students, and the gray bars depict responses made by mature students, (>26 years). The figure is presented in four panels, which correspond to: (A) The perceived task difficulty (scale 1–2 = easy, 3 = adequate, 4–5 = difficult). (B) The time spent completing the task (scale 1–2 = too little, 3 = about right to 4–5 = too much). (C) Perceived usefulness of the associated literature provided with the PBL task. (1–2 = not useful, 3 = neutral feelings, to 4–5 = very useful literature). (D) Thoughts on whether the PBL task improved overall learning. (1–2 = did not improve learning, 3 = No strong opinion, to 4–5 = aided learning).

with which to improve delivery and outcome in future years.

What Exactly is PBL and when should it be Used?

PBL appears to be quite an ill-defined term in the literature, in terms of exactly how it is put into place. What is clear is that PBL tasks should always be organized around problems rather than disciplines, to produce an integrated teaching approach, (Moss and McMillan, 1980). By doing so, PBL should encourage thought processes, which integrate knowledge across disciplines (Walton and Matthews, 1989). Traditionally, PBL is a means to encourage learning of a topic with which the student has no former knowledge base or experience (Maudsley, 2001). The current study illustrates successful use of a hybrid model of a small number of traditional lectures and PBL using a defined clinical case study (Christensen, 1981). The precise manner in which PBL has been used in this study, is that it has been applied to a very precise topic, Alzheimer's disease and its treatment, with a very defined self study framework underpinning the study. The core aim was to evaluate a medical scenario by adopting a holistic approach to reflect upon the disease process, its step-wise diagnosis, and the consequent pharmacological treatment and patient care plan. Such a simulated case study approach has previously been used by Barrows and Tamblyn (1976) for teaching PBL in small groups, with very positive outcomes. The use of two introductory grounding lectures were considered integral to this hybrid lecture and PBL means of teaching since the topic in question is quite expansive. Also, previously published data has shown medical students studying in pure PBL-based curricula, often complain of feeling "thrown into a subject with no expertise and find this too overwhelming" (Parikh *et al.*, 2001).

The student subjects in the current study were third year undergraduates with a very developed knowledge base in general pharmacology and central nervous system pharmacology. They collectively attended two lectures on the topic before they embarked on the defined PBL task, so they did have a substantial knowledge base from which to draw in order to solve the PBL task. It is certainly worthwhile

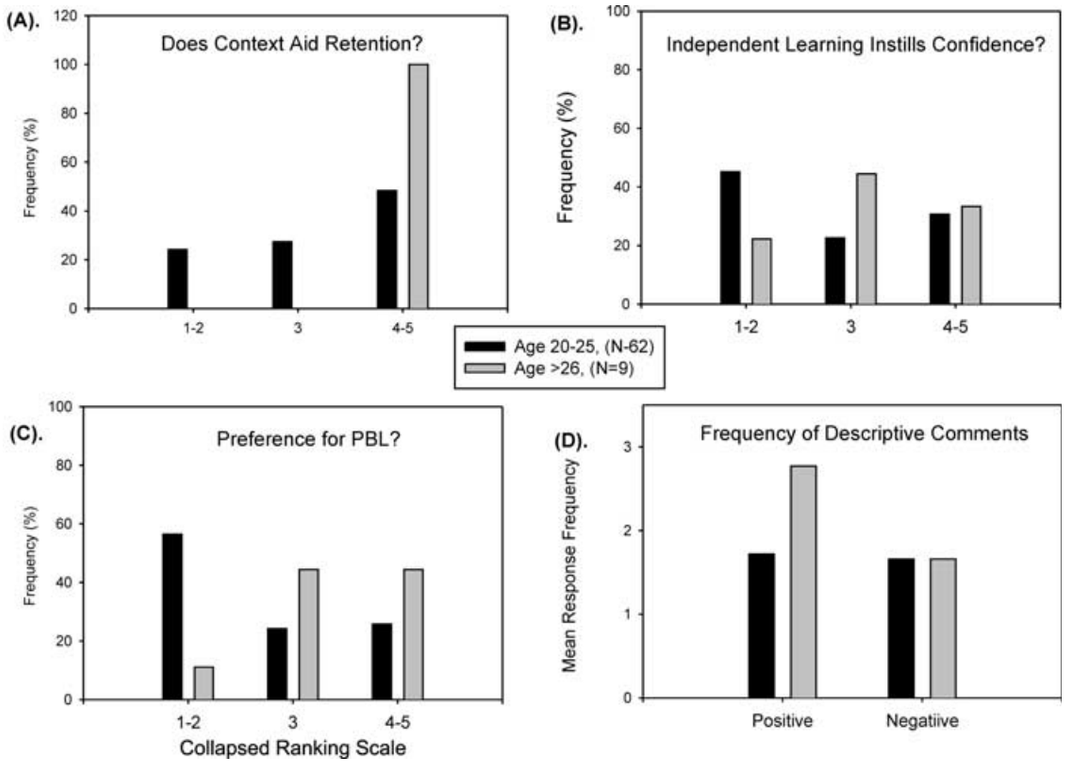

FIGURE 3 The effects of age on responses to the questionnaire relating to the hybrid lecture/PBL task made by the third year pharmacy student cohort. The data depicted are the frequency (% of respondents) selecting responses 1–2, 3, and 4–5 (collapsed ranking) on a Likert scale. The dark bars of the histograms depict responses made by regular aged (20–25 years) University students, and the gray bars depict responses made by mature students, (>26years). The figure is presented in four panels, which correspond to: (A) Perceptions concerning whether the contextual relevance of the clinical scenario aided information retention (scale 1–2 = did not aid retention, 3 = no strong opinion, to 4–5 = contextual learning aided retention). (B) Perceptions concerning whether independent self-directed learning boosted confidence in learning concepts (scale 1–2 = did not improve self-confidence, 3 = no strong opinion, 4–5 = responsibility for learning did aid self-confidence. (C) Preference for PBL style task or traditional didactic lectures? (1–2 = preferred lectures, 3 = no preference, to 4–5 = preferred PBL). (D) The frequency (%) of positive and negative written comments concerning the exercise made by both regular aged, and mature students.

considering the appropriate amount of information to be delivered to the student cohort prior to setting of the problem, and also the level at which such tasks are set through any undergraduates' university progression. Data from this study suggest that it may be important to introduce the concept of PBL early, and to appreciate that more mature students prefer this mode of teaching, whereas younger students sometimes struggle with aspects of PBL. This finding is substantiated by the fact that more mature students do cope better with a higher degree of freedom of individual self-directed study than do their younger counterparts (Brookfield, 1986).

The Learning Outcomes of the PBL Exercise

The desired learning outcomes associated with the current study were to promote student-centered and student-directed learning, i.e. to provide a situation in which students invested greater input into making decisions about what and how they learnt. Another learning outcome was to foster strategic learning, or the employment of effective study strategies, which may be called upon in the future to apply to similar tasks, in an attempt to cement strategies for life-long learning. A third learning outcome was to promote a more holistic view of health care (Margetson, 2000), to deepen the level of medical understanding and excellence of pharmacy practice. All of these goals were attained by substituting a simulated clinical case task in place of conventional instruction (i.e. large group lectures). Most of the learning outcomes were fulfilled, students were forced to become actively engaged learners, seeking out information and applying it to a real-life relevant clinical scenario. Students did extract knowledge from the literature and all students participated in the general interactive discussion following the PBL task. The vast majority of students obtained benefit from the debrief session, and learnt more about Alzheimer's disease and its treatment. All new PBL tasks should consider setting out clear learning outcomes, especially, as in this case, the students were naïve to this style of teaching.

Possible Pitfalls of and Improvements for PBL Exercises in This Context

In the past usage, PBL has traditionally been put into practice by use of small group tutorials that require a heavy time commitment from the academic staff. Quite often groups take on the PBL task, share the tasks required to research the problem, and then return to the small seminar group to discuss it. In the case of the pharmacy course at the University of Brighton, class sizes are very large. This third year group consisted of 104 students with 71 attending the PBL debrief session, making small group work logistically impossible. There should be no reason why a large group cannot be used for discussing the PBL tasks, to make this method of delivery almost as effective as one-to-one tutoring (Bloom, 1984) if sufficiently structured guided study and tutor-led support is in place. Barrows *et al.* (1986), have already validated a method for large group teaching using PBL, and the interactive debrief discussion proved sufficiently efficacious in the current study, and when employed by previous researchers (Moss and McMillan, 1980).

One way that the current PBL exercise may have been improved would have been to make use of problem-centered groups. Bligh (1998) has previously described the use of initial ground laying lectures, followed by the formation of peer discussion groups. The central idea here being that the initial lectures provide discussion stimuli, whilst also building salient background knowledge with which students may tackle group problems. This combination may actually be time-saving.

A way to increase motivation to perform the task is to formulate the problem to contain a high level of relevance to the student. Quite a number of students in the current study found themselves demotivated to invest the quite substantial amount of study time required. What appeared to drive these behaviors was a mindset of wishing to learn only what is perceived "to be required" for examination purposes, and not for the love of the topic, or for mastering a field or strengthening overall competency and clinical self-confidence. As teachers we need to try to de-emphasize this mind-set in some way, to re-emphasize learning for the "love of the subject". Student induction is another important issue by which academic staff can encourage effective learning strategies, the search for meaning and a deep engagement with the subject matter. The students in the current study were previously totally unexposed to PBL, and some did not know precisely what was required of them under these circumstances. Another possible future improvement to the current task would be to have a proportion of the task assessed, as assessment always drives motivation to complete coursework. The current PBL task was set up as a formative study exercise. However, in the future a summative component could be brought into play.

If the method of PBL is to achieve the highest quality of teaching, utility needs to be crafted with a very student-focused teaching perspective. This means that the tutor must aim to see and understand the needs and situation of the student, to urge the use of effective independent learning styles and to adapt teaching to make learning more integrative in giving the student "the big picture", and not only a list of unrelated facts. In this respect I believe that the hybrid lecture and clinical case scenario PBL achieves the big picture end point and encourages both surface and deep learning at various points through the whole process. This really encourages a dedication to read around the subject in the students and, with repetition, slowly certain facts may "gel" and begin to interconnect.

Novel Teaching Techniques: Resistance to Change

Many of the students in the current study displayed a marked preference for traditional lecture style information delivery to PBL style teaching. This preference was shown despite the majority of students indicating that they understood and appreciated the many benefits of PBL. This may be seen as a major problem, as although lectures have utility (Brown, 1978; Bligh, 1998), they are transmissive by nature, and it often becomes a problem to get students actively thinking in a lecture situation. The other major problem is that students all too often assume a passive, non-thinking, information-receiving role, and it is this that PBL challenges and tries to change. PBL attempts to prompt students to use and remember information, and to be actively engaged by thinking about the content of information to be retained. Overall, it is hoped that PBL may facilitate students becoming more knowledgeable, more clinically skilled, of more positive attitude and more confident practitioners, to allow a transfer of learning from the classroom into pharmacy practice.

Adherence to the Pharmacy Benchmark Statement:

The guidelines of the quality assurance agency for higher education (2002), establish that the pharmacy degree establishes a basis for learning, which continues throughout the pharmacist's career, focusing on (among other criteria) (1) the processes leading to disease and the symptoms of common illnesses; and (2) the safe and effective use of medicines to treat disease. Listed in the defining principles of pharmacy as a professional discipline, defined by the application in a healthcare context of scientific principles and intellectual rigor through the "purposeful integration of information and

the process of critical evaluation leading to the application of pharmaceutical knowledge". Inherent in the pharmacy-related cognitive abilities and skills listed in the benchmarking document are "recognition and analysis of problems and planning of strategies for their solution". More specifically it is of utmost importance that pharmacists be able to interpret patient and clinical data, and to contribute to the development of a health care strategy through reflective practice, enquiry and innovation.

Listed in transferable skills is "Problem solving, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information". It is also noted that in curriculum delivery "the student is encouraged to take responsibility for his/her own lifelong learning both within the degree course and as a basis for later continuing professional development". Emphasis is also placed upon the inclusion of independent assignment based learning and problem solving exercises, and the development of decision making skills. Also a multidisciplinary and integrative approach to solving health care problems is urged. With respect to these documentations, it appears that problem based learning exercises may well fulfill many of the teaching and learning criteria proposed in the bench-marking document.

Possible Utility to Train Students in Clinical Problem Solving Prior to their Objective Structured Clinical Examinations (OSCEs):

During the third year of the pharmacy course, students are placed at, and make ward rounds in, hospitals in the area. They were therefore somewhat familiar with such things as patient drug histories and care plans prior to encountering this PBL exercise. The employment of a PBL-style of teaching may provide a degree of training for the skill-based oral clinical examinations that they receive during the final year. These examinations are called OSCEs. The structure of the OSCE exams comprises a circus of six clinical cases, which are presented to the student for their appropriate interpretation. The cases comprise real patients suffering common medical conditions, who volunteer to visit the university from the hospital, and talk to the students to give them their history of presenting conditions. The students have to interview the patients to gain appropriate amounts of diagnostic information. They are also required to review patient's files, speak to a real doctor to advise on therapy, possibly calculate drug doses; and make recommendations to consultants. These exams are purely skill-based, since they are open book, and they are thereby designed to assess abilities (in a simulated version) of the actual work setting. Self-confidence is vital in achieving a high-grade pass in these exams, and it seems logical that prior practice in clinical problem solving may be invaluable in nurturing self-belief that one possesses all the skills to be an effective pharmacist.

How PBL Fits with the Trend Toward e-learning Strategies

In the new millennium, the impetus for facilitating e-learning is ever accelerating. Online delivery of learning materials may, it is hoped:

(1) improve the quality of teaching;
(2) improve the access to teaching; and
(3) decrease the overall cost of teaching.

The current PBL exercise outlined in this study made use of e-learning, in that not only were quite detailed supplementary course lecture notes covering Alzheimer's disease and its treatment provided, but guidelines on PBL learning outcomes, references for guided study, and relevant links to web sites were provided. Students do use information on the intranet very readily and use of material prior to lectures may well aid learning. Reducing the amount of formal contact within the pharmacy course could be beneficial in promoting self-directed learning and fostering a sense of a student's own responsibility for the search for relevant applicable knowledge. This could be a major possible strength of the hybrid lecture and PBL task approach, in fostering life-long learning.

Overall Philosophy of PBL in the Context of the Current Study

In summary, the use of PBL as an integrated component of the teaching within this module described in this manuscript is to be very student focused, and to ultimately produce highly competent graduates. The structure of the PBL exercise must act as the trigger for the desire to acquire knowledge, to stimulate natural interest in the topic, and to enhance and facilitate knowledge application in practical situations. If these goals are achieved, it will impact on the transfer of learning from the classroom into pharmacy practice.

CONCLUSIONS

Medical-based knowledge of the nature required by pharmacists for the efficacious provision of health care in the UK might best be learnt by use of a more practical based learning methodology. Such a learning "methodology" may be the use of PBL clinical scenarios. Results from this study conclude that students undertaking an integrated masters

degree in pharmacy at the University of Brighton, do find much utility in the use of such an approach to teaching. However, on the whole they would prefer to attend traditional lectures. There are many possible underlying reasons for this outcome, including student age group, lack of prior experience with such types of teaching, lack of motivation to research a large topic independently, an under-developed self-confidence to cover the breadth of information required or adoption of a belief that they have not acquired the basic facts before encountering the problem.

Many of these negative points may be addressed and employed to vastly improve delivery of this style of teaching. For example, this type of learning methodology may be introduced at an earlier stage in the student's career, creating familiarity with the diagnostic interpretive approach. A hybrid PBL methodology may be used to supply an adequate number of lectures in which to lay down the knowledge foundations immediately before presenting the student with the problem. The use of one or more debrief seminars also ensures that all students have reached correct conclusions. The problem of lack of motivation to complete the task independently, may be overcome by suggesting that the task be shared in groups, thus setting up team working skills, and establishing a forum for knowledge sharing and peer-tutoring.

Mature students in this third year pharmacy cohort strongly favored the PBL technique. This may suggest that learners entering the university degree later in life enjoyed the freedom of individual study and benefited more from a guided, discursive mode of learning over the transmissive learning genre of traditional didactic lectures. This may also indicate a more developed self-confidence in knowledge gathering and problem solving *per se*. This does highlight the fact that PBL might best be used in the later stages of any degree course as students reach a stage of having acquired foundation factual knowledge, and are just developing abilities to cross-pollinate ideas from many sub-disciplines, to apply to any practical problem.

Overall, it appears that PBL is a highly effective teaching and learning strategy, and if used correctly, may well dramatically benefit pharmacy students whilst reading for their degree at the University of Brighton, and beyond along their path of life-long learning and practice as health care professionals.

Acknowledgements

The author would like to extend her warm thanks to Drs Marcus Allen, Paul Gard and Graham Davies of the School of Pharmacy and Biomolecular Sciences, and Dr Pauline Ridley of the Institute for Learning and Teaching of the University of Brighton; for having read and commented upon preliminary drafts of this manuscript.

References

Albanese, M.A. and Mitchell, S. (1993) "Problem-based learning: a review of literature on its outcomes and implementation issues", *Acad. Med.* **68**(1), 52–81.

Barlow, J.D. (1997) "Learning skills and skills for learning", *Educational Dilemmas: Debate and Diversity* Reforms in higher education, (Cassell, London) **Vol. 2**, pp 57–66.

Barrows, H.S. (1993) "A taxonomy of problem-based learning methods", *Med. Teacher* **5**, 291–309.

Barrows, H.S. and Tamblyn, R.M. (1976) "An evaluation of problem-based learning in small groups using a simulated patient", *J. Med. Educ.* **51**, 52–54.

Barrows, H.S. and Tamblyn, R.M. (1980) *Problem-based learning: an approach to medical education* (Springer Publishing Co., New York).

Barrows, H.S., Myers, A.C., Williams, R.G. and Moticka, E.J. (1986) "Large group problem-based learning: a possible solution for the 2 sigma problem", *Med. Teacher* **8**(4), 325–331.

Berkson, M. (1993) "Problem-based learning: have the expectations been met?", *Acad. Med.* **68**, S79–S88.

Birch, S. (1986) "Towards a model for problem-based learning", *Stud. Higher Educ.* **11**(1), 73–82.

Bligh, D.A. (1998) *What's the Use of Lectures?* (Direct Design Products, Hants).

Bloom, B.S., ed, (1956) *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook 1: Cognitive Domain* (MacKay, New York).

Bloom, B.S. (1984) "The 2 sigma problem: the search for methods of group instruction as effective as one-to-one tutoring", *Educ. Res.* **13**(6), 4–16.

Brookfield, S.D. (1986) *Understanding and Facilitating Adult Learning: A Comprehensive Analysis of Principles and Effective Practices* (Open University Press, Milton Keynes).

Brown, G. (1978) *Lecturing and Explaining* (Meuthen, London).

Christensen, C.P. (1981) *The Case System in Medicine* (Harvard Business School, Division of Research, Boston).

Donabedian, A. (1966) "Evaluating the Quality of Medical Care", *Milbank Meml. Fund Q.* **44**, 166–206.

Entwhistle, N. (1981) *Styles of Learning and Teaching an Integrated Outline of Educational Psychology for Students, Teachers and Lecturers* (Wiley, Chichester).

Kolb, D.A. (1984) *Experiential Learning: Experience as the Source of Learning and Development* (Prentice Hall, Englewood Cliffs, NJ).

Kujdych, N. (1999) "Annie get your gun… A three-session problem-based learning case focusing on migraine headaches for fifth-year doctor of Pharmacy students", *J. Clin. Problem-based Learn.* **2**, 3–42.

Margetson, D.B. (1991) "Is there a future for problem-based education?", *Higher Educ. Rev.* **23**(2), 33–47.

Margetson, D.B. (2000) "Depth of understanding and excellence of practice: the question of wholeness and problem-based learning", *J. Evaluation Clin. Pract.* **6**(3), 293–303.

Marton, F. and Salijo, T. (1976) "On qualitative differences in learning: outcome and process", *Br. J. Educ. Psychol.* **46**, 4–11.

Maudsley, G. (2001) "What issues are raised by evaluating problem-based undergraduate medical curricula? Making healthy connections across the literature", *J. Evaluation Clin. Pract.* **7**(3), 311–324.

Mierson, S. (1998) "A problem based learning course in physiology for undergraduate and graduate basic science students", *Adv. Physiol. Educ.* **20**(1), S16–S27.

Morgan, A. (1993) *Improving your students learning: reflections on the experience of study* (Kogan Page, London).

Moss, G.D. and McMillan, D. (1980) "A strategy for developing problem-solving skills in large undergraduate classes", *Stud. Higher Educ.* **5**(2), 161–171.

Norman, G.R. (1988) "Problem-solving skills, solving problems and problem-based learning", *Med. Educ.* **22**, 279–286.

Norman, G.R. and Schmidt, H.G. (1992) "The psychological basis of problem-based learning: a review of the evidence", *Acad. Med.* **67**, 557–565.
Norman, G.R. and Schmidt, H.G. (1993) "Where is the learning in problem-based learning?", *Pedagogue* **4(No. 2)**(1), 4–6.
O'Neill, P.A., Metcalfe, D. and David, T.J. (1999) "The core content of the undergraduate curriculum in Manchester", *Med. Evaluation* **33**(2), 121–129.
Parikh, A., McReelis, K. and Hodges, B. (2001) "Student feedback in problem based learning: a survey of 103 final year students across five Ontario medical schools", *Med. Educ.* **35**, 632–636.
Prosser, M. and Trigwell, K. (1999) *Understanding Learning and Teaching* (Kogan Page, London).
Resnik, L.B. (1989) *Education and Learning How to Think* (National Academic Press, Washington, DC).
Sadlo, G. (1995) "Problem-based learning", *Tertiary Educ. News* **5**(6), 8–10.
Schon, D.A. (1983) *The Reflective Practitioner: How Professionals Think in Action* (Temple Smith, London).
Sinnot, J. (1988) *Everyday Problem Solving* (Praeger, New York).
Vernon, D.T.A. and Blake, R.L. (1993) "Does problem-based learning work? A meta-analysis of evaluative research", *Acad. Med.* **68**(7), 550–563.
Walton, H.J. and Matthews, M.B. (1989) "Essentials of problem-based learning", *Med. Educ.* **23**, 542–558.
Woods, D.R. (1993a) "Problem-solving—where are we now?", *J. Coll. Sci. Teaching* **22**, 312–314.
Woods, D.R. (1993b) "Problem-solving—what doesn't seem to work", *J. Coll. Sci. Teaching* **23**, 57–58.
Woods, D.R. (1993c) "On the learning in problem-based learning", *Pedagogue* **4**(2), 2–3.

APPENDIX 1

PBL task: clinical scenario to teach the etiology, diagnosis and treatment of Alzheimer's disease

PY325: Central nervous system pharmacology.

Problem based learning exercise: treatment of Alzheimer's disease

Aim

You should be able to read through the information given and consider all aspects of the presenting disease and its possible treatment to then be able to contribute to group discussion following your period of individual study. This exercise should be regarded as a contextual framework around which to begin to study the underlying physiology and pharmacology relevant to each case, and not as a means of learning clinical practice *per se*.

Please read the document on the intranet explaining PBL and its objectives before you begin.

Case Scenario

HPC

Mrs Mavis B., is an 81-year-old widow, who is currently living alone in the house she has resided in for 33 years. She has a 18–24 month history of some behavioral changes, now reported to her consultant neurologist by her daughter, Doreen. Forgetfulness, disorientation, lability of mood and some paranoia mainly characterize Mrs B's behavioral changes. Mrs B has occasional day-to-day help from Doreen who now accompanies Mrs B to a hospital neurology consultation following referral by her local GP.

PMH

Doreen reports that she first became worried that something maybe wrong with her Mother between 12–18 months ago, when she seemed to be repeating herself frequently, making multiple phone calls to ask the same questions of her daughter, and failing to remember dates and times of meetings. Mrs B made exhaustive lists of things to do to help get her through the day, and now relied heavily on writing instructions down for the simplest of procedures. Initially her daughter believed that Mrs B's complaints were just due to her getting old, but now she is becoming increasingly worried about her welfare and mental condition.

Mrs B has been treated for mild hypertension for the past two years. She displays symptoms of depression but is currently not being treated for this. She appears to be a little disoriented even in familiar surroundings, but is still capable of functioning almost independently.

Q's to Guide you in Your Thinking

- Before diagnostic tests were carried out, what possible diagnoses could have been drawn from the available patient information?
- Why did the consultant neurologist request the tests he did to aid diagnosis?
- What other tests could the consultant have requested and would they have lead to a more conclusive diagnosis?
- How crucial is the neuropsychological examination, in this case, and what has it told us from this particular patient?
- What is the relevance of the staging in this diagnosis?
- How does Alzheimer's disease differ from cerebrovascular dementia?
- What possible causative factors may have lead to Mrs B's disease?
- What brain pathology underlies Mrs B's disease?
- Why did the consultant prescribe the drugs listed for Mrs B and what is their pharmacological mode of action?
- What is co-dergocrine mesylate, how useful is it clinically, and how does it have it's action?
- Do you have to warn Mrs B of any side effects she may experience on these drugs?
- Why did the consultant insist that Mrs B stop taking her Nytol®?

OE	Mrs B appeared to be in fair overall health, with no physical symptoms of infirmity.
	She had no apparent sign of head trauma, ^{0}neck stiffness, ^{0}pyrexia.
CNS	PERLA, reflexes normal, ^{0}retinopathy, ^{0}vertigo, ^{0}tinnitus, ^{0}weakness, ^{0}paralysis, ^{0}photophobia. ^{0}previous seizures, ^{0}known ischemic events.
CVS	BP 130/94, pulse 88.
RS	NAD
GU	NAD
Abdomen and GI system	NAD
FH	Mother deceased, CA breast.
	Father deceased, stroke.
DH	Captopril, 12.5 mg po bid.
	Diphenhydramine HCl (Nytol®) 50 mg po on for insomnia).
SH	Mrs B is 81-years-old, widowed for 3 years, with 1 daughter, Doreen. Lives alone. Retired.
	She drinks only very occasionally, and smokes (10 a day).
Allergies	None
(Laboratory tests requested) (Test results returned and added to patient notes later)	
FBC	NAD
Blood panel	Serum electrolytes, glucose, urea, liver functions,
	Vitamin B_{12}, thyrotrophin levels, all NAD.
	Syphilis serology: negative.
Urinalysis	NAD ^{0}bacteria, ^{0}protein
Brain structural imaging	3-D coronal volumetric magnetic resonance imaging (MRI)
MRI results	No significant evidence of cerebrovascvular disease.
	Moderate volume loss in medial temporal lobe structures.
	Query evidence of expanded volume of ventricles?
Neuropsychological examination	Normal full-scale intelligence quota
	Elemental neurologic exam: NAD
Mental status	MMSE (mini-mental status exam) score was 22/30
Attention	Some decrement on digit span test
Reading/writing	NAD
Language	Expression, comprehension/repetition: NAD
Memory	10-word list showed learning curve of 2, 5, 7 after 3 trials
	After a 5-min interval with interference, the patient spontaneously recalled 1/10 words.
Verbal and non-verbal memory	Impairments in encoding and storage.
Frontal lobe tests	Absence of perseveration.
Visuospatial function	Slight problems in copying a 2-dimensional figure and a 3-dimensional cube.
Executive function	Some hesitancy on calculation ability (2-digit addition and multiplication), and word problems, with eventual correct responses.
Diagnosis	Probable Alzheimer's disease.
	Apparent Stage I, borderline stage II.
Rx	Donepezil 5 mg po 1 × daily.
	Increase to 10 mg 1 × daily according to response and tolerance.
	Citalopram 20 mg po 1 × daily on.
	Increase to 40 mg 1 × daily according to response and tolerance.
NB	Consultant neurologist urged the immediate cessation of Diphenhydramine for insomnia.
	(Replaced with below)
	Temazepam: 10 mg po. 1 on prn.
Career counseling	Mrs B's daughter was offered counseling support, if required, in helping to cope with/understand her Mother's medical diagnosis.
	An appointment was also made for Mrs B's daughter with social services to provide information related to home help/district nurse support for her Mother.

- Are SSRI's considered safe for use as anti-depressants in the elderly?
- How may Mrs B's condition change over the next 5–10 years?

Three Month Follow up OPA

Mrs B returns to see her consultant with her daughter, who reports that her Mother appears to be significantly improving on the drugs that she was prescribed. Her memory is sharper, and she appears to be coping with looking after herself, and day to day living chores more efficiently. Mrs B herself appears in more positive spirits, and notes herself that her memory is better.

Review

Please review all drugs prescribed for Mrs MB and concentrate on their pharmacological mechanisms of action. What are your impressions of how the diagnosis was made and how treatment was given?

Additional Q's

- Please gather some information on novel therapies for Alzheimer's disease and consider their possible efficacy (according to available data), and possible mechanism of action.
- Consider other psychiatric conditions that may be co-morbid with Alzheimer's disease, and suitable treatment.

APPENDIX 2

Debrief notes for the PBL clinical scenario to teach the topic of Alzheimer's disease and its pharmacological treatment.

PY325: Central nervous system drug use and abuse. Debrief to Alzheimer's disease PBL exercise. Dr Bratt.

General Introduction

The aim of this exercise is to approach a fictitious case of patient with memory loss. We are required to approach dementia as a whole syndrome in order to make a specific diagnosis. There are a number of possible diagnostic outcomes:

(a) Age associated memory impairment (AAMI)
(b) A reversible dementia state (many causes)
(c) Alzheimer's disease

Reviewing General Patient Information

Bear in mind that any information may be a diagnostic clue

- Advanced patient age (81). Age is a major risk factor for AD and disease incidence rises with age, 5% of the population >65 have AD, whereas 20% of those >80 have AD.
- Mrs B's symptoms are not transient, they have a lengthy history.
- Mrs B's condition appears to be of a gradually progressive nature, highlighted by the raised concerns of her daughter.
- Mrs B's behavioral changes are starting to have an impact on her day-to-day living, to be socially disabling.

Reviewing History of the Presenting Condition

- Indicated cognitive decline. Need to ascertain the nature and severity of this major symptom.
- Reported symptoms of depression. Pursue causes. Bear in mind that anxiety and depression are often co-morbid in 50% of cases of AD.
- Mrs B suffers from insomnia. Need to determine the nature and severity of this symptom. Consider that approximately 50% of AD patients characteristically display "sun-downing" (agitation and akathesia at night leading to heightened nocturnal locomotor activity).

Consider FH

Must Consider 2 Points

- Any previous familial history of AD?
- Any previous familial history of cardiovascular disease?

No family history of AD, however, Mother died of cancer, and Father died of CV disease, both presumably before reaching an advanced age. In this line of thought we must consider that familial AD is not that widespread, and that most cases are idiopathic in nature. True familial AD is confined typically to a few large families (autosomal dominant on chromosome 21), which leads to early onset (40s–50s), and a very rapid progression.

Father had a history of angina, and Mrs B herself is mildly hypertensive. Cerebrovascular dementia cannot be ruled out.

Consider SH

Mrs B has been widowed for 3 years. Consider the possibility that a traumatic life event, such as loss of partner or moving into a nursing home can

precipitate a noticeable decline in symptoms in the case of AD.

Consider Data Obtained OE and Test Results

All data to be considered in order to eliminate reversible causes of dementia.

- No sign of head injury, outward appearance of intoxication, or of CNS infection. (All of these may cause a transient dementia syndrome)
- Visual and auditory system fine. Full consciousness, with no paralysis or weakness (Tends to suggest absence of CNS trauma due to a fall, or CNS neoplasia).
- No apparent renal disease, no diabetes (certain systemic disorders can cause confusional/dementia states)
- NAD detected in blood screen: normal white cells indicate no infection, like meningitis. Liver function tests normal, eliminating alcoholism (also can lead to dementia). Thyroid function appears fine (endocrinopathies, such as hypothyroidism can lead to blunted cognition). Blood Vitamin B_{12} levels are normal, suggesting that it is not a deficiency state such as in Korsakoff's dementia that has caused Mrs B's symptoms).
- Mrs B presents with a blood pressure that is in the hypertensive range. This indicates that she is not adhering to her medication regimen, and may well be the result of her memory impairment.

Consideration of *In Vivo* Imaging Results

MRI is best used in all definitive diagnoses of dementia, as it can produce clear brain images to a resolution of 2–3 mm. Imaging technology is best used diagnostically when employed over time to carry out a longitudinal study of each patient. MRI should be repeated at certain intervals to ascertain changes. However, this isolated MRI has indicated enlarged ventricular volume, and volume loss in medial temporal lobe structures.

It is useful to contrast this set of data to what we expect in a cognitively normal patient of similar age. In adulthood we lose a small number of irreplaceable brain cells, so that the non-diseased brain of an 80-year-old will have decreased in weight by approximately 10–15%. However, in cases of Alzheimer's disease, a decrease of $>30\%$ in brain tissue will be apparent. This scan tends to suggest the presence of a neurodegenerative disorder.

The MRI did not show the classic cortical and subcortical focal lesions which are characteristic of cerebrovascular dementia.

Consideration of Neuropsychological Assessment

The MMSE is a reproducible tool with which to specifically measure patient's cognitive abilities across many domains, with normal values adjusted for age and educational level. In order to rule out transient confusional states, the digit span test is administered at the start of the MMSE. This assesses whether the patient is capable of paying attention in order to complete the exam fully. The digit span comprises asking the patient to make elementary calculations, such as add 2 to 7 in an ascending series. Do not forget, cognitive deficits in delirium tend to fluctuate (and get better), however, in dementia these deficits are stable or progressive. Since Mrs B's daughter has reported decline then this definitely points to dementia.

The neurocognitive battery employed here consisted of orientation, memory, abstract object drawing and verbal fluency. The overall score was significantly reduced, and this in combination with *in vivo* imaging results allows the diagnosis of probable AD. An absolute diagnosis cannot be made, since brain tissue has not been tested for the presence of characteristic plaques and tangles, the pathological rubber-stamp hallmarks of the disease.

Criteria for Probable Alzheimer's Disease:

(1) Dementia present
(2) Onset 40–90 years
(3) Deficits in >2 cognitive domains
(4) Progression over 6 months
(5) Consciousness undisturbed
(6) Absence of any other reasonable causes of dementia.

Criteria for probable Alzheimer's disease:

(Taken from: McKhann, G., Drachman, D. and Folstein M. (1984) "Clinical diagnosis of Alzheimer's disease: report of the NINCDSADR work group Department of Health and Human Services Task force on Alzheimer's disease", *Neurology* **34**: 939–944.)

Disease Staging

The stages correspond to the level of functional impairment. This should be assessed according to past functioning and ideally be reviewed at intervals.

Other Possible Diagnostic Tests?

- *Electroencephalography*: Lowered frequencies of cortical brain waves correlate with deficits in attention and memory.
- *Lumbar puncture*: To test for levels of Aβ, or heavy metals such as aluminium (raised in cases of AD).

- Genotype testing for the E4 allele of apolipoprotein E. (Does not predict which individuals will get AD, but does add information to routine diagnosis.
- Functional MRI can measure blood flow to various brain regions and detect changes such as decreased glucose uptake by neurones, indicative of functional impairments underlying cognitive change.

AD Treatment

Many modes of treatment can be used in cases of dementia. Treatment has to be guided by the staging of the illness and the range of symptoms seen. Behavioral interventions (such as art or music therapy) can be used in addition to drug treatment. Ideally carers should be educated and supported.

Management of AD Has to Be Guided By

- Treating the cognitive deficit
- Ameliorating associated behavioral disturbances.
- Treatment of general medical problems which may worsen the patient's physical or mental state.

Treatment of Cognitive Impairment

Much research evidence has highlighted a depletion in cholinergic function in AD patients. Acetylcholine plays an important role in adequate memory, learning and attention functions. The cholinergic cell body area, the nucleus basalis of Meynert (NBM) innervates wide ranging areas of the cerebral cortex, including frontal, temporal and parietal areas and limbic cortical areas, such as the hippocampus and septum. Cells are lost from the NBM and synapses are lost from all projection sites gradually over time. Many parameters of cholinergic function are depleted, such as synaptic density, dendritic branching, receptor number and choline acetyltransferase (CAT), the enzyme responsible for Ach *de novo* synthesis. So there is a selective destruction of acetylcholine neurones early in the disease, however, in later stages, other neurotransmitter systems undergo depletions also, leading to a global neurodegeneration. The hippocampus, so critical for cognition, is severely affected early in the disorder. This evidence led to the first treatment strategy for AD treatment, that is cholinergic replacement therapy.

Currently the only drugs licensed for use in AD are palliative by nature. They simply ameliorate symptoms. Possible in the future, drugs may be developed which are neuroprotective (prevent gradual cell loss by whichever toxic mechanism).

Cholinergic Therapies

These are the cholinesterase inhibitors, such as donepezil. They are presumed to act by inhibiting the breakdown of Ach, so promoting the action of Ach released in cholinergic neurones in the basal forebrain. What is most important to remember here is that these drugs will only have efficacy if a reasonable level of cholinergic function still exists (i.e. the staging is not too late that degeneration has progressed massively, and many receptors have been lost).

Vasodilator Agents

Vasodilator agents, such as co-dergocrine mesylate may increase blood flow to areas of the brain which are functioning poorly. They may be of more potential benefit in vascular dementia, but have a somewhat limited effect overall.

Possible Future Agents?

- Antioxidants: e.g. Vitamin E may reduce progressive neurodegeneration due to oxidative stress (production of unwanted high energy free radical species). Some long-term studies utilizing vitamin E have shown positive improvement in AD patients, although this has yet to be definitively proved.
- Anti-inflammatory agents: Such as indomethacin or aspirin may reduce neuroinflammation, which has been proven to contribute to the neuropathological mechanisms of AD. Some long-term studies utilizing aspirin have shown positive improvement in AD patients.
- Calcium channel antagonists may reduce neurodegeneration caused by excitotoxic mechanisms (consequent with toxic or free-radical neural brain insult).
- Inhibitors of beta or gamma secretases to aim to decrease production of toxic beta amyloid.
- Inhibitors of toxic beta amyloid deposition.
- Neurotrophins to promote the survival of injured neurones.

CASE STUDY TREATMENT

Mrs B should be periodically reviewed on her donepezil treatment. She should have follow-up neuropsychological and MRI studies at 6 monthly intervals to check for possible symptom improvement. She should be warned that some side effects she may experience on cholinesterase inhibitor therapy are hypotension or syncope.

Mrs B is prescribed citalopram for her emerging depression (about 50% of patients with AD develop depression). Selective serotonin reuptake inhibitors (SSRI's) are the safest treatment in the elderly AD patient, as they are generally highly effective and also safe in overdose. They also have negligible cholinergic side effects. Mrs B is also receiving Tamzepam for her insomnia. This must be used with caution, considering its dependence potential, and also the occurrence of amnestic effects of benzodiazepines.

Any co-existing behavioral impairments present with cognitive decline in AD should be treated as required. Standard neuroleptics for psychosis or paranoiac tendencies, and anti-manic drugs for hyper agitation or akathesia should be considered, with appropriate dose selection for the elderly.

SUMMARY

This case attempts to illustrate a typical assessment strategy directed toward a patient complaining of apparent cognitive impairment. The multifaceted approach of using clinical examination, laboratory assessments and *in vivo* medical imaging are almost invariably used. What is not stressed here, but must be nevertheless, is the importance of follow up, repeating all investigations at 6–12 monthly intervals to assess change, against baseline data. This also may of course be used to monitor treatment efficacy.

The very earliest diagnosis of Alzheimer's disease is of paramount importance for maximizing treatment outcome. The reason for this is that palliative treatments such as cholinergic replacement therapy lose efficacy as the disease progresses, and putative novel therapies aim to halt or slow the disease progression.

CLINICAL SCENARIO ABBREVIATIONS

AAMI	Age associated memory impairment
Aβ	Beta amyloid
AD	Alzheimer's disease
APOE	Apolipoprotein E
CA	Carcinoma
CNS	Central nervous system
CVS	Cardiovascular system
DH	Drug history
FBC	Full blood count
FH	Family history
GI	Gastrointestinal system
GU	Genitourinary system
HPC	History of presenting case
OE	On examination
MMSE	Mini mental status examination
MRI	Magnetic resonance imaging
NAD	Nothing abnormal detected
NFT	Neurofibrillary tangle
PERLA	Pupils equal and reactive
PMH	Patient medical history
PSE	Presenilin
RS	Respiratory system
SH	Social history