Knowledge may not be the best target for strategies to influence evidence-based practice: Using psychological models to understand RCT effects.

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Running Head: Using psychology models to understand RCTs

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Abstract

Background

Interventions to enhance the implementation of evidence-based practice have a varied success rate. This may be due to a lack of understanding of the mechanism by which interventions achieve results.

Purpose

Use psychological models to further an understanding of trial effects by piggy-backing on a randomised controlled trial testing 2 interventions (Audit & Feedback and Computer-aided Learning) in relation to evidence-based third molar management.

Method

All participants of the parent trial (64 General Dental Practitioners across Scotland), regardless of intervention group, were invited to complete a questionnaire assessing knowledge and predictive measures from Theory of Planned Behaviour and Social Cognitive Theory. The main outcome was evidence-based extracting behaviour derived from patient records.

Results

Neither intervention significantly influenced behaviour in the parent trial. This study revealed that the interventions did enhance knowledge, but knowledge did not predict extraction behaviour. However, the interventions did not influence variables that did predict extraction behaviour (attitude, perceived behavioural control, self-efficacy). Results suggest both interventions failed because neither influenced possible mediating beliefs for the target behavior.

Conclusion

Using psychology models elucidated intervention effects and allowed the identification of factors associated with evidence based practice, providing the basis for improving future intervention design.

Key words*: process evaluation; evidence-based practice, intervention, psychological models, Theory of Planned Behavior, dentistry*

A number of strategies are employed in trials to improve patient outcomes by influencing the behaviour of healthcare professionals through enhancing their implementation of evidence-based practice. These implementation interventions tend to be aimed at increasing clinicians' knowledge and skills, and include a range of approaches including the dissemination of guidelines and educational materials, small group education courses, and audit and feedback. However, systematic reviews have shown that similar implementation interventions tend not to be consistently effective, often failing to achieve changes across a variety of clinical behaviours (Oxman et al, 1995; Bero et al., 1998; Grimshaw et al., 2001; Grimshaw et al., 2004). The variable success rate of even apparently identical interventions is difficult to understand, making it impossible to create a scientific rationale to guide the design or choice of intervention strategy in subsequent implementation trials.

One possible explanation may be that interventions are not targeting appropriate mediators, which may differ for different clinical behaviours. For example, even the most detailed and successful technique for influencing attitude is unlikely to be effective if attitude is not a causal mechanism of the target behaviour. Literature reviews (Davies et al., 2003; Grimshaw, et al., 2004; Eccles et al., 2005) suggest that implementation interventions continue to be developed and trialled without any understanding or description of possible causal mechanisms driving their design.

Psychological models have been developed to understand, predict and influence individual behaviour. Two models, the Theory of Planned Behaviour (Ajzen, 1991) and Social Cognitive Theory (Bandura, 1997), have often been used in Health Psychology to successfully predict variation in many different behaviours, including clinical practice (Conner & Norman, 1996; Walker et al., 2001; Hardeman et al, 2002; Bonetti et al, 2003; Bonetti et al., 2005, Bonetti et al., 2006; Eccles et al., 2007). These theories identify intention to perform the behaviour, attitude toward the behaviour, perceptions of social pressure to perform the behaviour (subjective norm), and confidence in ability to perform the behaviour (self-efficacy) as modifiable predictors of behavior. The theories also outline associated methods for measuring and influencing these predictors.

Given that these theories identify possible mediating mechanisms of behaviour, they may be useful when applied to the evaluation of an intervention to influence behavior, even if that intervention has no theoretical underpinning. Assessing theoretical predictors should allow a better understanding of trial results, furthering an appreciation of why an intervention succeeded or failed.

A randomised controlled trial (Bahrami et al., 2004) examined the effects of two interventions (audit and feedback / computer-aided learning) on the management of wisdom teeth (third molars), in particular, evidence-based extracting behaviour. Although neither intervention were designed using cognitive behavioral theories, the aim of the current study was to see if it was possible to further an understanding of intervention effects. Variables from the Theory of Planned Behaviour and Social Cognitive Theory were assessed to identify mediating beliefs of interventions that succeeded in influencing clinicians' behavior, or to identify predictive beliefs to target when modifying unsuccessful interventions. Given that both the interventions were based on the usual medical education approaches, knowledge was also assessed in order to integrate the results of this study into the current implementation literature.

Method

Participants and Procedure

The parent study was a randomised controlled trial with a 2x2 factorial design, which investigated the effects of audit and feedback (A&F) and computer-aided learning (CAL) on evidence-based wisdom (third molar) teeth management (Bahrami et al., 2004). Participants, 63 General Dental Practitioners across Scotland, were randomly allocated to groups experiencing either, both or neither intervention. The minimum intervention was the traditional method of disseminating guidelines i.e. postal distribution and notification of related professional development education courses. For the Audit and feedback (A&F) intervention, participants were asked to use the guidelines to complete an audit project on different aspects of clinical practice relating to third molar teeth. Feedback and advice were provided by a researcher and a Scottish Council Dental Audit Tutor. For the Computer aided learning (CAL) intervention, a laptop computer equipped with software designed specifically for this study was distributed to participants in this group. The software package incorporated material from the guidelines about evidence-based practice, and provided support tools to assist the dentists in the decision to

extract. Patient records and radiographs were examined independently by 2 clinicians, blind to the group allocation, who judged if extractions were evidence-based.

This allied study invited all participants, regardless of intervention group, to complete a questionnaire assessing predictive measures 1 month before (T1) and 1 month after the intervention period (T2: 8 months after baseline assessment).

Measures

Behaviour was the main outcome of this study. This was assessed in terms of the percentage of evidence-based third molar extractions performed by each dentist, calculated by weighting the number of evidence-based extractions by the total number of third molar patients seen during the intervention period.

The ***predictive measures*** used in this study follow the operationalisation protocols of Ajzen (1991), Bandura (1997), and Connor & Sparks (1996). The questionnaire content was informed by the results of a pilot study (semi-structured qualitative interviews) of 16 dentists, recruited independently from the larger study, which identified the salient beliefs concerning the barriers and facilitators and the advantages and disadvantages of extracting of third molars. In line with the protocol for developing the Theory of Planned Behaviour questions, the 'TACT' principle was observed: 'Target' was the patient; 'Action' was extracting third molars; 'Context' was the management of the patient; and 'Time' was during a course of treatment, all specified in the introduction to the questionnaire. Unless otherwise stated, all questionnaire items were rated on a 7-point scale from *Strongly Disagree* to *Strongly Agree* and scored so that higher scores represent greater support for evidence-based extracting behaviour.

Knowledge items covered a wide range of areas relating to the evidence base for third molar management (e.g. 'An asymptomatic third molar should not be removed when it is buried and in close relationship with the inferior dental nerve; An asymptomatic third molar should not be removed when it has a functional role in dentition; Dentigerous cyst formation is rare in association with third molars… (*Yes/ No / Not Sure*). Knowledge was assessed as the number of correct answers out of a possible seventeen.

Attitude was the mean score of twenty items assessing the extent that dentists believed that extracting third molars would result in a particular consequence identified in the pilot study

(e.g. extracting a third molar will relieve the patient's pain; mean recurring problems; relieve problems in neighbouring teeth; result in short-term discomfort; result in permanent damage; can be a stressful procedure; is something I ought to do; prevent potential problems in the future; give me a feeling of personal/professional satisfaction; is a time-consuming procedure) as well as the perceived value of each consequence (e.g. relieving the pain of patients is *Unimportant/Important)*.

Subjective Norm was the mean score of four items assessing the perceived pressure from patients, colleagues, professional bodies, and the NHS for extracting third molars (e.g. My colleagues think I should extract third molars).

Perceived Behavioural Control was the mean score of fourteen items assessing control beliefs relating to barriers and facilitators of extracting third molars (e.g. a difficult extraction; a calm patient; if a specialist centre (e.g. a dental hospital) is near; if more than one third molar is to be extracted at the same time; If the practice policy is not to extract; If the patient has a medical problem; whether it is an upper or lower third molar) (*Unlikely/Likely* and *Difficult/Easy)*.

Behavioural Intention was the z score of the sum of two items: "Of all the patients you see in the next month who require a third molar extraction, approximately how many do you intend to perform?" (*None/Some/Most/All*); and "How likely is it that you will extract a third molar within the next month?" (*Less Likely/More Likely*).

Self-efficacy was the mean score of six items reflecting the control belief items, assessed in terms of confidence (e.g. How confident are you in your ability to successfully: extract a third molar from a calm patient; extract an *upper* third molar; extract a *lower* third molar; perform a difficult extraction; perform simultaneous third molar extractions; to extract a third molar from a patient with medical problems; to extract a third molar from a patient who is not calm (*Extremely confident/ Not at all confident*).

Analyses

10% of both the pre-intervention (T1) and post-intervention (T2) questionnaires were double-entered and univariate descriptive statistics were examined for accuracy of data entry. If variables had missing values, these were replaced with the series mean, providing approximately 90% of the measure was completed. The data was examined for univariate outliers using z scores > 3.29 ($p = 0.001$). All variables were examined for their approximation to

a normal distribution using skewness and kurtosis statistics greater than ±1. Group differences were investigated using Chi-Square, and repeated measures ANOVA (GLM). A Paired Samples t-test was used to examine whether the publication of the third molar guidelines alone influenced evidence-based extracting. Relationships between outcome and predictor variables were examined using Pearson correlations and regression analyses.

Results

Data

The data base was considered accurately entered as there was less than 1% error rate in double-entered sample comparison. No outliers were identified and variables were found to fall within acceptable parameters. Only one dentist from each practice completed questionnaires and only data from their patients were included in the computation of the outcome variable. It was therefore not necessary to allow for intracluster correlation between dentists within the same practice in these analyses. Descriptive statistics of measures by group are reported in Tables 1 and 2.

Participants / Attrition

The parent RCT had a response rate of 11% (63/ 601). At 4 month follow-up, the final sample consisted of 51 dentists (41 males and 10 females), with mean age = 42.33 years (SD = 7.77 years). Years qualified ranged from less than 3 years to over 25 years. 26% of participants had been qualified less than16 years, 50% had been qualified between 16 and 24 years, and 24% had been qualified over 25 years The number of patients with third molar problems seen during the 4 months before the intervention period ranged from 1 to 16, with mean = 4.82 (SD = 3.63). The mean number of extractions performed during the intervention period was 1.9 (SD = 1.9), ranging from 0 to 8 extractions with a median = 1.

There were no significant differences (at the $p<.05$ level) between dentists who withdrew from the study before completing the second questionnaire and those who continued in: Age ($t(1,49) = -1.34$, $p = 0.19$); gender ($\chi^2(1,50) = 0.15$, $p = 0.70$); postgraduate qualifications ($\chi^2(1,49) = 2.24$, $p = 0.13$); number of other dentists in the practice ($t(1,49) = 0.69$, $p = 0.54$); how many patients with third molar problems they saw in the previous year ($t(1,40) = 0.94$, $p = 0.36$); or their intervention group ($\chi^2(3,50) = 4.28$, $p = 0.23$).

The representativeness of the study participants was examined by comparing their demographics with the demographics of an independent, randomly selected sample from the Scottish Dental Practice Board Register who participated in a postal study examining intention to follow dental guidelines (N=99; Response rate 49%: Bonetti et al, 2003). There were no significant differences in Age ($t(1,140) = -0.63$, $p=.53$); Gender ($\chi^2(1,150) = 1.64$, $p=.24$); Number of other practitioners in their practice ($t(1,147) = 1.35$, $p=.18$); Years qualified ($t(1,147) = -1.11$, $p=.27$); Number of courses attended since qualification ($t(1,137) = -1.11$, $p=.27$); or general knowledge of third molar management ($t(1,147) = -1.22$, $p=.22$).

Chi-Square and ANOVA analyses revealed no significant differences ($p<.05$) between the intervention groups for outcome or predictive variables at T1. Post hoc power analysis showed that this study (N=51: 2x2 factorial design) had power = 0.42 to detect a medium effect size (.25) and power = 0.80 to detect a large effect size (.40) (F-test on means in ANOVA) at alpha = 0.05 (Faul & Erdfelder's (1992) Gpower program).

Do the interventions successfully influence behaviour (evidence-based extracting)?

Neither intervention had a significant impact on evidence-based extracting (Tables 1 and 2). Since the interventions did not influence evidence-based extracting, it was not possible to examine whether variables from the psychological models mediated successful intervention effects. We therefore examined whether the interventions had influenced cognitive predictors in the following research questions:

Do the interventions influence knowledge or theoretically-derived beliefs about evidence-based extracting?

Dentists who experienced audit and feedback significantly increased their knowledge of the third molar management evidence-base compared to dentists who did not experience audit and feedback (Table 1). Experiencing computer aided learning did not influence knowledge (Table 2).

Neither intervention had a significant impact on any of the theoretically-derived beliefs relating to evidence-based extracting (Tables 1 and 2).

Did the publication of the guidelines influence evidence-based extracting?

Analyses were also performed examining whether the publication of the third molar guidelines alone influenced evidence-based extracting, independent of intervention group. A

Paired Samples t-test showed no significant differences between evidence-based extracting before and after the guidelines were distributed (t =1.16, df = 49, p = .25).

Regardless of intervention group, what predicted evidence-based extracting?

Baseline evidence-based extracting did not predict post-intervention behaviour (r = 0.12, p=0.42). Evidence-based third molar extracting was predicted by attitude, perceived behavioural control, and self-efficacy (see Table 3). Together these variables predicted 20% of the variance in evidence-based third molar extracting. However, perceived behavioural control and self-efficacy did not contribute significantly to the regression equation after accounting for the variance explained by attitude (Table 4).

Discussion

Audit and feedback and computer-aided learning were two strategies employed in a parent trial (Bahrami et al., 2004) to increase evidence-based extracting of third molars. Both interventions failed to significantly influence the target behaviour. Usually in implementation research, this result, the failure of the interventions, would be all that a reader would be left with. It is difficult to see how people designing or choosing interventions to influence clinicians' behaviour in future can learn from this event, since both interventions already have a history which includes success and failure (e.g. Thomson-O'Brien et al., 1997). The aim of this study was to see if it was possible to further an understanding of intervention effects.

Both interventions were designed to increase evidence-based behaviour by increasing knowledge of the evidence-base, so knowledge was assessed. The results demonstrate that both of the interventions were successful in increasing knowledge, and that this was a significant increase for the Audit and Feedback intervention. In terms of the desired interim effect, both interventions, particularly Audit and Feedback, achieved what they were designed to achieve – and yet both the interventions failed to influence behaviour.

These intervention strategies were based on an assumption that, if the dentists knew what the evidence was supporting as best practice, they would be more likely to do it. However, when we tested this assumption, we found no association between knowledge and behaviour. Regardless of intervention group, the number of items correct on the knowledge measure was not related to evidence-based extracting. It is possible that this may have been a problem with the measure itself. The knowledge measure included items covering a wide range of areas from

the evidence-base about both the how and the why of extracting third molars and, being multidimensional, had very poor internal consistency. Nevertheless, some evidence of the measure's validity is provided since it acted as expected in response to interventions designed to increase knowledge.

Since implementing guidelines often require clinicians to change their behaviour, we also assessed beliefs derived from psychological models of behaviour to see if this might further an understanding of the underlying process. Neither intervention influenced any of the beliefs which these models depict as likely predictors of behaviour. However, in line with model expectations, beliefs from these models were associated with behaviour, both at baseline and eight months later. These significantly predictive beliefs also acted in line with theoretical predictions. Dentists who had a more positive attitude toward evidence-based extracting, perceived that they had more control over evidence-based extracting or had greater self-efficacy for evidence-based extracting, were more likely to perform evidence-based extracting. Using the models allowed the identification of possible mediators of the target behaviour. The results of this study suggest that psychological models can be applied to understanding this behaviour and that an intervention designed to target self-efficacy, perceived behavioural control, and especially attitudes, may increase the likelihood of successfully influencing evidence-based extracting. These results also suggest one reason for the failure of these interventions – that both of them were aimed at changing a variable not associated with the target behaviour. While there are many reasons why interventions might fail in service-level trials, (see www.re-aim.org), this explanation may also account for the history of inconsistent success of similar interventions focusing on educational approaches. Assuming information and knowledge should be intervention targets may not always be the most appropriate basis for designing strategies to encourage the implementation of evidence-based behaviours.

When examining whether the mere publication of guidelines influenced the behaviour of the dentists in this study, there was further evidence to suggest that knowledge dissemination was not enough to influence this behaviour. For all participants, regardless of group, there was no significant difference in evidence based practice during the data collection period before and after the guidelines were published. This result is in line with the results of other studies showing a lag between the publication and implementation of guidelines for medical practice. The finding

that the publication of guidelines in itself did not lead to change in practice suggests that some accompanying strategy may indeed be necessary to encourage the following of these guidelines in everyday dental practice.

There are limitations in the study which may be impacting on the results. The low response rate means that this sample may not be representative of the population, even though they did appear to be representative of dentists participating in other guideline-related research. It is possible that another group of dentists may have different psychological beliefs associated with evidence-based extracting. Also, as stated above, there may be reasons that the interventions failed, other than inappropriate interim variable targeting. In this study there may have been problems with the outcome measure. One of the strengths of this study was that the outcome was an observed rather than self-reported behaviour, and that baseline measures of both predictor and outcome variables were taken into account when assessing the impact of the interventions. However, the results revealed that there was no association between pre- and post-intervention behaviour. The outcome measure also had standard deviations larger than the group means. This may be due to how the outcome was assessed, or to the nature of the behaviour itself. On average, each dentist performed only two extractions (regardless of being evidence-based or not) during the entire period of the study – indeed this was reduced to one extraction if using the median descriptive. It is possible that the failure of the interventions to influence evidence-based extracting reflect only the difficulty of meaningfully assessing a percentage of a rare behaviour or examining variance in a rare behaviour. Even so, the results showed that dentists in this study acted in accordance with their beliefs, suggesting that even this rare behaviour may be understood and influenced by applying psychological models.

Conclusion

Overall, the results of this study suggest that these implementation strategies failed to change behaviour because they missed affecting significant predictors, and therefore possible causal mechanisms, of that behaviour. In this study, using psychological models made it possible to identify potential causal mechanisms which may act as more successful interim targets than knowledge when designing future interventions to influence this behaviour. This study thereby adds to an increasing evidence base that psychological theories may provide the basis for

better informing the design and choice of guideline implementation strategies. The value of identifying causal mechanisms of an intervention is in enhancing the likelihood of its exact replication out with the trial, and/or in providing a theoretical justification for its modification if required. Giving implementation interventions a theoretical underpinning should increase the generalisability of intervention study results and is in line with the UK Medical Research Council's framework for the development and evaluation of complex interventions (Medical Research Council, 2000).

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Table 1. *Testing The Effect Of Audit And Feedback (A&F) On Beliefs And Evidence-Based Extracting Of Third Molars*

	Group 1 No A&F (N=25)		**Group 2 A&F (N=26)**		**Results of repeated measures ANOVA (GLM)**
	Mean	***SD***	***Mean***	***SD***	***F statistic, p value***
Knowledge T1	10.29	1.97	11.04	1.46	
T2	11.00	1.74	12.08	1.57	**F(1,48)=6.23, p=0.02***
Intention T1	0.30	1.80	0.28	1.42	
T2	0.20	1.55	0.38	1.65	F(1,49)=2.01, p=0.16
Attitude T1	5.16	0.46	5.21	0.42	
T2	5.22	0.42	5.13	0.48	F(1,48)=0.04, p=0.85
S. Norm T1	3.26	0.72	3.35	1.29	
T2	3.33	0.83	3.30	1.09	F(1,48)=0.02, p=0.90
PBC T1	4.45	0.61	4.53	0.48	
T2	4.64	0.76	4.88	0.64	F(1,48)=0.89, p=0.35
Self-efficacy T1	4.73	1.14	5.07	0.83	
T2	4.47	1.28	4.89	1.08	F(1,49)=1.84, p=0.18
Behaviour % T1	41.37	33.98	29.51	30.14	
T2	31.15	27.61	26.26	25.52	F(1,47)=1.80, p=0.19

T1=Baseline; T2 = 8 months from baseline; S.Norm = Subjective Norm; PBC = Perceived Behavioural Control; Behaviour % = Percentage of performed extractions which were evidence-based

Table 2. *Testing The Effect Of Computer Assisted Learning (CAL) On Beliefs And Evidence-Based Extracting Of Third Molars*

	Group 1 No CAL (N=26)		**Group 2 CAL (N=25)**		**Results of repeated measures ANOVA (GLM)**
	Mean	***SD***	***Mean***	***SD***	***F statistic, p value***
Knowledge T1	10.54	1.86	10.83	1.63	F(1,48)=1.94, p=0.17
T2	11.19	1.88	11.96	1.49	
Intention T1	0.10	1.73	0.10	1.54	F(1,49)=0.80, p=0.38
T2	0.17	1.60	0.37	1.62	
Attitude T1	5.13	0.40	5.25	0.47	F(1,48)=0.27, p=0.61
T2	5.18	0.43	5.17	0.48	
S. Norm T1	3.47	1.14	3.14	0.91	F(1,48)=0.35, p=0.56
T2	3.29	0.94	3.36	1.01	
PBC T1	4.43	0.56	4.56	0.54	F(1,48)=1.36, p=0.25
T2	4.64	0.79	4.91	0.60	
Self-efficacy T1	4.86	1.05	4.94	0.96	F(1,49)=0.09, p=0.77
T2	4.64	1.30	4.74	1.08	
Behaviour %T1	38.12	28.81	31.91	35.78	F(1,47)=1.02, p=0.32
T2	31.73	23.55	25.24	29.13	

T1=Baseline; T2 = 8 months from baseline; S.Norm = Subjective Norm; PBC = Perceived Behavioural Control; Behaviour % = Percentage of performed extractions which were evidence-based

Table 3. ***Descriptives And Pearson Correlations Showing The Relationships Between Predictors (T1 And T2) And The Behaviour Of Evidence-Based Extracting (T2) For All Participants, Regardless Of Intervention Group***

Beliefs	Mean	SD	Alpha	Behaviour (T2)
Knowledge T1	10.68	1.74	.13	0.08
T2	11.56	1.73	.29	0.05
Intention T1	0.00	1.62	.52	0.27
T2	0.09	1.61	.51	0.14
Attitude T1	5.19	0.43	.63	**0.30***
T2	5.15	0.48	.74	**0.46*****
Subjective Norm T1	3.31	1.04	.74	0.02
T2	3.33	0.96	.66	0.02
PBC T1	4.49	0.54	.61	0.14
T2	4.74	0.74	.72	**0.29***
Self-efficacy T1	4.90	0.99	.86	**0.33***
T2	4.69	1.18	.92	**0.30***

T1=Baseline; T2 = 8 months from baseline; Alpha = Cronbach's alpha; PBC = Perceived Behavioural Control; Intention descriptives are z scores; *p < .05; **p < .01;***p < .001.

Table 4. *Results Of Linear Regression Analysis Incorporating Post-Intervention (T2) Beliefs That Significantly Predicted Dentists' Evidence-Based Extracting Behaviour (T2)*

Beliefs	***B***	***Beta***	***df***	***F***	***p***	***Adjusted R^2***
Attitude	21.68	0.40**				
PBC	4.51	0.13				
Self-Efficacy	2.10	0.09	3,45	5.07	0.004	0.20

Dependent Variable: Evidence-based extracting of third molar teeth; B = Unstandardized Coefficients; Beta = Standardized Coefficients