

The SCRIPT project: a knowledge translation approach to improve prescription practice in a general intensive care unit

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Errors related to prescribing and administering medications in intensive care units are common, and potentially dangerous.¹ The incidence of medication errors has been identified as a key quality indicator in the ICU.² Errors are classified as being related to ordering, dispensing and administering.³ Ordering errors are the commonest, mainly due to illegible handwriting or incomplete orders.^{4,5}

To standardise prescription practice nationally, the Australian Commission on Safety and Quality in Health Care introduced the National Inpatient Medication Chart (NIMC) in 2008.⁶ The NIMC has been found to reduce the incidence of common prescription errors,⁷ and has since been adopted in all Australian hospitals. It has mandatory fields for prescriber identity and documenting allergies, and optional fields for drug indications. Guidelines emphasise the use of generic drug names and “legible handwriting”, but do not mandate printing in capital letters.

Our ICU uses a paper-based system of prescription practice — the NIMC for medications administered as a bolus (Figure 1), and customised “flowsheets” for medications administered as continuous infusions (Figure 2).

The NIMC has a 7-day cycle before mandatory recharting, and the flowsheet has a 24-hour duration (ie, recharted daily). Additional medications are charted whenever required.

Despite being in use for over a year, anecdotal reports in our ICU indicated poor compliance with many of the NIMC guidelines, resulting in frequent errors related to illegible handwriting, lack of prescriber name and/or signature in the medication chart and the flowsheet, and lack of indication for initiating antibiotics.

Methods

This project was designed to study and improve prescription practice using the principles of knowledge translation (KT), primarily focusing on medication orders by doctors. KT is an emerging tool designed to implement the results of research into clinical practice.⁹ It is particularly suited to evaluating quality assurance projects, especially those pertaining to changes in systems, process and structure.

The difference from a standard quality assurance audit is the strong emphasis on inclusion of the key stakeholders, who are encouraged to actively participate in the project, as

ABSTRACT

Background: Medication errors can be dangerous and are an intensive care unit quality indicator. Few studies have assessed interventions aimed at improving prescription practice. Anecdotal reports in our ICU indicated a high incidence of prescription errors, including illegible handwriting, and lack of prescriber identity and antibiotic indications. Knowledge translation (KT) is an emerging tool that uses collaborative stakeholder participation and focuses on education and inclusiveness rather than punitive audits.

Objective: To evaluate interventions aimed at improving prescription practice.

Design: A KT quality assurance project with three phases: (1) measuring baseline performance; (2) education; and (3) measuring post-education performance.

Setting and participants: Doctors and nurses working in the 19-bed general ICU of a tertiary referral hospital.

Interventions: Education protocols were developed by senior doctors, nurses and the pharmacist. “Walking the process” with all doctors and nurses identified local barriers and issues. Ten weeks were allocated for the baseline and post-education audits, and 8 weeks for education. The project was then delayed for a few months to prevent the Hawthorne effect.

Main outcome measure: Incidence of prescription errors in the post-education phase.

Results: There was a highly significant improvement in many error rates — illegible prescriptions reduced from 39.4% to 13.4% ($P < 0.001$); absent or illegible prescriber name from 38.3% to 27.0% ($P < 0.001$); not documenting antibiotic indication from 64.8% to 32.5% ($P < 0.001$).

Conclusion: A systematic KT process of collaborative education can reduce ICU prescription errors.

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opposed to being monitored or audited from above. This participation is built through a process of consultative education to identify the local practice barriers, followed by development and implementation of solutions. Thus, the

Figure 1. National Inpatient Medication Chart for bolus medications^{8*}

The figure displays two pages of a medication chart.
Page 2 of 4: Contains patient identification (URN, family/given names, address, date of birth, sex), a box for allergies and adverse drug reactions, and a 'REASON FOR NURSE NOT ADMINISTERING' section with codes (A, F, R, V, L, N, W, S). It also includes 'RECOMMENDED ADMINISTRATION TIMES' and 'WARFARIN EDUCATION RECORD'.
Page 3 of 4: Features a 'REGULAR MEDICATIONS' table for 'YEAR 20'. The table has columns for 'DATE & MONTH' and rows for various medications. Each row includes fields for 'Date', 'Medication (Print Generic Name)', 'Route', 'Dose', 'Frequency & NOW Enter Times', 'Indication', 'Pharmacy', 'Prescriber Signature', and 'Print Your Name'. A 'Pharmaceutical Review' section is at the bottom.
 Between the pages are two vertical circles with text: 'DO NOT WRITE IN THIS BINDING MARGIN'.

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key components of the KT approach are a focus on systems rather than the care of individual patients, and engagement and empowerment of local interdisciplinary teams to assume ownership of the project and the intervention, finally promoting a collaborative culture within the local unit and larger system.⁹ The KT model is similar to a pre- and post-intervention audit, with the intervention placing a strong emphasis on collaborative education of the personnel being audited.

From November 2008 to November 2009, we designed and implemented a KT project with the aim of improving prescription practice in our 19-bed general ICU.

This project fulfilled the Human Research Ethics Committee criteria for not requiring ethics approval, and was considered a quality assurance project, involving routine practice.

Planning phase

After the identification of the prescription error problem, the current project was first discussed at the research

advisory committee in November 2008, then at two meetings of the senior management advisory committee in November and December 2008, attended by all ICU specialists, senior nurses and the pharmacist. While accepting that a randomised controlled trial model ensured the highest integrity, it was considered unfeasible in a single centre, due to contamination of the usual practice group by the protocol group, with a consequent lack of separation of the two groups.

The KT model was considered to be an acceptable and feasible method of evaluating the impact of a targeted quality improvement intervention.

Local practice issues and barriers were identified by “walking the process” of prescription practice with the medical and nursing staff. Concurrently, junior medical and nursing staff were asked to submit their opinions on barriers and issues and ideas to improve prescription practice.

The barriers and issues identified were: poor communication from doctors to nurses and senior doctors to junior

Figure 2. Continuous infusion flowsheet used in the intensive care unit, Nepean Hospital

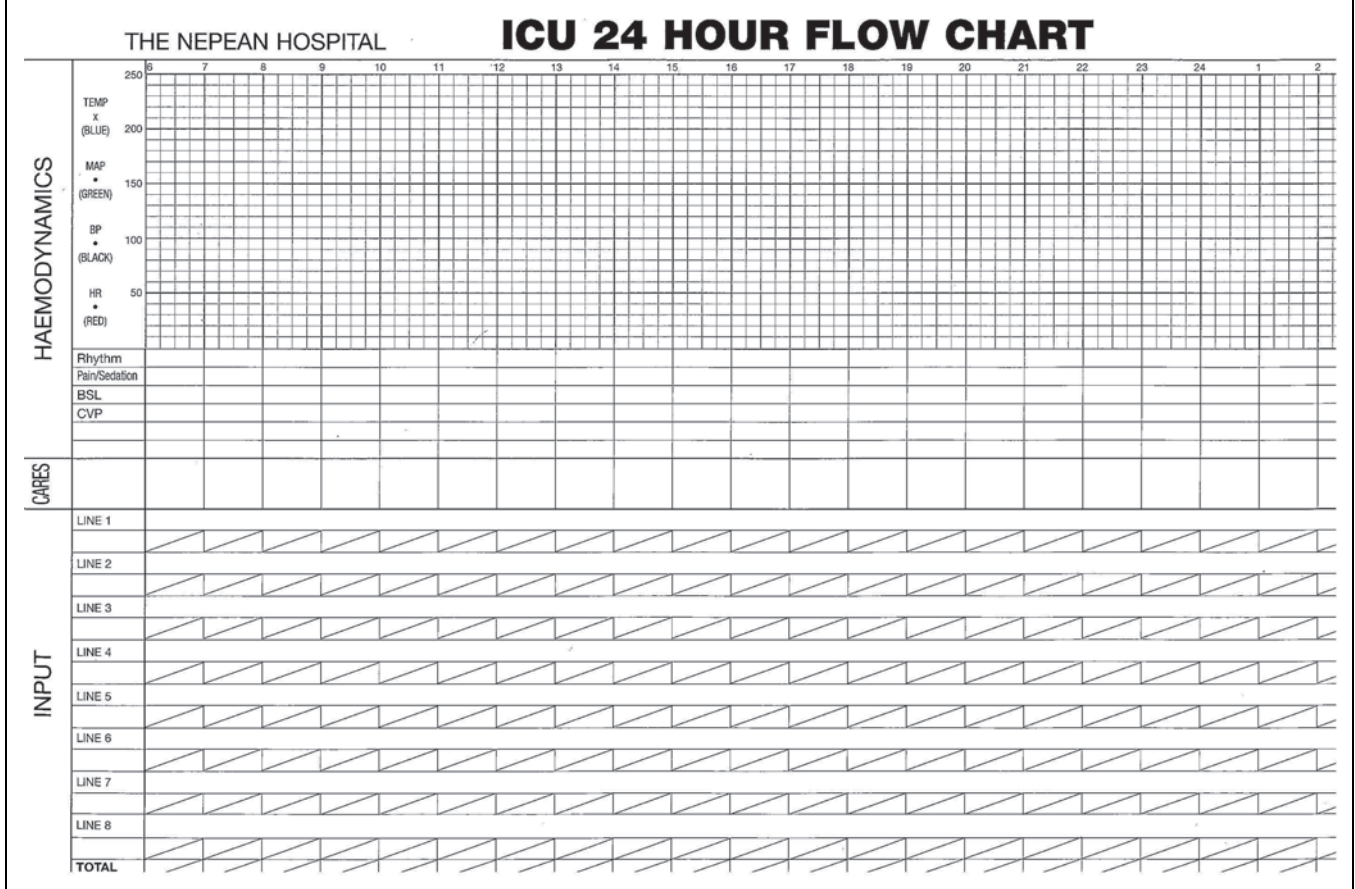
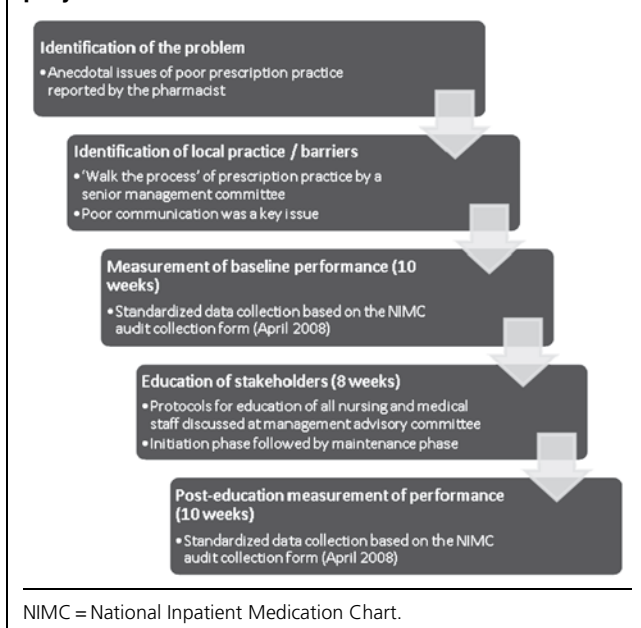


Figure 3. Design of the knowledge translation project



doctors, illegible handwriting, and poor documentation of indication for antibiotics and physiological targets for infusions such as catecholamines and insulin.

Assuming an existing error rate of 25%, 500 medication prescriptions were required to demonstrate a 10% decrease in the incidence of error rate following education with 90% power.⁷ As most charted medications are usually largely unaltered for 2–3 days, it was decided to perform a daily audit on every alternate bed, and any new patients admitted in the previous 24 hours. Clinical staff were unaware of the schedule of the audit. Assuming a minimum of 15 prescription orders being audited every alternate working day (ie, about 50 prescriptions audited per week), the duration of the pre- and post-education phases was fixed as 10 weeks each, with 8 weeks of education (Figure 3). Due to the variability of junior medical officer (JMO) terms (senior registrar, registrar, resident medical officer and senior resident medical officer), it was impossible to have an identical group of doctors for the entire 28-week study duration. However, most doctors remained the same in the study period (six specialists, three senior registrars, five of seven registrars, and two of four senior resident medical officers).

Data collection

Based on our local issues, a standardised data collection form was developed by making the following modifications to the NIMC audit form:

- **Writing the indications for antibiotics:** Initial empirical broad-spectrum antibiotic therapy in suspected or proven sepsis is usually narrowed or ceased after results of microbiological analysis. Not documenting the indication for an antibiotic has the potential to delay this de-escalation, with a risk of increasing antimicrobial resistance.
- **Documenting targets or goals for continuous infusions prescribed on the flowsheet** (eg, mean arterial pressure for vasoactive medications, blood glucose levels for insulin, sedation and analgesia targets among others) influences day-to-day nursing management. Inappropriate targets have the potential to lead to catecholamine overuse, prolonged sedation and poor glycaemic control, and prolonged ICU stay.
- **Excluding data collection on warfarin**, as it is rarely used in our ICU.

Data collection was done electronically on a Microsoft Excel (Microsoft Corporation, Redmond, Wash, USA) worksheet using a designated laptop computer.

To ensure consistency, it was decided that only two of us (MT and DP) would perform the data collection. Both data collectors were given guidelines on the specific aspects of data (Table 1), with instructions to contact the other two investigators (AR or SS) for help if required.

In a separate set of 59 prescriptions from five patients, interobserver agreement between the data collectors was tested for subjective parameters, and found to be good for legibility of handwriting (κ statistic, 0.65), and very good for legibility of prescriber name (κ statistic, 0.85).

Outcome measures

The outcomes measured were the incidence of specific prescription errors, namely:

- legible documentation of name and signature of prescriber in the medication chart;
- legible documentation of name and signature of prescriber in the continuous infusion flowsheet;
- legibility of handwriting of every component of the prescription (ie, drug name, dose, route, frequency and indication);
- documentation of indications for antibiotics; and
- documentation of goals and targets for continuous infusions on flowsheet (eg, mean arterial pressure for vasoactive medications, sedation target, analgesia targets).

Phase 1: measurement of baseline performance

The onset of the project was deliberately deferred by a few months (until April 2009) to prevent the Hawthorne effect, the phenomenon of altered behaviour and/or performance resulting from the awareness of being part of a study.^{10,11}

Table 1. Guidelines for data collectors

Parameters of data collection	Guidelines and definitions
Total no. of charts	All the currently active medication charts for the patient. Charts that have completed the 7-day cycle are not included.
100% correct identification	Correct patient identifying details include first name, surname, medical record number and date of birth; 100% correct identification demands all of these to be documented legibly.
Legible and unambiguous prescription	A legible prescription is one that is clearly readable at first look. Any prescription that either requires a second look for interpretation or requires the help of another person to interpret is defined as illegible. In addition, a prescription must be unambiguous. An unambiguous prescription is one that has clear documentation of the route, dose and frequency, and must not have more than one route of administration (eg, a medication that specifies the route as "nasogastric/intravenous" is ambiguous).
No. of orders in which prescriber name is not legible	A legible prescriber name is one that is clearly readable at first look. Any prescriber name that either requires a second look for interpretation or requires the help of another person to interpret is defined as illegible.
Documentation of antibiotic indication	If there is a confirmed source of sepsis, it must be specified clearly and legibly. If there is no confirmed source of sepsis, the suspected source of sepsis must be clearly and legibly documented with the words suspected or empiric or their equivalent (eg, "suspected community-acquired pneumonia", "?community-acquired pneumonia")
Flowsheet infusions goals/targets	Any infusion on the continuous flowsheet such as insulin, catecholamines, sedatives and analgesics must have physiological end points documented as goals or targets (eg, blood glucose level target for continuous insulin infusion; mean arterial pressure for vasoactive medications such as catecholamines; Richmond Agitation Sedation Scale for sedative infusions). (If the data collector was unaware of whether an infusion required a target, two of us (AR or SS) could be contacted for clarification.)

Phase 2: education of stakeholders

Draft protocols developed by the first and second authors were approved by the senior management advisory committee. Although mandatory printing (capital letters) of the prescription to improve legibility and writing the indication for every medication were considered “best practice”, the NIMC guidelines did not mandate these. Hence, this was not standard practice in our hospital. With a floating pool of JMOs, the consensus was to invest time in educating them to embrace these practices.

Education was performed by two of us (AR and SS), targeting all medical and nursing staff. Education was provided during bedside teaching of small groups of nurses and doctors as well as in formal forums, such as the daily morning clinical handover, the daily clinical meeting, weekly JMO teaching session, and the fortnightly management advisory and staff specialist meetings. After an initial intensive education phase (8 weeks), ongoing (maintenance) education with 1-minute reminders continued throughout the project, usually at the end of the daily clinical handover meeting.

Education was simple and time-efficient (5–10 minutes), with 10 Microsoft PowerPoint slides outlining the importance of the issue, summary of the evidence, de-identified examples of erroneous prescriptions, local barriers in our ICU, and the recommended solutions, including the responsibilities of all staff. Medical staff were specifically educated regarding the importance of writing antibiotic indications on medication charts, and physiological targets for continuous infusions on flowsheets. Senior medical officers were reminded of their responsibility to ensure correct orders.

Education for nursing staff was done in small groups at the bedside. The focus of nursing education was to remind nurses of their right to refuse to administer an illegible or unambiguous prescription, and their responsibility to report erroneous prescriptions to their immediate managers or the most senior available medical officer.

The acronym SCRIPT (Figure 4) was printed and displayed at prominent locations in the ICUs (staff toilets, tearoom, near the medication chart shelves, conference room, and clinical meeting room).

Phase 3: post-education measurement of performance

The same electronic standardised data collection form used for the baseline audit was used.

Statistical analysis

The z test for proportions was used to compare error rates before and after the intervention. $P < 0.05$ was considered significant.

Results

In all, 24 medical officers (six specialists, three senior registrars, seven registrars, four senior resident medical officers, and four resident medical officers) received education. Each JMO received at least two educational sessions,

Figure 4. The SCRIPT acronym

Script project

Nepean ICU Prescription Standards
Remember SCRIPT for all prescriptions...

- S** – Senior Doctor cross-check
- C** – Check allergies
- R** – wRite indications for antibiotics
- I** – (Initial Date) of charting drug in parenthesis
- P** – PRINT and sign your name
- T** – Appropriate Targets for infusions

Together, we can script a better prescription!

Table 2. Summary of results

Parameter	Pre-education	Post-education	P
Charts with ADR or NKDA not documented	4/97 (4.1%)	7/103 (6.8%)	0.60
Pages without 100% correct identification	30/152 (19.7%)	19/149 (12.8%)	0.14
Orders where any component of the prescription was either illegible or ambiguous	359/912 (39.4%)	154/1151 (13.4%)	<0.001
Orders where prescriber name is absent or illegible	349/912 (38.3%)	311/1151 (27.0%)	<0.001
Antibiotics with no indication documented	79/122 (64.8%)	50/154 (32.5%)	<0.001
Flowsheet infusions without legible prescriber name or signature	78/137 (56.9%)	23/158 (14.6%)	<0.001
Infusions not written in legible handwriting	11/137 (8.0%)	10/158 (6.3%)	0.19
Flowsheet infusions with goals or targets not written	5/71 (7.0%)	3/87 (3.4%)	0.51
Serious adverse events ascribed to medication error during the study period (reported to the ICU Advanced Incident Monitoring System)*	0	0	

ADR = adverse drug reaction. NKDA = no known drug allergy. ICU = intensive care unit. * Serious adverse events include any of: death, clinical deterioration, known adverse effects of drug, major allergic reaction, or any adverse event reported by the clinician as serious.

in addition to several 1-minute reminders. All the nursing staff received at least one educational session.

Ninety-seven charts from 54 patients were audited in the pre-education and 103 charts from 58 patients in the post-education phases. In the pre- and post-education phases, the median number of NIMC medications for each patient was 16 (range, 2–42) and 17.5 (range, 4–41), respectively; the median number of antibiotic prescriptions was two (range, 0–8) and three (range, 0–9); and, the median number of flowsheet prescriptions was two (range, 0–8) and three (range, 0–8).

The results are summarised in Table 2.

Discussion

The results of this KT project demonstrated a significant reduction in a number of prescription errors — illegible prescriptions, absent or illegible prescriber name, and not documenting antibiotic indication.

Prescription errors are a common and preventable problem.¹² Surprisingly, despite an abundance of data regarding the incidence and risk factors of prescription errors,^{5,13} we only found three previous studies specifically designed to evaluate the effect of targeted educational interventions to reduce the incidence of errors.^{7,14,15}

In a 2-year cross-sectional study in a tertiary paediatric hospital, Otero and colleagues demonstrated a reduction in medication error rate from 11.4% to 7.3% using a three-phase pre- and post-interventional model.¹⁵ Although the intervention involved an “educational program” to bring about a “cultural change”, the KT model was not used. Also, details of the consultative steps and the education protocols were not mentioned. In a department with 13 000 admissions over the 2-year period, prescription charts from only 187 patients were analysed, with no reasons given for the significant discrepancy.

A three-phase study (pilot, pre-intervention and post-intervention phases) by Campino and colleagues was truncated before the intervention phase, due to a significant reduction in the error rate after the pilot phase.¹⁴ The authors attributed this surprising finding to the Hawthorne effect.

To prevent this effect in our study, we deliberately delayed the onset of our baseline audit until a few months after the protocols had been discussed and finalised; this coincided with the beginning of a new JMO term. For the same reason, clinical staff prescribing medications were kept unaware of the schedule of the pre-education and post-education audits. Specifically, staff were unaware when the education phase ended and the post-education data collection audit began.

The only other intervention-based study was by Coombes and colleagues, and demonstrated a reduction in prescrip-

tion error rate.⁷ The intervention in their study was the introduction of a new standardised medication chart, subsequently adopted across Australia as the NIMC. The introduction of the NIMC was a significant landmark step in streamlining prescription practice in Australia. However, as seen in other areas of public health policy designed to alter human behaviour, such as reducing alcohol consumption,^{16,17} the mandatory NIMC standards are a necessary first step towards achieving the solution, but not the complete solution. An audit in Western Australia showed that the average compliance with the NIMC guidelines was only 56%.¹⁸ Despite the NIMC being in use for more than a year before we started our project, we identified several prescription errors due to lack of compliance with the established NIMC standards (ie, a problem with behaviour rather than awareness). This warranted a strategy to alter human behaviour, which is best achieved by motivating the stakeholders to embrace the change rather than ordering them to change.^{19,20} Hence, we used an education-based intervention founded on the principles of KT to bring about a change in prescription practice.

In our study, there was a significant reduction in the rates of several common errors in the post-education phase. Particularly noteworthy was the documentation of antibiotic indication, which was an uncommon practice for JMOs before the start of this project. The significant improvement in this parameter reflected the success of educating and coopting the stakeholders to change their practice.

There were non-significant trends towards improvement in flowsheet order legibility and flowsheet infusion targets. The baseline incidence of illegible flowsheet infusion orders was low, possibly because only a handful of medications are prescribed on the flowsheet. Presumably, data collectors and nurses found such orders familiar and therefore, “legible”. The baseline error rate of not documenting flowsheet targets was low, as these are checked daily by senior medical staff as part of the ward round.

In relation to the substantial improvement in prescription practice, the time required for education was surprisingly short. The education sessions only required 5–10 minutes per day. This is a reflection of the success of the KT approach in coopting clinicians into becoming partners in the initiative, instead of imposing solutions. Indeed, we are likely to incorporate the KT approach to other similar areas requiring alteration of human behaviour, especially quality assurance projects.

Limitations

An obvious limitation is the lack of randomisation and blinding, raising the possibility of researcher bias. Although we tried to minimise this as much as possible by separating

the personnel involved in protocol development and education, and data collection, these measures cannot be expected to replace the rigour of a randomised controlled trial.

As the data-collecting personnel were not aware of correct medication dosages and/or routes of administration, errors due to wrong medication and/or wrong dosage were not part of the data collection or outcome measures. However, the study was neither designed nor powered to evaluate changes in patient outcomes from medication errors, but was designed mainly to study the effect of a collaborative educational program in influencing clinician behaviour. In this specific objective, we believe that the outcome measures used in this project have sufficient methodological rigour.

Similarly, due to the logistics of time management of data collection personnel, we did not assess the influence of other factors in the process such as day versus night shifts, senior versus junior doctors' prescriptions, or communication between the doctor and the nurse.

Finally, the relevance of our single-centre study in ICUs with computerised prescription systems is questionable, but the principles of education remain the same.

Conclusions

This study demonstrates that it is possible to improve prescription practice in the ICU by implementing simple, sustainable and time-effective interventions based on the KT model. Coopting stakeholders as partners for improvement may result in more enduring benefits, and could potentially be used in other quality improvement areas.

Competing interests

None declared.

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