

Developing an innovative online medication calculator for patients with Parkinson's disease who are nil by mouth

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ABSTRACT

Missed Parkinson's disease (PD) medications when patients are admitted to hospital are associated with increased morbidity and mortality. Swallowing difficulties in hospitalised PD patients are common and should prompt clinicians to consider conversion of a patient's PD medications to a non-oral form – this is, however, recognised as a challenging area with potential for error. Northumbria Healthcare NHS Foundation Trust's PD service set out to address this patient safety issue through the development of an innovative online medication calculator (pdmedcalc.co.uk). This article summarises the development process underpinning the calculator, presents numerical data on the usage of the calculator and presents survey data relating to user experiences of the calculator. Lastly, we highlight how user feedback has been used to refine subsequent iterations of the calculator and how use of the calculator has rapidly spread beyond our trust because of it being freely accessible online.

KEYWORDS: Dose calculator, nil by mouth, medications, Parkinson's disease, patient safety

Introduction

Parkinson's disease (PD) is the second most common neurodegenerative condition with increasing prevalence.¹ It is recognised that control of PD often deteriorates in hospital because of incorrect medication administration.² As highlighted by a National Patient Safety Agency alert, sudden cessation of PD medications can be extremely dangerous.³ Missing dopaminergic medications can precipitate neuroleptic malignant-like syndrome, which is potentially fatal.⁴

When PD patients are admitted to hospital, they may be made 'nil by mouth' (NBM) because of concerns about swallowing safety or in advance of a procedure. In such situations, appropriate conversion of PD medication to a non-oral form is essential.⁵ Within 'daylight' working hours,

expert advice can usually be sought from local PD specialists. Outside these hours, however, there is potential for harm. It is recognised that junior doctors lack a detailed understanding about safe prescribing practice for PD medications⁶ and that conversion of PD drugs to non-oral forms is a particularly challenging area.⁷

The Northumbria Healthcare NHS Foundation Trust (NHCT) PD service (which covers a population of approximately 500,000 people across 10 inpatient sites) sought to develop a safer system to address this challenging area. In this article, we describe the development of an innovative, online PD medication calculator to assist with conversion of a patient's PD medication to a non-oral form.

Methodology

Funding for the development of our online PD medication calculator came from the NHCT PD service, who worked in collaboration with a computer scientist from Newcastle University to develop it.

Initially, it was proposed that we would develop an application for use on internet-enabled smartphones. Subsequent discussion highlighted a number of difficulties with this approach. Firstly, mobile phone reception is often suboptimal within hospital buildings, which may adversely affect usability. Secondly, regular updates would be needed to keep pace with updates of smartphone operating system software, which would prove costly and time consuming. As such, it was agreed that the calculator would instead be based on the trust intranet, as well as the internet (<http://pdmedcalc.co.uk/>).

The calculator itself was designed to be simple and intuitive. Computer science expertise was sought to enable the development of a bespoke calculator, informed by the needs of practising PD clinicians. Page one contained a brief explanation of the purpose of the calculator and prompted the user to click a disclaimer to proceed. Page two asked the user to select their patient's current PD medication using a drop-down menu. Page three provided the results, in a format that could be easily transcribed direct onto a medication chart (Fig 1).

Two different results were provided:

- 1 a direct conversion of medication to dispersible co-beneldopa for administration via a nasogastric (NG) tube
- 2 a conversion to a rotigotine patch (transdermal dopamine agonist) for situations where an NG tube was not tolerated or not appropriate (eg end-of-life care).

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Your Results:

Based on the entry of the following medications:

Name	Frequency
Madopar (co-beneldopa) 125mg (100mg/25mg)	4 per day

the total levodopa equivalent dose for this patient is **400 mg** per day.

The equivalent dose of levodopa for this patient can be provided in 2 different ways; below is a brief explanation of each option and the accompanying prescription.

Option 1: Conversion of all usual medications for administration via naso-gastric tube using dispersible madopar (co-beneldopa)
NB - this should be the default option for use, assuming a naso-gastric tube is tolerated and is appropriate.

0800	1200	1600	2000
1 x Madopar Dispersible 125mg (100mg/25mg)	1 x Madopar Dispersible 125mg (100mg/25mg)	1 x Madopar Dispersible 125mg (100mg/25mg)	1 x Madopar Dispersible 125mg (100mg/25mg)

Option 2: Conversion of all usual medications for administration via rotigotine trans-dermal patch
NB - this option may be considered if a NG tube is contraindicated or if the patient is for palliation (caution for precipitation of confusion and/or delirium with high doses of rotigotine)

0800	1200	1600	2000
1 x Rotigotine Patch 4mg (Replace every 24 hours)			

Fig 1. An example of the online Parkinson's disease medication calculator's results page.

The underlying algorithms developed to calculate the doses were informed by previously published work.^{5,8} It is recognised that high doses of rotigotine can, in drug-naïve patients, precipitate confusion, hallucinations and delirium. As such, a pragmatic decision was taken to reduce calculated doses of rotigotine by a factor of four – this was informed by the clinical experience of the clinicians within the PD service. This step was clearly signposted within the calculator, along with the reasoning for it, as well as the recommendation to 'start low and go slow' with up-titration of rotigotine.

To evaluate the use of the calculator, two approaches were employed. Firstly, a simple 'hit-counter' was incorporated into the results page of the tool to enable the number of users to be quantified. Secondly, an online survey (SurveyMonkey), containing a mix of multiple choice and free-text response questions, was developed. A link to complete this survey was included on the results page of the online calculator.

Outcome

The calculator was launched on the 1 July 2015. As of 1 May 2016, the calculator had recorded a total of 1,713 users and 20 users had provided feedback via the SurveyMonkey link.

Based on the 20 surveys, the calculator was predominantly used by medical staff (five consultants, five registrars, one core trainee, one foundation doctor) and by pharmacists (n=7), with one job title left blank. The calculator was primarily used for patients on medical wards (n=9), with only one user reporting its use on a surgical ward. The calculator was predominantly used within Monday to Friday 'office hours' (n=13) rather than out of hours (Mon–Fri 17:00–21:00=2, Saturday/Sunday=2).

Users were also asked to indicate, using a five-point Likert scale, how easy (or difficult) it was to:

- enter medications into the calculator
- interpret the results of the calculator.

Responses to these items are displayed in Fig 2.

Survey respondents were also invited to provide free-text comments on how the calculator might be improved. These comments are summarised in Table 1, along with the subsequent changes to the calculator that were implemented in response to them. Of note, one survey respondent indicated

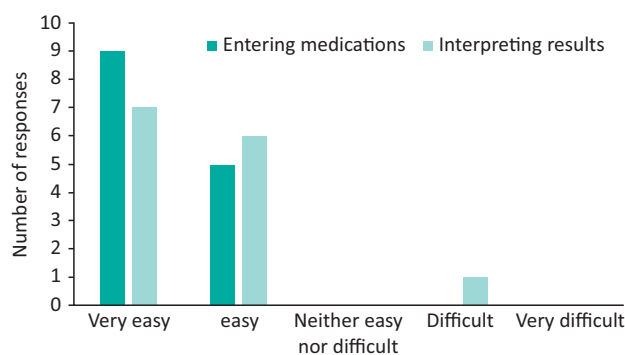


Fig 2. How easy (or difficult) was the calculator to enter medications (A) and interpret the results (B)?

that they had found interpretation of the calculator's results to be difficult. Examining this respondent's free-text feedback highlighted that they had been unclear how to proceed because their patient was on PD medications that did not appear in the drop-down menu. These particular medications and others (such as entacapone, selegiline, rasagiline and amantadine) can in fact be safely omitted when a patient is NBM. As described in Table 1, additional explanatory text was added to the opening page of the calculator to ensure this was made clear.

Table 1. Suggestions for development emerging from survey data and the resulting changes that were implemented in response

Suggestion for development	Change implemented
<i>I selected a drug then clicked calculate, but it gave an error that I hadn't 'added' anything. A short line explaining that you need to do this would be helpful.</i>	The following text was added: <i>No medications have been added – please return to the previous screen and ensure you have correctly added the patient's medications</i>
<i>Minimal guidance to do with the other PD meds.</i>	The following text was added: <i>The following medications can be safely omitted if swallow is compromised: entacapone, selegiline, rasagiline and amantadine.</i>
<i>Need to understand how it has been validated; referencing doesn't appear to be comprehensive</i>	References were included in initial version. ^{5,8} For improved access, links were added to enable users to access these references direct from the calculator.
<i>Not sure about levodopa to rotigotine conversion. Seems to give very low doses of rotigotine</i>	Specific guidance on this did already exist within the calculator. To render it more visible, the sub-heading "Caution with Rotigotine Patch" was inverted in colour and was placed directly below the rotigotine dose output.

Conclusion and next steps

Thus far, the medication calculator has proven to be a success, as evidenced by the large number of users since its launch. Initially, the growth in users was slow. We suspect these initial users were predominantly within our trust and were directed to the calculator via the NHCT trust guideline for PD, which advocates use of the calculator for NBM PD patients. Thereafter, the growth in users has steadily increased. This has been driven by the calculator being endorsed by the British Geriatrics Society Movement Disorders Section and more recently, through recognition of the calculator by the Parkinson's UK Excellence Network. Subsequently, the Parkinson's UK Excellence Network have incorporated the calculator into their regional NBM guideline, which is currently in use across the north-east of England and Cumbria.⁹

We acknowledge that the number of survey respondents, compared with the number of users, is small and hence caution must be employed when analysing the survey results. We suspect that response to the survey has been low because users will typically access the calculator in the clinical workplace and pressures of work may mean that they are less inclined to access and complete an online survey. The primary motivation for the survey, however, was to source feedback as to how the calculator could be improved, and not to provide a comprehensive overview of who was using the calculator and the environments in which they were doing so.

We aim to increase awareness of the calculator within our trust through an advertising campaign, coordinated via the trust's communications team. An advert for the calculator will be incorporated into the rolling screensaver that appears on all trust computers. We anticipate this will give excellent exposure to the calculator and drive further use within the clinical workplace. Orientation to the tool has already been incorporated into trust-wide junior doctor teaching on PD – further feedback from these users (who were comparatively under-represented in our survey) may inform improvements in future iterations of the tool. Future work could also consider capturing data pertaining to clinically meaningful outcome measures, such as the incidence of medication errors with PD medications, before and after the implementation of the tool. Lastly, we hope that sharing our innovation via *Future Hospital Journal* will help raise awareness of the calculator among physicians around the world.

Key learning points

- > Being 'nil by mouth' and missing PD medications is a potential patient safety issue.
- > In such patients, working out a suitable non-oral medication regimen can be challenging for junior doctors, particularly out of hours.

- > Computer science expertise was central to the development of an intuitive, reliable medication calculator.
- > Making the medication calculator freely accessible on the internet (pdmedcalc.co.uk) has enabled its use to spread beyond our trust.
- > Endorsement and dissemination of the calculator by professional bodies has further enhanced its use across the UK.
- > Capturing user feedback, and modifying the calculator in light of it, was a crucial part of maximising usability of the calculator. ■

Conflicts of interest

The authors have no conflicts of interest to declare.

Author contributions

All authors fulfil the ICMJE criteria for authorship.

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