

Student and doctors' handwriting and transcription skills: how great is the potential for medical error?

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Illegible handwriting and prescription errors within healthcare settings have consistently been shown to affect patient wellbeing. The aim of this study was to analyse the handwriting and transcription skills in cohorts of undergraduate students and doctors or varying levels of experience, and assess the impact of these skills as a potential for prescription errors. Students and doctors were asked to copy and complete a pre-prepared prescription including five medications onto a standard hospital prescription chart. Every participant's handwriting was graded using a standard score, cross-checked by two researchers and a further three independent assessors.

166 prescriptions were completed by 137 students and 29 doctors, of which 15 had some prior handwriting training. Handwriting quality was of 'print quality' in 25% of the participants, legible in 50% and poorly legible in 25%. Transcription and prescription errors were made by 92% of all participants, with a mean and median of 2 errors per participant. 111 errors made in the writing of patient's name, identification, age, height, weight and allergies. 422 errors were identified in the prescriptions of the 5 given medications, including the omission of drug details (53%), incorrect dosage (49%) and incorrect instructions for administration (47%). Although some of these errors were relatively minor, all could have resulted in serious consequences if extrapolated to real patients.

78% of participants admitted to being concerned with poor handwriting and would take appropriate action, 22% reported that they would choose to ignore illegible texts. Undoubtedly, the causes of prescription errors are multifactorial secondary to a combination of individual and organisational factors and there are no standardised methods to ensure error-free prescriptions. A concerted effort to address this problem at undergraduate level, and ongoing emphasis during and after medical training is essential if medical errors and subsequent patient morbidity and medico-legal costs are to be averted.

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Illegible handwriting and prescription errors within healthcare settings have consistently been shown to affect patient wellbeing. Mistakes may cause delayed treatment, unnecessary tests and inappropriate/incorrect prescriptions and doses, which can all ultimately lead to decreased quality of patient care causing significant morbidity and mortality.¹⁻² This issue has also been demonstrated to have adverse medico-legal implications, as well as affecting the efficiency of those working in healthcare, leading to frustration and wasted time.³

The Institute of Medicine in the United States (IoM) reported that medical errors cause approximately 44,000-98,000 preventable deaths annually, of which, 7,000 deaths are attributable to illegible handwriting alone.² Indeed, doctors are known to have poor handwriting, possibly due to their time constraints and demands for multi-tasking.⁴⁻⁵ In the workplace, poor handwriting and related practices should be brought to attention without delay and remedial steps taken to implement change and prevent unnecessary patient harm in the future. Therefore, it is crucial to assess the legibility of handwriting within the medical profession at all levels from student level, at the start of doctors' careers and after some years working in the field.⁶

The aim of this study was to analyse the handwriting of, as well as identify prescription errors made by both medical students and doctors working in a large, busy National General Hospital. This is to determine any characteristics within these two populations that may influence the quality of handwriting.

Subjects

The study was conducted at Mater Dei Hospital, an 800-bedded National General Hospital and incorporating the only State-run Medical School in Malta. Students in the third year through to fifth (final) year of the medical course were recruited to take part in the study. Students were selected by contacting every third student within the class list of each of the three student cohorts. Doctors ranging from junior doctor through to consultant level were randomly selected to take part in the study. These included junior doctors in the first and second year of their foundation programme, basic and higher specialists in training, resident specialists and consultants within a number of departments, including Medicine, Surgery, Paediatrics, Psychiatry and Anaesthesia. Other doctors who delivered tutorials to the co-authors, according to a pre-set rota prepared by the Medical School of Malta, were also invited to participate. The randomly selected students and doctors were briefed and invited to participate. All were free to decline or opt out without reservation at any stage of the study.

Questionnaire

The handwriting of participants was assessed by asking participants to complete a brief questionnaire and copy a pre-set list of medications onto a routine-issue Mater Dei Hospital prescription chart. The questionnaire, summarised in Figure 1, was divided into three sections: the first requested simple participant demographic data, including age, gender, and current training/job level. The second part consisted of the handwriting task: a fictional patient admitted to hospital for treatment was presented. He required five medications that varied in the complexity of their generic name,

route of administration, dose and frequency of administration. An example of a correctly completed drug chart is shown in Figure 2. The participants were asked to transpose the five medications from the narrative provided onto the standard treatment chart, as a theoretical exercise (not on the wards) and without any time constraints. Participants were asked not to sign the drug chart to maintain anonymity.

The final part of the questionnaire requested self-reflective feedback from participants in order to gauge their own attitude toward legible handwriting. Participants were also asked what action would they take when encountering poor-to-decipher handwriting. All participants were asked whether they had had any prior training in handwriting skills, or not.

Figure 1 Summary of Questionnaire

Part 1: Basic Information

Age:	<input type="checkbox"/> ≤ 20 <input type="checkbox"/> 21-30 <input type="checkbox"/> 31-40 <input type="checkbox"/> 41-50 <input type="checkbox"/> 51-60 <input type="checkbox"/> ≥ 61	Gender: M / F
Position:	Student Year: 3, 4, 5 / FY1 / FY2 / BST / HST / SR / Consultant	
Department:	_____	

Part 2: Case Scenario

A 60-year gentleman, Mr Mario Borg, ID 079165(M), 80Kg, DOB (4.2.1963) was admitted to MS7 ward, MDH. He was allergic to penicillin and NSAIDs. He was prescribed the following medications: Paracetamol, five hundred milligrammes by mouth, as required for fever; Ipratropium bromide, five hundred microgrammes by nebulizer, six hourly; Gentamicin naught point three per cent eye drops, three times a day; Mogamulizumab one milligramme per kilogram intravenously, once a week for eight doses; Gliclazide sixty milligrammes slow release, by mouth, once daily.

Please transcribe the above information of the case into the prescription sheets on pages 3 and 4.

Part 3: Questions

Before completing this part of the questionnaire, please fill in part 3, beginning overleaf.

1. Taking what you have written in the prescription on the next page, how would you rate what you have written in terms of legibility when compared to your usual handwriting?

Much Worse	Worse	Same	Better	Much Better
1	2	3	4	5

2. How much are you bothered by illegible text in this hospital?

Very Bothered	Quite Bothered	Somewhat Bothered	Hardly	Not At All
1	2	3	4	5

3. What do you normally do when you encounter something which you could not read clearly in any hospital documentation? (Tick one or more from the following)

i.	Ask a colleague for help	
ii.	Call / speak to the person who wrote it to clarify	
iii.	Try and find more information elsewhere	
iv.	Ignore the text	
v.	Other (please specify)	

4. Have you ever had any formal training in handwriting/calligraphy? YES / NO

Figure 2 Example of correctly filled in Drug Chart

Surname BORG	Admission Date (Today's date) 12/5/17	Ward MW7	
Name MARIO	Bed Number	DOB 4/2/1963	Age 60 years
ID Number 079165M	Consultant	Height (in metres) 1.77M	Weight (in kilograms) 80kg
ALLERGIES AND IMPORTANT CLINICAL CONDITIONS ALLERGIC TO PENICILLIN AND NSAIDS			

AS REQUIRED MEDICATIONS (PRN)

Medication PARACETAMOL	Date 12/5/17
Dose 500mg	Frequency QDS/PRN
Route PO	Stopped by on
Indications WHEN FEBRILE	
Signature	Reg No

Medication IPRATROPIUM BROMIDE	Date 12/5/17
Dose 500mcg	Frequency QDS
Route NEBULISED	Stopped by on
Indications FOR 8 COSES	
Signature	Reg No

Medication GENTAMICIN EYE DROPS	Date 12/5/17
Dose 0.3% (1drop)	Frequency TDS
Route BOTH EYES	Stopped by on
Indications	
Signature	Reg No

Medication MOGAMULIZUMAB	Date 12/5/17
Dose 80mg	Frequency ONCE WEEKLY
Route IV	Stopped by on
Indications FOR 8 COSES	
Signature	Reg No

Medication GLICLAZIDE SLOW-RELEASE	Date 12/5/17
Dose 60mg	Frequency DAILY
Route PO	Stopped by on
Indications	
Signature	Reg No

Data Analysis

Each aspect of the completed treatment chart was independently scored by two authors. The drug name, its route, dose and frequency of administration, as well as the date of the prescription were assessed for legibility and whether any errors were made on the prescription. The list of errors reviewed is shown in Table 1.

A rating scale for grading the degree of legibility of the handwriting was designed. This used a Likert-score from one to five, ranging from: *Print quality (=1)*; *Clearly Legible (=2)*; *Moderately Legible (=3)*; *Barely Legible (=4)* and *Completely Illegible (=5)*. If a discrepancy was noted between the score awarded by each of the two authors, the better of the two scores was taken as the final grade.

Inter-assessor variability and any potential bias was minimised by asking independent assessors to review and grade every tenth prescription. To this end, three independent assessors who were fluent in English and acquainted with the study investigators but from outside of the field of Medicine were invited to independently score treatment charts. The scores awarded by these three independent assessors: a fourth year English student, a third year Psychology student and a newly graduated lawyer, were then compared with those awarded by the authors.

Anonymous data was collected and analysed using unpaired t test, comparisons were made between the results obtained from different grades of students and doctors. A *p* value of ≤ 0.05 was taken to represent a significant association or difference.

Table 1 List of errors analysed by medication

Drug	Error
Paracetamol	Spelling
	Dosage
	Dose Units
	Frequency
	Route
	Indication
Ipratropium Bromide	Spelling
	Dosage
	Dose Units
	Frequency
	Route
Gentamicin	Spelling
	Dosage
	Dose Units
	Frequency
	Route
Mogamulizumab	Spelling
	Dosage
	Dose Units
	Frequency
	Route
	Stop Date
Gliclazide	Spelling
	Dosage
	Dose Units
	Frequency
	Route
	Slow Release

Table 2 Data on questionnaires returned

Position	
Student Year 3	49
Student Year 4	49
Student Year 5	39
Foundation Doctor	8
Specialist Trainee	6
Senior Registrar	5
Consultant	9
Job Title Missing	1
Total	166

RESULTS

A total of 150 students and 50 doctors were invited to participate over a six-week period, from March to April 2017. A total of 200 questionnaires were distributed and 166 (83%) questionnaires were completed, 137 by medical students and 29 by doctors. 15 (9%) of the participants admitted to have had previous handwriting training. The breakdown of the results from the questionnaires collected is shown on Table 2.

Handwriting quality

There were a total of 25 (15%) instances where the grades awarded by the two authors did not match. In those cases, the lower (better) grade awarded was accepted for analysis. The third party independent assessors reviewed 17 questionnaires, and in all cases awarded the same grade as those given by the two authors.

In total, 41 participants (25%) had print-quality handwriting, 84 (50%) were clearly legible, 36 (22%) moderately legible, five (3%) barely legible and none were completely illegible. Figures 3 and 4 show the breakdown of the handwriting grades between the different training levels with no statistical difference noted between the student and doctor groups ($p=0.35$).

Errors in transcribing patient information

When transcribing the patient data onto the 'Patient Information' section of the Drug Chart, participants recorded a total of 111 mistakes or omissions. 37 participants (22%) failed to complete or inputted incorrect information relating to the section on allergies. 28 (17%) recorded an incorrect age for the patient, 18 (11%) incorrect height, 9 (5%) incorrect weight, and 13 participants (8%) made mistakes in the transcription of the patient's name, surname or identification number.

Errors in prescription

The questionnaire required the participants to transcribe five drugs into a drug chart using their generic name, dose and frequency. A total of 422 prescribing errors were made by the 166 participants. 14 (8%) participants handed in a faultless drug chart, 37 (22%) committed a single error, 44 (27%) made two errors, 31 (19%) three errors, and 49 (30%) of participants made between four to nine prescription errors (Figure 5). The most common errors included: omitting the term 'slow release' for Gliclazide in 53% of cases, not calculating the correct dose of Mogamulizumab (49%), and omitting or recording the incorrect indication 'as required' (PRN) for Paracetamol (47%), as shown in Figures 6 and 7.

Figure 3 Breakdown of handwriting quality by participant grade

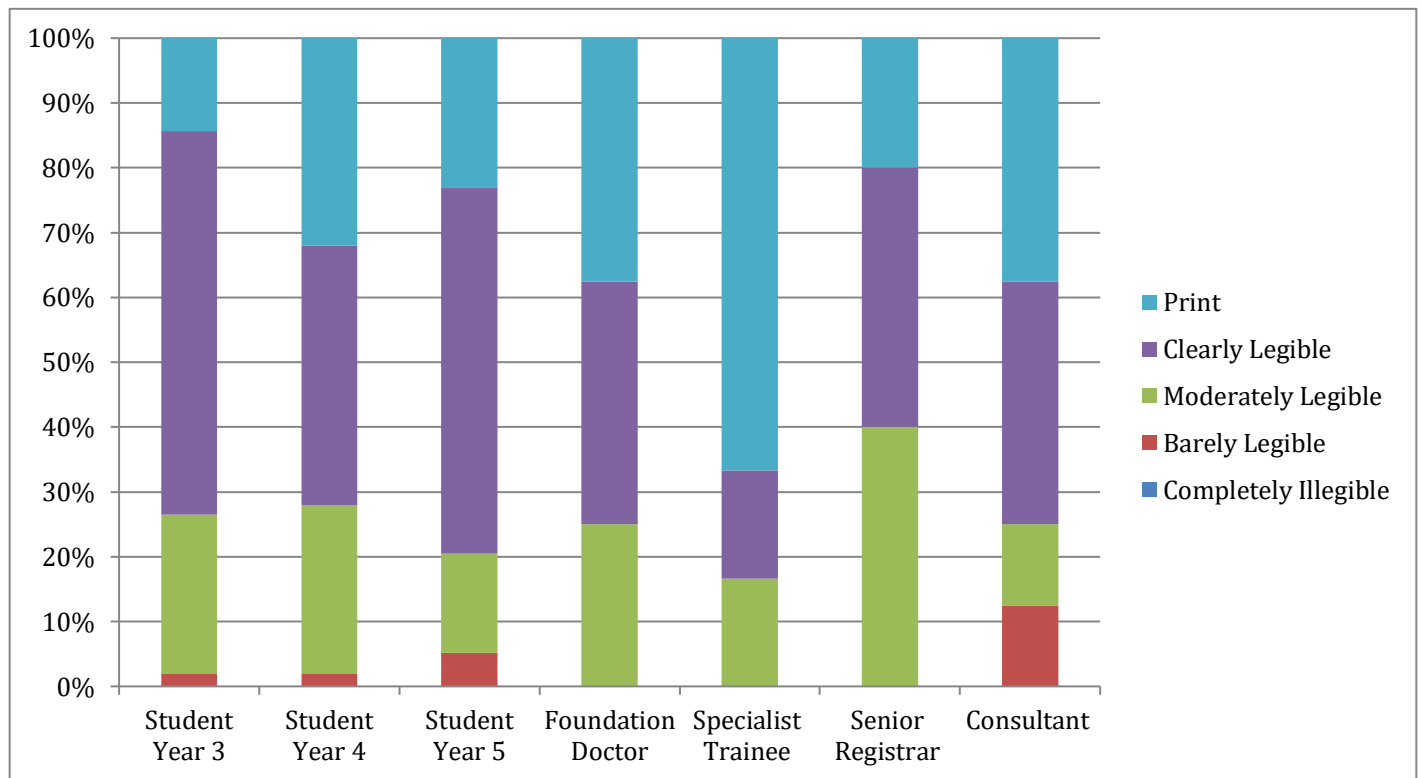


Figure 4 Comparison of handwriting between students and doctors

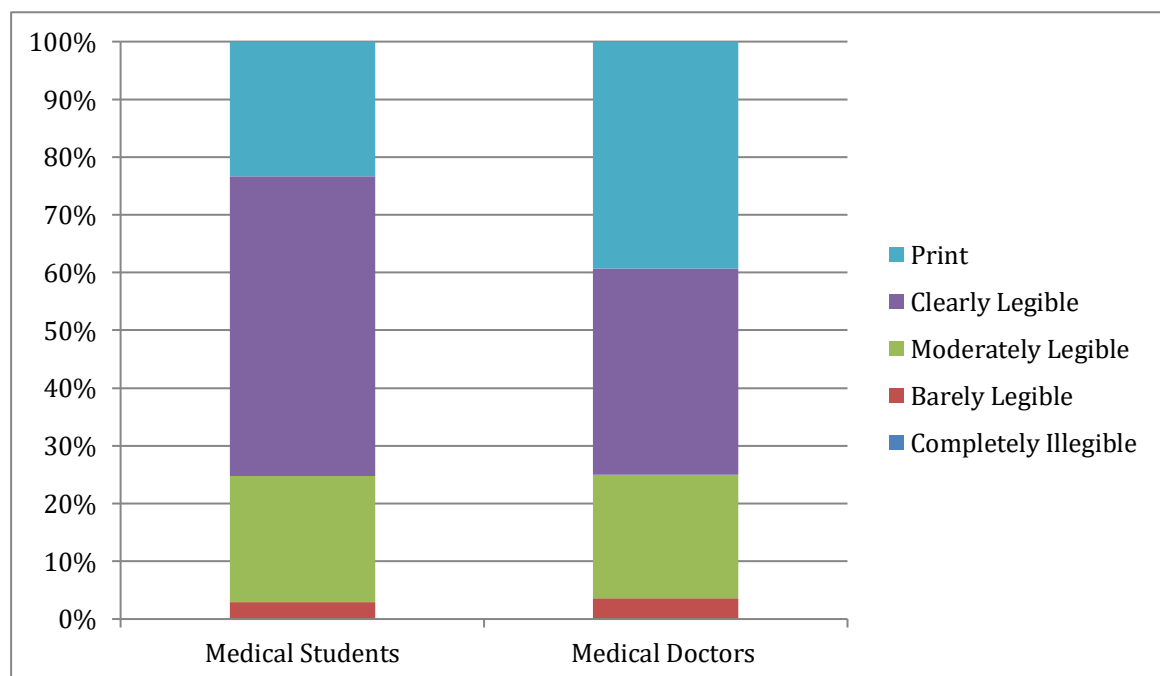


Figure 5 The number of prescription errors made per person

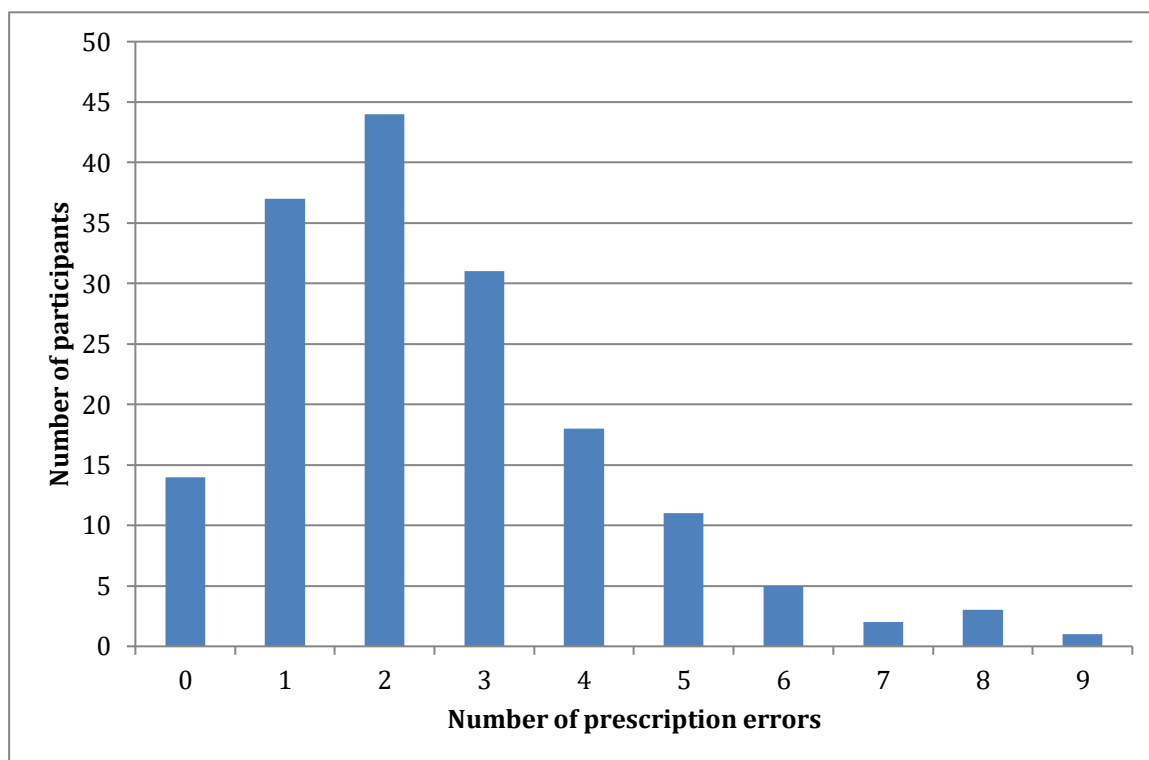


Figure 6 Breakdown of prescription errors

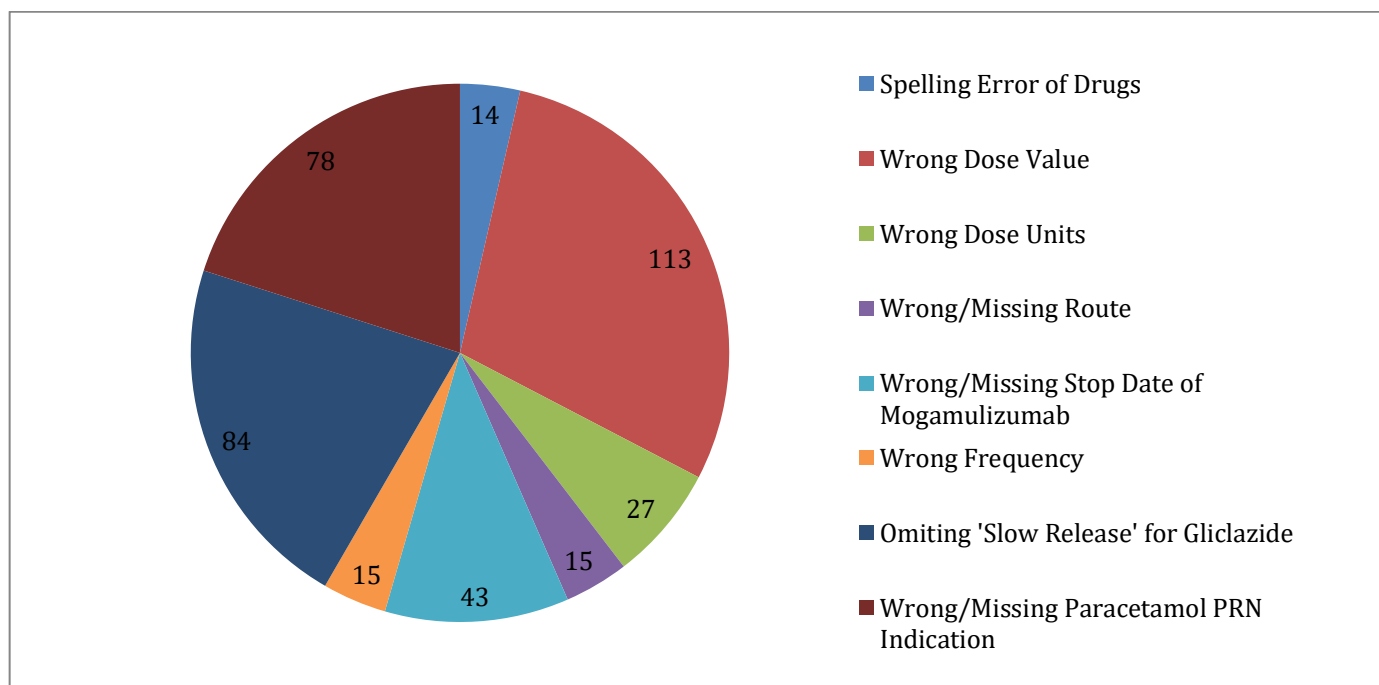


Figure 7 Prescription errors according to training grade (number per participant)

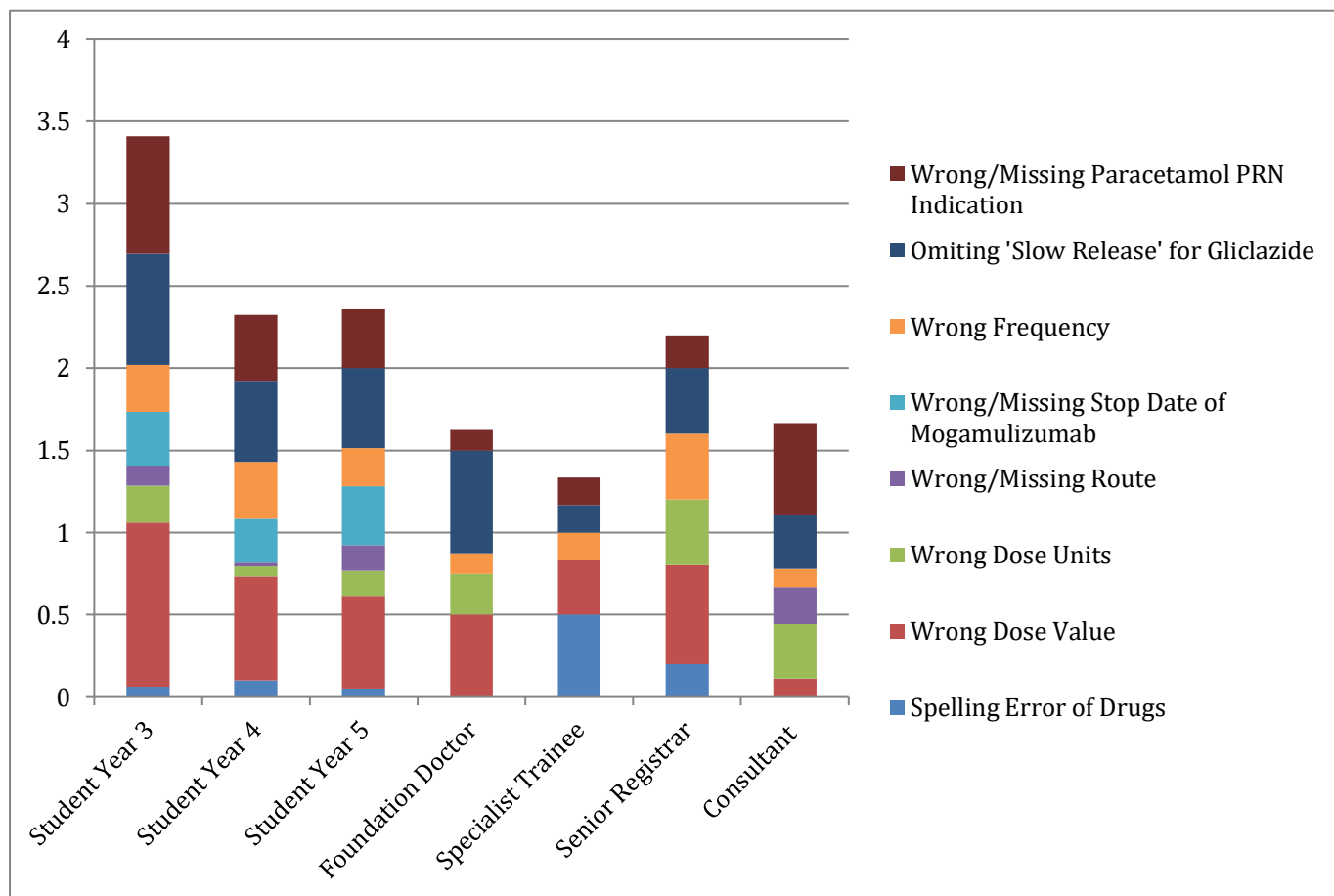
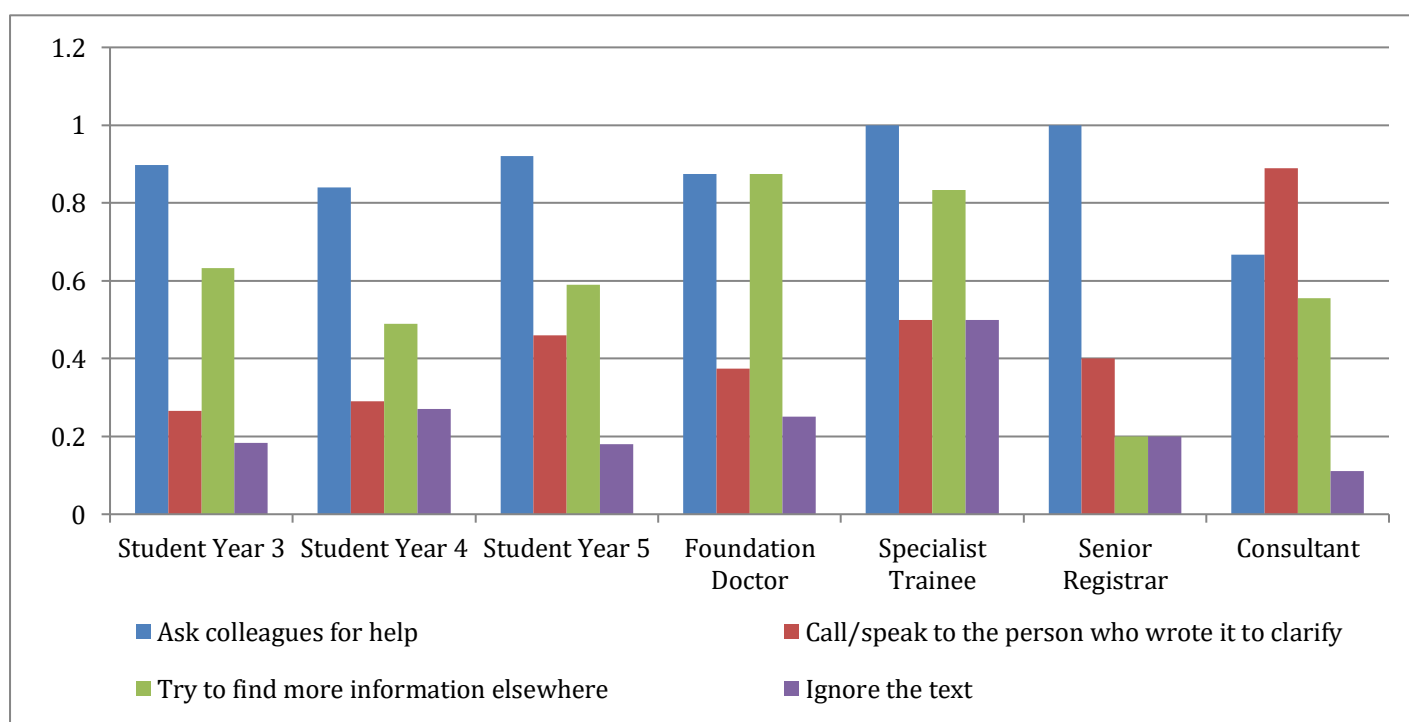


Figure 8 Result of self-directed feedback



Self-reflective feedback

65% of the participants stated that their handwriting in this exercise was similar to their usual standard of handwriting. 23% of participants perceived their handwriting as “better” or “much better” during the exercise, whereas 12% thought their handwriting was “worse than usual”. The majority of participants reported being “very” (36%) or “quite bothered” (42%) by the legibility of colleagues’ handwriting, with 6% reporting that they were “hardly bothered” or “not bothered at all”. There was no statistical difference between the responses obtained from the medical students and doctors ($p=0.93$).

On questioning, 78% admitted to being concerned with poor handwriting in the healthcare work environment. In the event that participants had difficulty reading a prescription due to poor handwriting, 146 (88%) of participants reported that they would ask colleagues for help, 96 (58%) would try to find the information elsewhere and 37 (22%) stated that they would ignore the text completely (Figure 8).

DISCUSSION

Poor handwriting is a well-recognised problem within healthcare settings despite being described as “the dinosaur that is long overdue for extinction”.⁶ It results in patient morbidity and mortality,¹⁻⁴ and leads to unnecessary health costs and medico-legal expenses.⁷ One area where poor handwriting is particularly problematic within hospital settings relates to the writing of prescriptions and medication errors, and these may result in significant lawsuits and penalties, where both doctors and pharmacists have been found guilty of serious negligence.⁸⁻¹⁰ Prescription errors occur on average 52 times per 100 admissions

and 24 times per 1,000 patient days.⁴ The financial implications of prescription errors have been difficult to evaluate, with a systematic review demonstrating the economic impact of one prescription error to range from €2.58 to €111,727.98.⁷ This study assessed the handwriting skills of medical students and doctors, as well as their own perceptions of this problem.

In order to obtain a representative overview of the problem, medical students from the three clinical years of their training and doctors of various grades were invited to participate in the study. Handwriting was assessed according to a pre-determined grading system, was cross-checked for reproducibility by two of the researchers, and further assessed by three independent assessors who were not otherwise involved in the study. In practice, a difference in the handwriting grade awarded by the two researchers occurred in just 15% of 166 questionnaires and prescriptions. The final grade was verified in all cases when graded by independent assessors who, unlike the researchers, did not have the benefit of knowing what the prescriptions read beforehand. Furthermore, participants were themselves asked to adjudicate their own handwriting and 23% admitted to having made an effort and filled in the study forms using handwriting that was superior to their norm, whereas 12% felt that they writing was worse than usual. Overall, therefore, the handwriting as presented in this study was deemed representative of that of the participants on a daily basis.

Unfortunately, recruitment of doctors was suboptimal and the resulting doctor subgroups were too small for effective statistical comparisons. Nevertheless, for all groups, handwriting quality was deemed to reach ‘moderately legible’ or ‘barely legible’ in

as many as 25% of participants. Others have reported similar results with up to 15% of medical and 37% of surgical case notes being illegible, with just 24% having 'excellent' handwriting.¹¹⁻¹² Interestingly, 15 participants (9%) admitted to having some form of prior training in handwriting and, on analysis, these scored higher grades (26% 'print quality', 53% 'clearly legible' and 20% 'moderately legible').

Overall, prescription errors were commonplace and found in an alarming 92% of all participants. Although third year students made more errors compared with fourth and final years, there was no statistical difference within student groups and doctor grades.

Only 14 participants (8%) returned a perfect questionnaire, whilst one individual made 9 errors. Indeed, this study reported an average of 2 errors per participant (Figure 5), with no difference in those who have had previous handwriting training. Simple transcription of patient details included 111 mistakes, all of which could potentially be linked to subsequent medication errors. Omissions relating to allergies included two cases documenting "No known allergies" when these were clearly stated in the patient's information given to participants that, in the real world, could prove very dangerous. Of more concern, there were 422 errors in the actual prescriptions of the five given medications, including the omission of drug details in 53% of cases, incorrect dosage in 49% and incorrect instructions for administration in 47% of prescriptions. Although some of these errors were relatively minor, all could have resulted in serious consequences if extrapolated to a real patient.

The majority of participants (78%) admitted to being concerned with poor handwriting in the healthcare work environment and the majority

would take appropriate action in an attempt to circumvent any illegible script. Nevertheless, 22% still reported that they would ignore the illegible writing, an attitude that could potentially increase the risk of medication errors.

This study was limited by a low recruitment rate particularly with doctors that negated any meaningful comparisons within this subgroup. No account was taken for level of experience although, interestingly, third year students made more errors than their colleagues in Final year. Sources of error were not limited to handwriting alone and, indeed, transcriptional and other prescribing variables also contributed to many of the errors identified. A real-life study focusing on actual drug prescriptions in the workplace would go some way to circumventing these limitations. Despite these limitations, and although this study comprised a theoretical 'paper' exercise, if extrapolated into real life, the findings would amount to a significant and worrying level of errors on every prescription chart.

Traditionally, doctors have a reputation for poor handwriting and some have argued that this is secondary to the nature and pressure of the job.^{5,13} Others have reported that doctor' handwriting is no better or worse than non-medics.¹⁴⁻¹⁵ Either way, all typographical errors carry a significant financial burden and, for example in the UK, the cost to online business from such errors has been estimated to run in the millions.¹⁶ This burden is, however, considerably greater when medical or prescription errors are concerned due to the added sequelae on health, adverse events and, in some cases, mortality. The need, therefore, to eradicate this preventable problem with all its implications, cannot be understated. A comprehensive approach to a solution is required.⁵ This may include penmanship

classes, the use of self-inking stamps to heighten prescriber' awareness and traceability,^{5,17-19} use computer generated prescribing, voice activating systems and, as this study would support, routine training for medical students.^{3,5,18,20} Some countries and states have gone one step further and have introduced legislation for good handwriting and impose fines if errors result.²¹⁻²²

CONCLUSION

The Medical Defence Union lists "Thou shalt write legibly" top of their 'things to do' list.²³ Therefore, the aim should be to achieve legible handwriting of near-print quality at all times,

but particularly when it comes to areas that are susceptible to medical errors that may result in harm to the patient with medico-legal implications. This study has shown that this ideal is clearly not being reached and, moreover, the lack of concern for illegible handwriting is worrying. Undoubtedly, the causes of prescription errors are multifactorial secondary to a combination of individual and organisational factors and there are no standardised methods to ensure error-free prescriptions. A greater emphasis on correct and safe prescribing during formative medical education and training is required, and should also address issues relating to the quality and clarity of handwriting.

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