Learning in practice

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Randomised controlled trial of clinical decision support tools to improve learning of evidence based medicine in medical students

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Abstract

Objective To assess the educational effectiveness on learning evidence based medicine of a handheld computer clinical decision support tool compared with a pocket card containing guidelines and a control.

Design Randomised controlled trial.

Setting University of Hong Kong, 2001.

Participants 169 fourth year medical students.

Main outcome measures Factor and individual item scores from a validated questionnaire on five key self reported measures: personal application and current use of evidence based medicine; future use of evidence based medicine; use of evidence during and after clerking patients; frequency of discussing the role of evidence during teaching rounds; and self perceived confidence in clinical decision making.

Results The handheld computer improved participants' educational experience with evidence based medicine the most, with significant improvements in all outcome scores. More modest improvements were found with the pocket card, whereas the control group showed no appreciable changes in any of the key outcomes. No significant deterioration was observed in the improvements even after withdrawal of the handheld computer during an eight week washout period, suggesting at least short term sustainability of effects.

Conclusions Rapid and convenient access to valid and relevant evidence on a portable computing device can improve learning in evidence based medicine, increase current and future use of evidence, and boost students' confidence in clinical decision making.

Introduction

Evidence based information available to clinicians at the point of care in an "evidence cart" has been shown to increase the extent to which evidence was incorporated into decisions on patient care.[1] Such a cart could not be easily transplanted to ambulatory or other settings where most doctor-patient interactions occur. Handheld computers (personal digital assistants) containing concise summaries of evidence and decision making tools, can perform more functions than an evidence cart and hold promise in further promoting the practice and learning of evidence based medicine anywhere.[2]

We conducted a randomised controlled trial to test whether providing medical students with a handheld computer clinical decision support tool coupled with a brief teaching intervention could improve learning in evidence based medicine.

Participants and methods

All 169 fourth year undergraduates attending the University of Hong Kong consented to participate in the study during their senior clerkship in 2001. It was emphasised that participation was voluntary, would not affect academic records, and they were assured of anonymity and confidentiality.

The senior clerkship is organised into three teaching blocks: block A (internal medicine), block B (surgery), and block C (multidisciplinary, comprising microbiology, obstetrics and gynaecology, pathology, paediatrics, psychiatry, public health, and radiology). Students were assigned to start in one block and rotated through all three blocks for eight weeks each.

The students were randomised in two stages. Firstly, they were randomly divided into three groups of about equal size. Secondly, the groups were randomly allocated to start the clerkship in one of the three teaching blocks (groups A to C). Assignment and randomisation were concealed from the students and investigators.

Educational interventions

We used a crossover design with three intervention arms. InfoRetriever software (InfoPOEMs; Charlottesville, VA) loaded onto a personal digital assistant, a pocket card containing guidelines on clinical decisions, and a control arm. InfoRetriever is designed for rapid access to relevant, current, best medical evidence at the point of care. It contains seven evidence databases, clinical decision rules and practice guidelines, risk calculators, and basic information on drugs.[3] This software as well as a digital version of the pocket card were loaded onto a personal digital assistant.

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Additional tables appear on bmj.com

The pocket card contained information such as the evidence based decision making cycle, levels and sources of evidence, and abbreviated guidelines on appraising the relevance and validity of articles about diagnostic tests, prognosis, treatment, and practice guidelines.[4] The card was designed to remind and prompt students to apply evidence based medicine techniques in their clinical learning.

Each active intervention (InfoRetriever and pocket card) was accompanied by two interactive sessions lasting two hours and conducted by the same clinician in groups of about 20 students. During the first session, the principles and practice of evidence based medicine were revisited and reinforced. The application of the pocket card (in conjunction with traditional library facilities such as Medline searches) or InfoRetriever were shown through a simulated patient case. For the next session, the students were asked to apply the same techniques to a particular patient they had recently clerked. They shared their findings and experience with the rest of the group, and interactive group discussion was encouraged.

For the group that was assigned the InfoRetriever intervention for rotations 1 and 2, this active intervention was withdrawn during rotation 3, the washout period.

Measurement of outcomes

We defined a priori five key outcomes most relevant to the learning needs and objectives of the students, as assessed by self report through a locally validated, standardised questionnaire.[5] The items gauged respondents' current and future behavioural outcomes such as personal application and current use of evidence based medicine, future use of evidence based medicine, self reported actual use of evidence in clinical learning, and self perceived confidence in clinical decision making. These outcomes were measured by two summary factor scores and three individual item scores derived from the questionnaire (see table A on bmj.com). We excluded knowledge or attitudinal items because these have been criticised as unreliable.[6]

The students completed the questionnaire at baseline and after rotation through each of the teaching blocks. Response rates were 100% throughout. Investigators had access only to aggregate results and were blinded to data at the individual level.

Statistical analysis

We tested baseline equivalence of the three study arms using analysis of variance for continuous variables and χ^2 tests for categorical variables. Effects of the educational interventions in each arm were assessed on an intention to treat basis by changes in mean scores for the five outcomes using analysis of covariance. We also used paired *t* tests to look for changes in mean scores within groups, as the same groups of students progressed through different interventions longitudinally.

Results

The figure shows the progress of students through the trial. One student initially randomised to block A withdrew from medical school and therefore dropped out of the study during the first rotation.

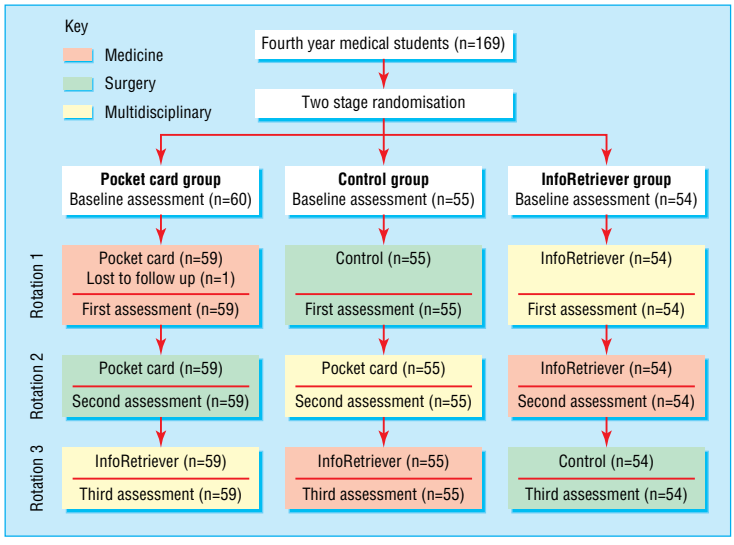
The characteristics of the students at baseline were similar between intervention arms for age, sex, educational background, and examination scores by year 3. Imbalances were, however, evident in the three item scores, which we accounted for in the analysis.

At the end of the first rotation both the InfoRetriever and pocket card groups showed improvements in scores for personal application and current use of evidence based medicine. They also reported more frequent use of evidence during clinical teaching rounds, when we observed a significant dose-response gradient in relation to the intensity of the intervention (P for linear trend 0.001). The InfoRetriever group showed significant gains in only self reported use of evidence based medicine and self perceived confidence in clinical decision making. The control group showed no statistically significant changes in any of the outcome measures.

During the second rotation, the InfoRetriever and pocket card groups continued with the interventions whereas the control group received the pocket card. We observed similar changes in mean scores from baseline to second assessment. The control group showed improvements for the two factor scores representing both current and future use of evidence based medicine. The InfoRetriever group showed slightly higher scores in all five outcomes, whereas those for the pocket card group were not appreciably different from the previous rotation.

To better study the effect of progressing from control to pocket card, we pooled the results of the control group (first to second assessment) and the pocket card group (baseline to first assessment; table). The two factor scores showed significant improvements whereas the mean score for frequency that evidence was considered during bedside rounds achieved only borderline significance. Both groups from second to third assessments were similarly combined to reflect the effect of progressing from pocket card to InfoRetriever. The two factor scores showed additional increases, and the three individual item scores all showed significant improvements.

We carried out sensitivity analyses to exclude confounding by both period effects (that is, increase in



Study organisation

Pooled effects of the progression from control to pocket card and from pocket card to InfoRetriever. Values are mean differences (95% confidence intervals) unless stated otherwise

Scores	Control to pocket card*	P value	Pocket card to InfoRetriever†	P value
Factor scores:				
Personal and current use of evidence based medicine	0.38 (0.26 to 0.49)	<0.001	0.19 (0.08 to 0.30)	<0.001
Future use of evidence based medicine	0.12 (0.01 to 0.24)	0.04	0.12 (0.03 to 0.21)	0.007
Individual item scores:				
On average, how often do you look up evidence during or after clerking each patient on the ward or in the clinic?	–0.12 (–0.32 to 0.09)	0.25	0.48 (0.22 to 0.74)	<0.001
How frequently have you raised the role of current best evidence during teaching rounds or bedside teaching?	0.18 (–0.03 to 0.38)	0.086	0.32 (0.13 to 0.51)	0.001
How much confidence do you have in your clinical decision making?	0.03 (–0.13 to 0.18)	0.73	0.19 (0.04 to 0.33)	0.011

*Pocket card group from baseline to first assessment combined with control group from first assessment to second assessment.
†Pocket card and control groups from second to third assessment.

experience rather than the educational intervention being responsible for progression) and teaching block (medicine, surgery, and multidisciplinary). The superior effect of InfoRetriever remained (see bmj.com for details). One possible remaining confounder was when the pocket card group received the pocket card intervention for two blocks (plus the additional teaching), which could have accounted for the inconsistencies of the higher factor scores.

The InfoRetriever showed improvements in all five outcomes. Such gains continued on an upward trend with time in three outcomes. During the washout period there was no significant deterioration in any outcome measure, suggesting a sustained effect, at least in the short term, that persisted after the withdrawal of the personal digital assistant.

Discussion

Providing students with a decision support tool on a personal digital assistant has the potential to improve their educational experience with evidence based medicine. This improvement was in addition to that achieved by the pocket card, suggesting that neither the pocket card itself nor the two accompanying teaching sessions could wholly account for the observed gains. Although the results preclude the assessment of the long term effects of InfoRetriever, there did not seem to be any significant deterioration in the improvements attained after withdrawal of the personal digital assistant during an eight week washout period, suggesting short term sustainability of effects. We caution, however, that the potential for confounding by teaching block, intervention timing, and progression, as well as the effect of student experience and maturity, should be considered in interpreting the findings. Sensitivity analyses did, however, support our hypothesis of the educational effectiveness of InfoRetriever.

To our knowledge this study is the first to evaluate, through a randomised trial design, the educational effectiveness of a handheld clinical decision support tool as measured by five predetermined self reported outcomes. It is also one of only a few trials on evidence based medicine learning in the undergraduate setting.[7 8]

Evidence from other studies suggests that improved patient outcomes may result from this evidence based approach.[9–11] In addition, ready access to current best evidence prompted the students with personal digital assistants in our study to raise the role of evidence during ward rounds or bedside teaching more often. Such activity promotes active learning, which is crucial to retaining knowledge.

Those students who were assigned the InfoRetriever intervention reported that they were more likely to be willing to adopt evidence based medicine techniques in their future clinical practice. This is important given the emphasis on lifelong learning and continuous professional development.

Limitations of study

Our study had several limitations. Firstly, we did not have expressly objective or evaluative type outcome measures. All five outcomes were self reported behaviour and future intentions. Also, the mean score differences between groups did not give a clear indication of the absolute magnitude of benefit. In the absence of better alternatives, nevertheless, we measured changes as a result of the educational interventions under study using a locally validated, standardised questionnaire to ensure consistency and applicability. Secondly, our study design was complex and the duration of intervention relatively brief in the overall context of the medical curriculum. However, since medical students in their clinical years rotate through a series of teaching blocks rapidly, the window period for intervention and measurement is often shorter than optimal. Thirdly, cross contamination of

What is already known on this topic

Information in an evidence cart at the point of care increased the extent to which evidence was sought and incorporated into decisions about patient care

The potential benefits of portable clinical decision tools to support students learning evidence based medicine are unknown

What this study adds

Rapid access to evidence on a portable computing device can improve learning of evidence based medicine in medical students

Other benefits are increased current and future use of evidence and more confidence in clinical decision making

interventions between study arms is a potential limitation in educational trials of this kind.[12 13] This would, however, only dilute the observed effects, and our findings might therefore have underestimated the true magnitude of benefit. Fourthly, part of the observations could have been influenced by differences between the core content and timing of the three teaching blocks, whereby a particular block might have presented relatively more or fewer opportunities for evidence based medicine learning. Some of these effects would likely have been buffered by the crossover design. Finally, it is difficult to predict the generalisability of our findings; whether other schools with different institutional arrangements and student bodies would achieve similar improvements with InfoRetriever is unknown.[13 14]

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Competing interests: None declared.

Ethical approval: Ethical approval for the study was granted from the Faculty of Medicine Research Ethics Committee, University of Hong Kong.

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Smoking on exhibition?

Walking in the Hongo Campus of the University of Tokyo, an exquisite garden landscaped by a feudal lord several hundred years ago, you pass through a dense grove beside a pond to encounter a group of statues of pioneers who contributed to the expansion of wisdom. The campus, being full of such commemorations and natural remains, along with its university museum, plays an important role in assembling and exhibiting materials to both researchers and society. Some materials are available only in this campus, increasing its prestige as a museum.

It seems that the University of Tokyo is chasing additional honour in this respect. Recently, it has added an outdoor exhibition of material that, though not yet rare, is becoming increasing scarce in its natural habitat. So far, no other universities or institutes are following the University of Tokyo. It may be the only institute that preserves the material in the near future, and it will thus acquire worldwide fame due to its clear vision and foresight.

The material is "smoking habit," which is facing extinction because of efforts by public health bodies around the world. The "Smoking Preserve" is designated in front of the main entrance to the School of Health Science. In the past, people used to smoke wherever they liked in the building; then smoking was confined to a few designated areas; now the whole building has become smoke free. Consequently, it was transferred to outside the building.

Here, we cannot but applaud the bold decision to choose the front entrance instead of one at the rear. This is the best place for an exhibition: students, researchers, staff, and visitors from all over the world can appreciate it whenever they enter the building. Seeing the exhibition, people in the tobacco-less future will say: "How could people have inhaled such disgusting smoke?"

We insist that the university should maintain the Smoking Preserve forever against all kinds of claims and complaints, as is the case with smallpox virus preserved in a few institutes for vaccine production or research purposes. Once the habit disappears, we cannot restore or study it. Actually, the university seems to recognise its obligation, and every effort is made to make the Smoking Preserve comfortable: sofas have been installed, and soft drinks are available from a vending machine there. The preserve is an indispensable global asset, and the university should enjoy international fame, or is it shame?

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