Introducing a diabetes e-learning module: a means of improving junior doctors’ confidence and ability in managing inpatients with diabetes

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Abstract
The aims of this study were to determine whether the introduction of a diabetes management e-module can increase junior doctors’ confidence in managing inpatients with diabetes and contribute to improvements in patient care.

A diabetes e-module was introduced at Barnet and Chase Farm Hospitals NHS Trust in October 2010. Junior doctors completed it and undertook an online exam at the end. Junior doctors were surveyed once, six to eight months after completing the e-module, and retrospectively ranked their confidence and knowledge levels in managing inpatients with diabetes before and after completing the e-module. Patient care was assessed by comparing the National Diabetes Inpatient Audit (NaDIA) findings at Barnet Hospital before and at two time points after the introduction of the e-module.

After undertaking the e-module there were statistically significant increases in the self-ranked confidence and knowledge levels of junior doctors regarding diabetes management. This included improvements in identifying different types of insulin, making insulin dose adjustments for hypoglycaemia/hyperglycaemia and a reduction in reported prescription errors. The results from the NaDIA also suggest an improvement in ‘good diabetes days’ for insulin-treated patients with diabetes and a pattern of reduction in prescription and management errors.

This study demonstrates that an inpatient diabetes management e-module increases junior doctors’ knowledge and confidence in managing diabetes. A multi-centre study would be needed to confirm whether this translates into better management of inpatients with diabetes. E-modules may be used to cover further topics in diabetes, and to support nursing and patient education. Copyright © 2013 John Wiley & Sons.

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Key words
diabetes; education; inpatient; e-learning

Introduction
The National Diabetes Inpatient Audit (NaDIA) 2011 found that people with diabetes account for 15% of hospital admissions.1 The majority of day-to-day management of these patients is often assigned to nursing and junior medical staff, who may feel inadequately equipped to deal with the challenges posed. A British survey in 2008 found that only 28% of postgraduate medical trainees felt confident in diagnosing diabetes, and 55% and 49% felt fully confident in treating hypoglycaemia and diabetic ketoacidosis respectively.2 Confidence was also found to be low in commencing or titrating intravenous insulin and changing diabetes drug regimens. In 2011, the NaDIA reported that insulin-treated inpatients with diabetes had poor glucose control, with common problems identified including insulin prescription and administration errors, and the misuse of insulin infusions.1

These findings highlighted the need for improved education and training for postgraduate doctors in diabetes management in hospitals. However, new teaching methods are required, due to expansion in junior doctor numbers over the last decade and reduced time for face-to-face teaching as a result of changing patterns of work within the European Working Time Directive. E-learning and web-based education have been increasingly used to provide effective, accessible and interactive forms of teaching in many disciplines. By encouraging the learner to play an active part in their education, e-learning may promote better retention of information and knowledge.3

This paper discusses the effect of introducing a Diabetes Management E-learning Module (DME) into the induction programme for junior staff.
Introducing a diabetes e-learning module

The DMEM was produced in a collaboration between Barnet and Chase Farm Hospitals NHS Trust Diabetes Department and MMT Digital Ltd (MMT Digital – Midlands, Uppingham, Rutland, UK). The DMEM was launched in October 2010 and included interactive teaching on aspects of inpatient and emergency treatment of diabetes.

This paper aims to evaluate the effect this module has on the confidence of junior doctors, and on their reported undertaking of discouraged practices, and to see if this in turn improves clinical outcomes, as measured by sequential NaDIAs carried out at Barnet Hospital. Although previous studies have looked at the improvement of academic and learning outcomes after e-learning, this is the first paper to analyse clinical outcomes following launch of a diabetes e-learning module.

The DMEM launch in October 2010 occurred two months after induction of new junior doctors in Barnet and Chase Farm Hospitals NHS Trust (BCFT). By March 2011, 50% of junior doctors from all hospital specialties (except paediatrics) had completed the DMEM, and this had increased to 74% by October 2011. The Medical Education Department at BCFT was involved in ensuring that new junior doctors were informed about and undertook the e-module training as part of their induction to the trust.

The DMEM provides the knowledge a junior doctor requires to safely identify and treat patients with diabetes in most clinical scenarios. The module covers: diagnosis of diabetes; use of oral hypoglycaemic drugs; different types of insulin regimens, and insulin dose adjustments (see Appendices 1 to 3 available at www.practicaldiabetes.com); safe insulin prescribing; safe use of insulin infusions; and the management of diabetes emergencies. The module includes many interactive features throughout and a 20-question true/false multiple choice exam at the end, requiring a score of 100% before a certificate of completion is issued. The module takes 40–60 minutes to complete. This user-friendly interactive learning experience provides a more detailed education than the diabetes e-learning tools currently available in the UK. The advantage of the DMEM over other available diabetes e-modules is that it is highly interactive, with a voice-over in addition to illustrations thus engaging the audience.

There were no other important diabetes-related educational or clinical interventions introduced in the trust during the time period of the study. A pharmacist-led prescription teaching session for junior doctors had been undertaken for many years previously and continued in the same format. Also, a nursing education programme was launched in spring 2010; however, less than 10% of the nursing staff at BCFT had attended this training session by October 2011. Although this could potentially improve patient care, it is unlikely to have had a great impact with such a low participation rate.

Methods

In order to assess the effect of introducing the DMEM, two sets of outcome measures were assessed. The primary analysis was an online survey which examined junior doctors’ knowledge and confidence in managing inpatients with diabetes. The secondary analysis focused on audit data at Barnet Hospital from three consecutive NaDIA audits (henceforth denoted as NaDIA-BH). The NaDIA-BH data before and after the introduction of the e-module were analysed to see if there were any demonstrable improvements in inpatient diabetes care. The methodology for each analysis is described in more detail below.

Survey of junior doctors’ experience of the DMEM

In June 2011, 200 junior doctors at both Barnet Hospital and Chase Farm Hospital (across the two sites of BCFT), who had undertaken the DMEM six to eight months previously, were invited to fill in a questionnaire regarding their experience of the DMEM. There were 50 respondents, who came from a wide range of specialties and training grades. These junior doctors completed an online questionnaire, retrospectively ranking their confidence and knowledge levels in managing inpatients with diabetes before and after completing the e-module. They rated their confidence in managing various aspects of diabetes inpatient care including: insulin identification; adjusting drug doses; managing intravenous insulin infusions; prescribing insulin safely and managing high and low blood glucose levels. They also reported on any use of discouraged practices in diabetes. Survey results were collated electronically using a web-based survey tool.
**Statistical analysis**

The primary analysis is of the junior doctors’ survey, which has a sample size of 50. Responses on pre- and post-DMEM were reported as percentages, and were compared using McNemar’s test. The secondary, and more explorative, analysis is of the NaDIA-BH data. The proportion of ‘good days’ was reported as mean (standard deviation), and compared using a non-parametric Wilcoxon-Mann-Whitney test. Errors committed during inpatient stay were reported as errors per patient (percentage) and compared using Fisher’s Chi-square test. Analyses were performed using STATA/SE 11.2 (StataCorp LP, TX, USA).

**Results**

**Junior doctors’ experience of the DMEM**

The uptake of the DMEM was monitored by the Education Centre, which collected data on which junior doctors had completed the e-module and obtained a certificate (after passing a test online) – 50% of all junior doctors across the trust (similar on both sites) had completed the DMEM training by March 2011, and 74% of all junior doctors across the trust (also similar on both sites) had completed the DMEM by October 2011.

Table 1 shows the change before and after completion of the DMEM in self-reported knowledge of identifying different types of insulin, and self-reported confidence in various aspects of diabetes management, based on the junior doctors’ survey. The results show a significant improvement in knowledge in identifying different types of insulin (mean increase 46%, 95% CI 29% to 63%, p<0.001), and in confidence in managing insulin dose adjustments (mean increase 28–40%, p<0.001).

Table 2 shows how the use of discouraged practices in diabetes, as reported by the participants, changed after completion of the DMEM. The results show a significant reduction in reported use of discouraged practices including: abbreviating units to ‘U’ or ‘IU’ on the drug chart (mean decrease 22%, 95% CI 6% to 38%, p=0.0074); omitting insulin following adequately treated/corrected hypoglycaemia (mean decrease 30%, 95% CI 13% to 47%, p<0.001); and prescribing stat doses of rapidly-acting insulin to patients with asymptomatic hyperglycaemia (mean decrease 14%, 95% CI 0.4% to 28%, p=0.0654).

**NaDIA-BH audit findings before and after DMEM introduction**

We compared the ‘NHS Inpatient Audit’ data from October 2009, March 2011 and October 2011 when the levels of uptake of the DMEM were different among junior staff (0%, 50% and 74% respectively).
The proportion of patients with diabetes ranged from 15–18% (see Table 3), in line with the national average for NaDIA 2011.1

The DMEM was primarily aimed at improving the management of patients with insulin-treated diabetes as this group suffer the highest number of incidents. The relatively small numbers of insulin-treated patients (16–25 in each of the three audits) made it difficult to demonstrate statistically significant improvements in audit data from one year to the next in this group. However, the results, summarised in Table 4, show very interesting trends towards improvements in diabetes care which are difficult to ignore: patients experiencing one or more prescription error fell from 32% in 2009 to 17% in 2011; and patients experiencing one or more management error fell from 36% in 2009 to 17% in 2011. The audit analysed the proportion of ‘good diabetes days’ spent in hospital, defined as the proportion of days since admission, or over the last seven days (whichever period was shorter) in which the frequency of blood glucose monitoring was appropriate, with no more than one reading greater than 11mmol/L and none less than 4mmol/L. The proportion of ‘good days’ increased from 0.17 in October 2009 to 0.38 in October 2011.

Discussion
This study clearly demonstrates the effectiveness of the DMEM in enhancing the self-reported confidence and knowledge levels of junior doctors in the management of inpatients with diabetes. There is a suggestion of improvements in patient care, as measured by the NaDIA-BH, which could be due to the DMEM. Although there have been studies previously which assess clinical knowledge before and after undertaking e-learning, this is the first to relate a diabetes e-learning module to patient care outcomes. The findings support the use of e-learning and other new educational technologies in order to increase the knowledge and skills of doctors. E-learning is becoming increasingly important due to time restrictions placed on face-to-face teaching. It is a powerful tool which can meet the challenge of educating large numbers of junior doctors working a shift pattern, with only a proportion available at any one time to attend face-to-face teaching.

The introduction of the DMEM was associated with highly significant improvements in junior doctors’ self-reported knowledge and confidence levels in all key areas of inpatient diabetes care. This included self-reported levels of knowledge (e.g. the identification of different types of insulin), confidence in managing hypoglycaemia and hyperglycaemia, as well as a reduction in

| Table 3. Patients with diabetes at Barnet Hospital during 3 audit periods |
|-----------------------------|-----------------|-----------------|-----------------|
| No. of patients with diabetes ( % of total) | 62 (18%) | 52 (15%) | 55 (16%) |
| Patients treated with insulin during admission | 25/62 (40%) | 16/52 (31%) | 24/55 (44%) |
| Patients started on insulin during admission | 10/62 (16%) | 4/52 (8%) | 3/55 (5%) |

| Table 4. Errors in inpatient stay experienced by subgroup of patients with insulin-treated diabetes |
|--------------------------------------------------|-----------------|-----------------|-----------------|
| Patients with 1 or more prescription error       | 8/25 (32%) | 5/16 (31%) | 4/24 (17%) | NS |
| Insulin not written up at all on admission       | 4/25 (16%) | 2/16 (12.5%) | 0/24 (0%) | NS |
| Name of insulin incorrect                        | 0/25 (0%) | 0/16 (0%) | 0/24 (0%) | NS |
| Dose written unclear                             | 0/25 (0%) | 0/16 (0%) | 0/24 (0%) | NS |
| Insulin prescription not signed by doctor        | 0/25 (0%) | 0/16 (0%) | 0/24 (0%) | NS |
| Insulin given or prescribed at wrong time        | 0/25 (0%) | 1/16 (6%) | 0/24 (0%) | NS |

| No. with 1 or more management error              | 9/25 (36%) | 6/16 (37.5%) | 4/24 (17%) | NS |
| CBG persistently high and no increase in insulin dose | 8/25 (32%) | 5/16 (31%) | 2/24 (8%) | NS |
| CBG <4 and no reduction in insulin dose          | 1/25 (4%) | 1/16 (6%) | 1/24 (4%) | NS |
| Inappropriate omission of insulin after hypoglycaemia | 0/25 (0%) | 1/16 (6%) | 1/24 (4%) | NS |

*P-values based on Fisher’s Exact Chi-Square test, comparing the October 2009 audit to the October 2011 audit; NS = not significant; p<0.05. CBG = capillary blood glucose.
In the NaDIA-BH data, the number of ‘good diabetes days’ experienced by the insulin-treated patient group appeared to increase after the introduction of the DMEM. There was no improvement nor deterioration in those patients not treated with insulin (diet or tablets/GLP-1 analogues alone), but this is not surprising as these patients are at a much lower risk of experiencing a prescribing or management error in hospital, as compared to patients with insulin-treated diabetes (type 1 or type 2). The DMEM was mainly targeted at insulin safety and the management of patients with insulin-treated diabetes.

The subjective observations of the diabetes team at BCFT, who have regularly reviewed inpatients with diabetes referred for specialist advice (before and after the implementation of the DMEM in 2010), have been that basic diabetes inpatient care has improved following the DMEM launch in several areas – including switching patients from intravenous to subcutaneous insulin, making subcutaneous insulin dose adjustments in response to low/high blood glucose and managing patients newly diagnosed with diabetes. The quantity of inpatient diabetes referrals fell after October 2010, and the quality of inpatient diabetes referrals improved following uptake of the module – patients being referred only when the advice followed in the DMEM did not work in that particular case.

This study contributes to the literature presently available on the importance of e-learning in education. Our findings have relevance beyond the field of diabetes and are pertinent to junior doctor training in all specialties. E-learning is also applicable to training nursing staff and other clinical staff whether inside or outside hospitals. We found that the DMEM was too complicated for nurses to follow and a separate e-module for nursing staff, based on the DMEM, is in development. E-learning technologies have previously been found to be at least as effective as traditional instructor-led methods such as lectures while being more flexible in terms of time and place of learning. They also enable adult-learning theory to be applied to medical education, whereby educators do not merely disseminate facts but, rather, facilitate an individual’s own learning journey.

The limitations of this study include the fact that the doctors’ survey was undertaken retrospectively which may have introduced some recall bias. Upward selection bias could be caused by junior doctors being more inclined to fill in the questionnaire if they had benefited from the e-module. There was a potential confounding factor in the NaDIA-BH observational data – a nursing education seminar programme started in April 2009, but uptake was very poor at 10% of nursing staff due to the time commitment during working hours. It is unlikely that this initiative contributed to the non-significant differences in results between NaDIA-BH audits.

In order to further assess the impact of a diabetes e-module on patient care, a NaDIA-style survey could be completed on a number of days before and after the implementation of the e-module in a single centre to increase the power of the study. Alternatively, a multicentre study could be conducted before and after implementation of the e-module, using the annual NaDIA data to assess response. The authors recommend the implementation of this DMEM (or a similar e-module) in all hospitals to improve junior doctor confidence and knowledge and thereby improve patient safety.

The advantage of the DMEM over other available diabetes e-modules is that it is comprehensive, interactive and has a voice-over in addition to multiple illustrations which engages the audience.

While this diabetes e-learning module was aimed at junior doctors, further e-modules should be designed to provide online education for nursing staff and primary care physicians, and also to provide patient education.

Conclusion

The DMEM has shown significantly positive results in improving junior doctors’ knowledge levels and confidence. While certain aspects of the
management of inpatients with diabetes appeared to improve, this study did not have the power to prove that categorically.

A multi-centre study would be needed to prove whether more confident and more knowledgeable junior doctors provide better diabetes care to inpatients. There are other diabetes education e-modules available but none provides the same depth and breadth of diabetes education as the Diabetes Management E-module.

The authors recommend that the NHS and other health organisations adopt or develop high-quality diabetes e-modules to educate staff managing patients with diabetes. We propose that NHS Diabetes and the Association of British Clinical Diabetologists promote further developments in diabetes e-learning in the UK. Further research is required to fully evaluate the effectiveness of such educational interventions in improving patient care, and to see how they could be more widely utilised in postgraduate medical education.

Declaration of interests
There are no conflicts of interest declared.

References

Book review

Diabetes and kidney disease

Edited by Gunter Wolf
Published in 2013 by Wiley-Blackwell
Price: £64.99; 280 pages
ISBN: 978 1 118 494103
Website: www.wiley.com

This book provides the reader with a practical and well thought-out approach to investigating and managing patients with diabetes and kidney disease. As the authors point out in their preface, the spectrum of patients with diabetes and renal disease is changing rapidly and is responsible for increasing economic burden; as such, this book would be a valuable reference for any clinician involved in the care of patients with diabetes or renal disease.

The book consists of 17 chapters. Part I of the book covers the background to renal disease in diabetes, and an introduction to the pathophysiology. As you may expect, this covers the basics in terms of pathophysiology, histology and diagnosis, but also the genetic risk factors for diabetic nephropathy. These chapters are presented in a clear and concise manner, ensuring that they provide the important facts in a manageable format.

The chapters I found most useful were those in parts 2 and 3 of the book. Part 2 deals with special situations, risk factors and complications, and addresses clinical situations and questions which arise when dealing with patients with diabetic nephropathy. Each of these chapters carefully presents the background to the problem, and an analysis of the key trial data and most up-to-date guidelines before reaching clinical conclusions based on the available evidence. I found the chapters entitled statin therapy and diabetic nephropathy, and also diabetes, the bone and kidney to be particularly useful.

Part 3 of the book deals with prevention and therapy of renal disease in patients with diabetes and, again, is very clinically based. Chapters 13 to 15 provide key information on management of patients in terms of their glycaemic and blood pressure control, not only regarding the best treatments, but how these doses should be adjusted in renal disease. In particular, the chapter on antihypertensive treatment provides a clear analysis of important trials, and reaches logical and clinically relevant conclusions, stressing the importance of prevention of progression of nephropathy where possible. Finally, treatment options for end-stage renal disease are explored in detail.

Throughout the book, good use is made of ‘key points’ boxes which were extremely helpful, and each chapter is subdivided into complementary sections, ensuring it is easy to read and assimilate the information. Overall, I would recommend this book to diabetologists and nephrologists to increase confidence when managing renal complications of diabetes.

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Appendix 1. Twice-daily insulin regimen

- Typical Biphasic insulin regime
- 2/3 before breakfast
- 1/3 before an evening meal
- Applies to most hospital inpatients
- Outpatients may require a 50:50 split
- Inpatients need to be started on their usual regime
- Adjustments made if levels are too high or low

Appendix 2. Basal bolus insulin regimen

- Typical Basal Bolus Insulin profile
- Allows greater flexibility of mealtime doses
- Suitable for younger patients or people who work shifts
- Mainly used in Type 1 patients
- Requires more monitoring / More work for the patient
Appendix 3. On the ward examples: insulin dose adjustment

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<th>CBG 1700</th>
<th>CBG 2200</th>
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