The effectiveness of web-based tools for improving blood glucose control in patients with diabetes mellitus: a meta-analysis

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CRD summary
The review found that web-based tools could result in a modest reduction in glycosylated haemoglobin in patients with diabetes who have suboptimal blood glucose control. Some limitations of the review process and reporting, particularly the lack of consideration of the quality assessment, mean that the authors' results should be interpreted with caution.

Authors' objectives
To assess the effectiveness of web-based health education tools in improving blood glucose control in patients with diabetes mellitus.

Searching
Several electronic sources including CINAHL, EMBASE, MEDLINE, The Cochrane Library, PsycINFO and OpenSIGLE (1996 to February 2010) were searched. OpenSIGLE covered grey literature. Search terms were reported in the review.

Study selection
Randomised, controlled trials (RCTs) in patients with type 1 or 2 diabetes who had sub-optimal blood glucose control (glycosylated haemoglobin above 7%) that compared a web-based education tool with usual care and that reportd glycosylated haemoglobin as an outcome were eligible for inclusion. Secondary outcomes were lipids, process efficiency and patient/clinician satisfaction. The web-based tools had to include standardised or personalised patient educational interventions that were intended to improve patients' awareness of their diabetes, and their knowledge, attitude and practices with respect to blood glucose control. Tools had to be primarily web-based, but could include a mobile phone component. Studies of combined interventions and those that reported change scores were excluded.

Participants in the included studies had type 1 or type 2 diabetes; where reported, participants were adults. The interventions all delivered standardised information; all but one study also gave personalised information. All but one also monitored blood glucose. Two studies involved mobile phone as well as internet-based activity. Usual care, where described, included follow-up meetings with endocrinologists, primary care providers (with or without access to a nurse manager) or provision of information.

Two reviewers independently performed the study selection.

Assessment of study quality
Study quality was evaluated using using 5-point Likert scales to assess randomisation, allocation concealment, blinding, accounting for drop-outs and losses to follow-up and the possibility of confounding or co-intervention. Overall quality assessment was based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) scale. If there was insufficient information for the assessment, the authors were contacted.

Two reviewers independently assessed study quality. Discrepancies were resolved by consensus.

Data extraction
Relevant data were extracted after three, six and 12 to 15 months.

Two reviewers independently extracted the data. Discrepancies were resolved by consensus.

Methods of synthesis
Mean differences were pooled using the inverse variance method, and combined in a fixed-effect model, to minimise the effect of one outlier. The heterogeneity of included studies was measured using $I^2$. Publication bias was assessed using funnel plots and Egger's test. Subgroup analysis was used to investigate sources of heterogeneity. Statistical results
were presented with 95% confidence intervals (CI).

**Results of the review**

Nine studies (1,822 participants) were included in the review. Two studies were graded as high quality, five as moderate quality and two as low quality. Three studies did not describe the process of randomisation; five did not mention allocation concealment; seven studies presented drop-out rates. Loss to follow-up ranged from 7.1% to 23.8%. Four studies used intention-to-treat analysis and three used per-protocol analysis.

Glycosylated haemoglobin was lower in patients who received the web-based intervention, the mean difference was -0.71% (95% CI -1.00, -0.43) after three months, -0.52% (95% CI -0.75, -0.29) after six months and -0.55% (95% CI -0.70, -0.39) after 12 months. At 12 months there was evidence of statistical heterogeneity. subgroup analysis indicated that this was driven by two studies which used mobile phone as well as internet-based interventions, which had a greater effect on glycylated haemoglobin than internet-only interventions.

Among the three studies which reported the effect of web-based tools on low-density lipoprotein cholesterol, the intervention was beneficial, mean difference -0.23mmol/L (95% CI -0.28, -0.19).

Web-based tools were not effective in reducing fasting plasma glucose (four studies), high-density lipoprotein cholesterol or total cholesterol (nine studies each).

There was no statistical evidence of significant publication bias.

**Authors’ conclusions**

Web-based tools could result in a modest reduction in glycysylated haemoglobin in patients with diabetes who had suboptimal blood glucose control.

**CRD commentary**

The research question was clear, and inclusion criteria stated. The search covered several databases, including one of grey literature. However, there was no manual search or review of reference lists. The authors acknowledged that the test of publication bias was not robust when based on small numbers of studies. One study that was not in English was excluded, which meant that language bias may have affected the results. Steps were taken to reduce error and bias in the study selection, data extraction and quality assessment phases of the review. Few details of the participants were given, so the generalisability of the results was unclear.

The meta-analysis methods were generally appropriate, but the authors used a fixed-effect model to minimise the impact of one outlier study, rather than investigating this in a sensitivity analysis. Although reasons for statistical heterogeneity were explored using a priori subgroup analysis, their interpretation of the results of the subgroup analysis did not consider that one excluded study was small, so that the results could have occurred by chance, and the other were consistent with the pooled results. No attempt was made to investigate the effects of the quality of the studies on the results of the review.

Some limitations of the review process and reporting, particularly the lack of consideration of the effect of the study quality on the pooled results, mean that the authors’ results should be interpreted with caution.

**Implications of the review for practice and research**

**Practice:** The authors stated that web-based tools could be considered as a supplement to usual medical care and lifestyle advice.

**Research:** The authors stated that future studies should assess the cost benefit of web-based tools; analyses of specific populations were needed, and a systematic review of interventions using mobile phones could provide useful information for improving the delivery of web-based tools.

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