Comparison of Dentist Preference towards Software Based Versus Handwritten Prescriptions in Pediatric Dental Patients- A Mixed Methods Study

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Prescriptions for children must be with accurate drug dosages and clear instructions. A digital tool to write, save and send prescriptions can potentially overcome the limitations of handwritten prescriptions. A preliminary mixed methods study comparing a novel ‘app-based’ and handwritten prescriptions in pediatric dental settings is reported.

Methodology: Eighteen post-graduate students from departments of pediatric dentistry of two dental schools participated in this mix-methods crossover study. An android app prototype PREASY was indigenously developed to make digital prescriptions. The handwritten and app-based prescriptions were compared in terms of time taken (seconds), precision (accuracy, legibility and clarity) and satisfaction (Likert rating). The mean time taken was compared using t-test, accuracy was compared using ANOVA and satisfaction using a Chi squared test. Qualitative feedback was obtained regarding the PREASY app.

Results: The mean time taken for handwritten prescriptions (154.28(± 54.06)seconds) was almost three times higher than that for the app based prescriptions (54.22 (± 25.66)seconds) [Student ‘t’
test P < .00001]. The mean differences for accuracy, legibility and clarity were 1.36 ± 0.66, 1.39 ± 0.44 1.11 ± 0.50, respectively and were statistically non-significant (P=.247). A majority of participants were very satisfied or satisfied (94.45%); and the remaining (5.55%), were neutral, dissatisfied or very dissatisfied, [Chi square test, P <.00001]. Qualitative analysis identified important themes that could be segregated in four domains from feedback obtained through open-ended questions and semi-structured group discussion.

**Conclusion:** App-based prescriptions were quicker and more accurate than the handwritten ones with the majority of participants satisfied. Valuable comments pertaining to limitations of the tool and improvement were identified.

**Keywords:** Dentist preference; handwritten prescription; pediatric; patients.

### 1. INTRODUCTION

A prescription is defined as “a healthcare program implemented by a physician in the form of instructions that govern the plan of care for an individual patient” [1]. Thus, a prescription is a written information or any advice provided for patients that brings into focus the diagnostic acumen and therapeutic proficiency of physician with instructions for restoration of patient’s health [2]. According to the World Health Organization (WHO), a prescription should identify the professional, the patient, the mode of administration as well as the medicines pharmaceutical form, dosage, frequency of use, duration of treatment along with patient guidance and information [1]. A well-documented prescription is not only a legal necessity but also a practice-builder for the dentist.

Prescribing medicines to children needs precision in terms of calculating drug dosages appropriately. Empirical scaling from adults to children continues to be the mainstream method for dose selection in children, with adjustment for body weight as the most commonly used approach [3].

Medication errors are common and may jeopardize patient safety. As pediatric dosages are calculated based on the child’s age and weight, risk of errors in dosage calculations is increasing. In pediatric patients, an overdose prescribed regardless of the child’s weight, age and clinical picture may lead to toxicity and even mortality, while a low dose may be ineffective in cure. Dental professionals have to be very skillful in mathematical calculation and numerical ability to calculate the proper dose and drug calculation.

Those stale jokes about a doctor’s poor penmanship are no laughing matter when it comes to writing prescriptions. Illegible handwriting can lead to misinterpretations of dosage, drug name, or abbreviations [4]. It may also lead to legal implications. An illegibility of handwritten prescription can lead to error in drug dispensing and administration.

Technology has enabled digitalization of records and the same can be used for both calculating drug dosages and creating a prescription. The education and training of prescribers and the use of online aids can inculcate the practice of sound prescription writing [5]. There are limited but positive data supporting the role of e-prescribing in mitigating medication errors, improving communication with dispensing pharmacists, and improving medication adherence. The American Academy of Pediatrics (AAP) recommends the adoption of e-prescribing systems with pediatric functionality [6]. There is evidence that computerized prescribing has improved legibility and clarity, saved time and reduced the time spent clarifying prescriptions with the dispensing pharmacist [7]. Few studies in dental literature have explored software-based prescriptions and compared them with handwritten ones. Furthermore, no standardized tools (mobile or desktop-based apps) are available to be used as standard. Therefore, we undertook a preliminary study to compare the dentist preference between software based and handwritten prescription in pediatric dental patients in a mixed method study. The following were the objectives:

- To compare the time taken for app-based and handwritten prescription
- To assess the accuracy of handwritten prescriptions
- To assess and compare the dentist satisfaction towards app-based prescriptions
- To assess the feedback of dentists to app-based prescriptions qualitatively.
2. METHODOLOGY

This pilot study was conducted amongst 18 post graduate students from the Department of Pediatric and Preventive Dentistry; 9 each from Bharati Vidyapeeth Dental College and Hospital and YMT Dental College and Hospital in Navi Mumbai. All the participants received training on prescription writing by the same trainer (AJ) with the use of a video-recording. In the first round of the study, the nine participants from YMT Dental College wrote prescriptions and the participants from BVP Dental College used the app (PREASY) following necessary instructions regarding the use of the same. After 15 days there was a crossover of interventions in the two groups (Fig. 1).

Development of the app: The prototype of the app used in the study was developed and named as PREASY (writing PRESCRIPTIONS made EASY). The app uses android platform as it is the most commonly used one in India. The app requires a Google login and registration number of the practitioner (first screen). The next screen mentions a disclaimer and asks the user to accept terms and conditions. The third screen allows entering the patient details (patient name, age, gender and weight) after which the subsequent screen appears for the selection of medicines (formulations). The prototype offers a choice of three antibiotics and two analgesics to choose from. On ticking the boxes of drugs as per the choice of the dentist, a text message is available on the next screen to view, edit and share as the prescription. The app had default sets for calculating drug dosages, selecting the formulation (syrup, tablet or capsule) and instructions pertaining to how the medicines could be used. A practitioner could add/change any drug or instruction if he/she desires so. The app format and its content were approved and validated by three pediatric dentists (authors of the study) and two other dentists. The app prototype including the name (PREASY) and the design is copyright-protected.

The clinical scenarios required for writing a prescription were made and put as chits in a bowl and postgraduate students were told to pick one and either write a prescription or make an app-based prescription depending on the study group they belonged to. The time taken to write or make an app-based prescription was noted in seconds. The handwritten prescriptions were assessed by two examiners independently for accuracy under the three domains of drug dosage, legible hand writing and completeness of description of each drug. The satisfaction of the participants was assessed on a 5-point Likert scale with categories: ‘very satisfied’, ‘satisfied’, ‘neutral’, ‘dissatisfied’ and ‘very dissatisfied’.

A study tool comprising of the study variables (Table 1) was generated as a Google form that was filled by all 18 post graduate students who participated in the study. The descriptive data was exported to Microsoft Office Excel in a spreadsheet, checked for discrepancies and processed for inferential statistics.

The study also included a qualitative component. A few open-ended questions were included in the feedback form (Google form) and a group discussion followed the study with semi-structured questions led by a moderator (primary investigator). The comments from the participants were audio-recorded and transcribed for themes to be identified.

2.1 Statistical Analysis

Data analysis was done using MedCalc (online) software. The data were assessed for normality using the Kolmogorov-Smirnov test and found to be normally distributed; hence parametric tests of significance were used. Intergroup comparison for the time taken was assessed using the t-test. Accuracy between the two groups across the three domains was assessed using ANOVA and the satisfaction categories were compared using the Chi squared test. The null hypothesis was stated as a statement of no difference between the app-based and hand written prescriptions on the parameters of time taken, accuracy and participant satisfaction. All tests were performed using two-sided tests with alpha 0.05.

3. RESULTS

The stages of the study are depicted in Fig. 1.

The characteristics of the study population are shown in Table 2. The mean age of the postgraduate students was 26 (+ 1.35) years; 77.8% of whom were females and 22.2% were males. On an average, number of patients (less than 18 year-olds) seen per day was 3 (mode 3, mean 3.5 ± 1.79).

The mean time taken for handwritten prescriptions versus app-based prescriptions was compared using independent samples ‘t’ test. Mean time taken to write a prescription in seconds [Group 1 Mean-154.28 (- 54.06)] and
was almost three times higher than that for the app based prescription [Group 2 mean 54.22 (+ 25.66)]; this difference being statistically significant (P< .00001). Please refer Table 3. The comparison of accuracy of handwritten prescription versus app-based prescriptions was made in three domains: dosage accuracy, legible handwriting and completeness of description for each drug. One way ANOVA with Tukey test was performed to compare within group and pairwise values. However, the differences in the means of three domains (Domain 1 Mean 1.36 SD ± 0.66, Domain 2 Mean 1.39 SD ± 0.44 and Domain 3 Mean 1.11 SD ± 0.50) were not statistically significant (p=.247). Please refer Table 4.

The responses of participants w. r. t. the satisfaction while using the app for writing prescriptions were recorded on a categorical scale. Amongst eighteen participants, twelve (66.7%) participants were very satisfied and five (27.8%) were satisfied. Only one participant (5.6%) gave a neutral response (Fig. 2). No participants were dissatisfied or very dissatisfied. Comparison was made after clubbing very satisfied and satisfied (94.45%); and the remaining three categories (neutral, dissatisfied and very dissatisfied, 5.55%), using the Chi square statistic. The difference was statistically significant (P<.00001*). Please refer Table 5.

Table 6 summarizes the qualitative feedback. A thematic analysis was attempted to identify important themes that could be segregated in four domains.

### Table 1. Variables in the study

| Variable of interest               | How they were measured                                      | Type of variable                      |
|------------------------------------|--------------------------------------------------------------|---------------------------------------|
| **Demographic**                    |                                                              |                                       |
| Age                                | Completed in years                                           | Quantitative discrete                 |
| Gender                             | Male / Female                                                | Categorical (dichotomous)             |
| Designation                        | Post graduate student                                        | Categorical                           |
| Number of patients (less than 18-year-old) seen per day |                                                              | Quantitative discrete                 |
| **Outcome Variable**               |                                                              |                                       |
| Time taken to write a prescription | In seconds                                                   | Quantitative continuous               |
| or make an app-based prescription  |                                                              |                                       |
| Accuracy of handwritten prescription| Three domains: accuracy of drug dosage, legible hand writing and completeness of description for each drug. | Quantitative continuous               |
| Dentist preference                 | Dentist preference was measured on a 5-point Likert scale    | Categorical                           |
| Feedback                           | Preference and feedback was assessed in an open-ended manner. | Qualitative                            |

### Table 2. Characteristics of study population N = 18

| Variable                        | Description                        |
|---------------------------------|------------------------------------|
| Age                             | Mean: 26.05 years, Standard Deviation: ± 1.349 |
| Gender (Male-4, Female-14)      | Male-22.2%, Female- 77.8%           |
| Number of patients seen per day | Mode:3, Mean: 3.5, Standard Deviation: ± 1.79 |
| Designation                     | Post-graduate students             |
Table 3. Comparison of time taken (in seconds) for handwritten prescriptions versus app-based prescriptions

| Group 1- Handwritten | Group 2- App-based | t value | P value |
|----------------------|--------------------|---------|---------|
| 178                  | 98                 | 7.09411 | < .0001* |
| 168                  | 51                 |         |         |
| 168                  | 36                 |         |         |
| 253                  | 66                 |         |         |
| 140                  | 37                 |         |         |
| 234                  | 62                 |         |         |
| 183                  | 50                 |         |         |
| 154                  | 46                 |         |         |
| 220                  | 71                 |         |         |
| 180                  | 60                 |         |         |
| 120                  | 90                 |         |         |
| 150                  | 80                 |         |         |
| 50                   | 20                 |         |         |
| 101                  | 32                 |         |         |
| 120                  | 30                 |         |         |
| 69                   | 31                 |         |         |
| 171                  | 44                 |         |         |
| 148                  | 42                 |         |         |
| Mean 154.28 SD + 54.05858 | Mean 54.22 SD + 25.65737 |         |         |

N=18, * Significant

Table 4. Accuracy score for handwritten prescriptions

| Domain 1: Dosage accuracy | Domain 2: Legible handwriting | Domain 3: Completeness of description of each drug | F-ratio | P-value |
|---------------------------|-------------------------------|-----------------------------------------------|---------|---------|
| 2                         | 1                             | 1                                             | 1.4364 | .247*   |
| 0                         | 1                             | 1                                             |         |         |
| 0.5                       | 1                             | 1.5                                           |         |         |
| 1                         | 1                             | 1                                             |         |         |
| 1.5                       | 1                             | 0.5                                           |         |         |
| 1                         | 1                             | 1                                             |         |         |
| 1.5                       | 1                             | 1                                             |         |         |
| 1.5                       | 1                             | 0.5                                           |         |         |
| 0                         | 1                             | 0                                             |         |         |
| 2                         | 1.5                           | 2                                             |         |         |
| 2                         | 2                             | 1.5                                           |         |         |
| 1.5                       | 2                             | 1                                             |         |         |
| 1                         | 2                             | 1                                             |         |         |
| 2                         | 1.5                           | 2                                             |         |         |
| 1.5                       | 1.5                           | 1                                             |         |         |
| 1.5                       | 2                             | 1.5                                           |         |         |
| 2                         | 1.5                           | 1.5                                           |         |         |
| 2                         | 2                             | 1                                             |         |         |
| Mean 1.36 SD +0.66        | Mean 1.39 SD +0.44            | Mean 1.11 SD + 0.50                          |         |         |

N=18, * Not Significant

4. DISCUSSION

Mobile Health (mHealth) is a mobile technology that supports mobile health care. With mHealth it has become easier for a user to access web-based applications and websites [8]. Arogya Setu and CoWIN apps are examples of mHealth in India during the COVID-19 pandemic which struck the globe in 2019. The rapid development of applications software (often abbreviated as
"apps") on both major mobile operating systems (Android and iOS) has made mobile medical apps popular, with multipurpose functions including retrieving drug prescribing information and clinical calculators [8]. Teleconsultation has become a norm in COVID-19 pandemic and facilitating health workers with tools for the same need not be over emphasized.

Accurate and effective prescriptions are paramount to clinical efficacy and patient safety, especially in the pediatric age group where the margin of safety may be narrow owing to the physiologic differences between children and adults. Though the American Academy of Pediatrics (AAP) has recommended e-prescriptions [6]; there is a paucity of such tools in the pediatric dental settings, hence this study on a novel mobile based prescription app.

A crossover randomized study design with a washout period of 15 days was chosen for the assessment of quantitative variables. Post graduate (PG) students were included as participants. PG students are authorised to write prescriptions independently as they are registered as dental surgeons with the Dental Council of India (DCI) [9]. The non-probabilistic sampling is considered appropriate for qualitative or mixed methods study. Furthermore, this being a pilot study, sample size was not precisely estimated and N=18 was considered adequate for statistical analysis. This pilot study was conducted and reported in accordance with the GRAMMS (Good Reporting of A Mixed Methods Study) guidelines for mixed methods studies [10]. A mixed method study design is important for subjective as well as objective parameters such as satisfaction, positive and negative criticism, etc.

In our study, the time taken for the app-based prescription was one-third the time taken for handwritten prescription. The formats for the personal details, the name of the drugs and the instructions of use are already included in the app logarithm which could account for the lesser time. In addition, the participants were PG students who were comfortable with the electronic interface of communication which

| Response category | No. of responses | Percentage | Dichotomous % | Chi square statistic | P Value |
|-------------------|-----------------|------------|---------------|---------------------|---------|
| Very satisfied    | 12              | 66.7       | 94.45         | 28.444              | P<.00001* |
| Satisfied         | 5               | 27.8       |               |                     |         |
| Neutral           | 1               | 5.6        | 5.55          |                     |         |
| Dissatisfied      | 0               | 0          |               |                     |         |
| Very dissatisfied | 0               | 0          |               |                     |         |

N=18, *Significant

| THEME                          | FEEDBACK                                                                 |
|--------------------------------|--------------------------------------------------------------------------|
| Positive remarks               | 1. Time saving                                                           |
|                                | 2. Hassle-free                                                           |
|                                | 3. User-friendly in terms of screen                                      |
| Technical suggestions          | 1. Availability on iOS platform                                         |
|                                | 2. Default layout of prescription after registering in App              |
|                                | 3. Availability of two to three layouts of prescription for doctors to decide |
|                                | 4. Incorporation of digital signature of dentist                         |
|                                | 5. Saving a file for a particular patient as data for future appointments |
|                                | 6. Certain set of instructions could be set as a format                  |
|                                | 7. PDF format could be preferable than the text message                   |
|                                | 8. Multiple language options can be given                                 |
| Dosage suggestions             | 1. "Weight was 38 kilograms but selected option of drug was in syrup form"|
|                                | 2. Pictorial representation of drug dosage quantity                      |
|                                | 3. More drugs can be included                                           |
| Criticism                      | 1. Keyboard does not appear automatically                               |
|                                | 2. Weight as compared to age is more but tablets not palatable by patients, |
|                                | so auto-generated tablet form prescriptions could be questionable         |
could also have accounted for this vast difference. Lastly, the calculation of drug dosage based on the weight requires a mathematical calculation, which most dentists (students of biology) may find cumbersome and tedious.

The accuracy of hand written prescriptions was marginally less accurate despite standardization; the difference in the three domains (drug dosage, legible hand writing and completeness of description of each drug) being non-significant.

The satisfaction level of the app in the participants was checked both quantitatively and qualitatively. Interestingly the dental post graduate students were satisfied with the app; only one participant being neutral in rating the satisfaction. The qualitative data suggested that the app-based prescription was time saving, user friendly and hassle free. Multiple suggestions were received on improving the formats, choice of drugs and modes of storage. This indicates that the app was well accepted by the participants who looked forward to its usage with certain additional features incorporated. The app being tested for the first time is likely to have deficiencies that may have been overlooked by the designers, but that can be incorporated without grossly altering the basic concept of the app. Based on the results, this study failed to accept the null hypothesis.

The app-based prescription is a novel tool hence this study was a pilot trial on a small sample of dental surgeons. The study was conducted on PG students who work under the supervision of guides, this may have an influence on the critical feedback of the app. An anonymous system of feedback was chosen to overcome this limitation. The effectiveness of the app in clinical practice and impact on patients was not assessed in this pilot study.

We could not find supporting literature for this study as app-based prescriptions have not been studied earlier. There are certain important limitations of this study, one being a pilot study, this study is based on a small and convenient sample. Hence the results of this study have limited generalizability. The other limitation is that
the current app includes drugs that are commonly used and the clinical scenarios required the use of only those drugs. A more comprehensive app may include a variety of formulations for much diverse clinical scenarios like infective endocarditis (IE) prophylaxis and possible allergies to certain drugs. The mean age of the participants was 26 years, indicative of a generation that is adept at using the digital platforms. Older practitioners may not be as quick and adept with mobile app based tools, this being one of the limitations of the study.

Despite such limitations; this being the first and only study of its kind, it lays a foundation for future research on this topic.

5. CONCLUSION

Overall, the app-based prescriptions required much lesser time to make and the levels of satisfaction were higher as compared to handwritten prescriptions.

Following specific conclusions can be drawn w.r.t. our study objectives.

- The time taken for making app-based prescriptions was almost one-third the time taken to write a prescription. This was statistically significant ($P< .0001$)
- The handwritten prescriptions were marginally less accurate. However, the difference amongst the three domains (drug dosage, legible hand writing and completeness of description of each drug) of accuracy was not statistically significant ($P= 0.247$).
- About 95% of the post graduate students were either satisfied or very satisfied with only 5% being neutral with respect to the satisfaction while using the app for making prescriptions. The difference was statistically significant ($P<.00001$).
- Qualitative feedback of the participants revealed themes such as positive remarks, criticism, technical suggestions and dosage suggestions.

Based on the results of this pilot study, we would be undertaking a more comprehensive study with a bigger sample size of dentists from diverse settings. Based on the feedback, amendments in the app for improving its quality and functionality would be suggested.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

This mixed methods study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of Bharati Vidyapeeth (deemed to be University)
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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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