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The effect of registry-based performance feedback via short text messages and traditional postal letters on prescribing parenteral steroids by general practitioners—A randomized controlled trial

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ABSTRACT

Background: It is conjectured that providing feedback on physicians' prescribing behavior improves quality of drug prescriptions. However, the effectiveness of feedback provision and mode of feedback delivery is not well understood. The objective of this study was to assess and compare the effect of traditional paper letters (TPL) and short text message (STM) feedback on general practitioners' prescribing behavior of parenteral steroids (PSs).

Methods: In a single-blind randomized controlled trial, 906 general practitioners (GPs) having at least 10 monthly prescriptions were randomly recruited into two interventions and one control study arms with 1:1 allocation, stratified by percentage of prescriptions. The intervention was the provision of 3 feedback messages containing prescribing indices in TPL and STM (in the first two arms) versus the control arm (CG) with an interval of 3 months between these messages. We calculated the PS Defined Daily Dose (DDD) for every GP, every month, and compared between the 3 arms, before and after the interventions. The expected primary outcome was to reduce prescription of parenteral steroids by participants. The study was performed in the Kerman Social Security Organization in Iran.

Results: A total of 906 GPs were selected for the trial, but only 721 of them (TPL = 191, STM = 228, CG = 302) were recruited for the 1st feedback. The mean age of GPs was 44 and 59% of them were male. The prescribed parenteral steroid DDDs at baseline were similar (TPL = 121.62, STM = 127.49, CG = 115.68, $P > 0.5$). At the end of the study, DDDs in the TPL and STM arms were similar (TPL = 104.38, STM = 101.90, $P > 0.9$) but DDDs in each intervention arm was statistically significantly lower than in CG (CG = 156.17, $P < 0.0001$). Being in TPL and STM arms resulted in 36.1 and 41.7 units of decrease in DDD respectively, compared to the control arm ($P < 0.02$ and $P < 0.005$) after the one-year duration of the study.

Conclusion: Feedback by TPLs and STMs on prescribing performance effectively reduced prescribing PSs by GPs. STM, being a cheap and fast tool, is potentially powerful and efficient for drug prescription rationalization.

1. Introduction

Rational use of drugs is an important topic in medicine. Physicians' prescribing is one of the most frequent medical interventions affecting care outcomes and costs [1–3]. Several studies have focused on physicians' prescribing behavior. Audit and feedback have the potential to improve prescribing behavior but studies showed they have little to moderate effect on improving professional practice [3–7]. According to a Cochrane Review, audit and feedback are defined as providing a summary of the clinical performance of healthcare provider(s) over a specified period of time [6]. Yet, evidence about the feedback effect is inconclusive due to contradictory results [8–11]. In addition, absolute effects of audit and feedback are likely to be larger when baseline adherence to

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recommended practice is low and intensity of audit and feedback is high [4,8].

Several reports in Iran have shown inappropriate prescribing and usage of corticosteroid drugs in the last decade. Corticosteroid prescribing was reported to have an incidence ranging between ten to fifty percent according to publications from different regions of Iran [5,12,13]. It increased nationwide from 12.7% in 1998 to 23% in 2007 [14], based on about 100 million prescriptions [14]. Among steroids, Dexamethasone Phosphate Ampule (8 mg/2 ml) was prescribed in roughly 12% of about 85 million prescriptions in Iranian patients. It has also been placed in the top ten prescribed drugs of any type in Iran over recent years. When not adequately monitored, usage of these drugs may lead to unsafe side effects. Both governmental and other health care organizations are putting much effort in improving the quality of prescriptions.

To ensure the appropriateness of prescription drug use, third party payers widely use retrospective drug utilization reviews [9]. Kerman is the largest province in Iran with around three million people living in its cities and villages. About half of these are covered by insurance via the Kerman Social Security Organization (SSO). More than 1800 general practitioners practice in the province and work together with the SSO. The SSO has a special office called Medical Documents Audit Office (MDAO). In MDAO, the Research and Scientific Council (RSC), run by official staff members, specialists and honorary members, focuses on checking the validity and correctness of diverse medical documents from all medical sections, e.g., medical labs, pharmacies, hospitals, private offices, governmental and private clinics. The main aim of MDAO and RSC is minimizing and preventing prescription drug violations and errors in medical documenting procedures.

MDAO members monitor the practice of physicians continuously. Important data about any individual prescription is recorded in a web based application when dispensed in pharmacy and all data are collected instantly into the comprehensive registry of SSO. In MDAO, the RSC members have weekly meetings for assessing the prescriptions based on reports extracted from the prescription registry. Based on these reports, the RSC director provides feedback letters about many prescribing indices. These letters may include comparison to other providers and advice or appreciation to the recipient. However, the number of weekly letters did not exceed 20, and there was no effort to evaluate their effect. The MDAO hypothesized that systematically sending feedback letters or face to face visits by inviting physicians to MDAO or even going to their offices are effective measures to change physicians' behavior. They hence sought to scientifically evaluate this hypothesis.

In this study we conducted a randomized controlled trial (RCT) aimed to assess whether registry based feedback to general practitioners (GPs) about their professional practice may affect their prescribing of parenteral steroids (PSs). We considered two types of feedback to improve prescribing behavior for PSs: by traditional postal letters (TPLs) and by short text messages (STMs). Also we compared the efficiency of STMs and TPLs. We hypothesized that STM could be a simple, rapid and effective way for providing actionable feedback in the form of quantitative and qualitative indices to the physicians, while respecting privacy and having low cost. The rationale is that these actions would improve their prescribing quality and hence also healthcare outcome.

2. Methods and materials

2.1. Overview and study timeline

In this randomized controlled trial, we evaluate the effect of providing performance feedback by traditional postal letters (TPLs) or mobile short text messages (STMs) compared to the control group (CG) with the normal feedback as usual on physicians' behavior in prescribing PSs. The study timeline is shown in Fig. 1a.

2.2. Recruitment of participants

There were 1886 GPs practicing in Kerman province at the recruitment phase of the study. In order to find an assumed improvement of at least 10% absolute decrease after the intervention, the calculated sample size was 150 for each group, but due to foreseen limitations like inaccessibility to mobile numbers and correct postal addresses we doubled this number. The target population was those having 10 or more prescriptions for patients with SSO insurance coverage of their total prescriptions during the last month before the first feedback. Based on the percentage of the monthly prescriptions of PSs, they were stratified into four stratums and then 906 of them (based on calculated sample size) were randomly selected and assigned to three equally sized study arms, TPL, STM and CG. To be divisible by 3, we added 6 cases to those four strata and finally had 302 in each study arm (See Fig. 1b).

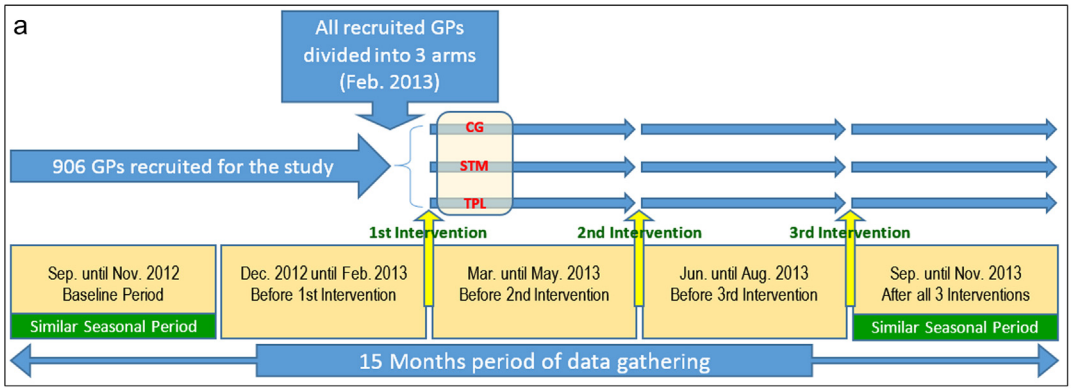
2.3. Letter and STM templates

In MDAO, to communicate with the physicians, there was already a routine procedure of sending feedback letters once or twice a year about the prescribing indices like ratio of antibiotics, parenteral drugs, and systemic steroids. In the current study, we revised the template of routine letters for the TPL arm and added STMs as the second arm, to provide feedback specifically for prescribing parenteral steroids, and intensified the provision of feedback. First, we identified all of the items to be included in the letters/STMs. These items were: each physician's first and last name, physician's Medical Council Number (MCN), the place of practicing, the number of written prescriptions in predefined periods, the number of prescriptions with at least one PS, percentage of PS among all monthly prescriptions, and name and count of the top two prescribed PSs among all prescriptions. In the next step, we categorized the feedback into four different levels as proxy to quantify the quality of prescription behavior based on the ratio of PS prescribing indices from organizational protocols (not further reported in this paper).

All the TPLs and STMs were individualized for each participant according to the above items using the mail merge tool available in Microsoft Word® and Microsoft Excel® 2013. A message's length ranged from 80 to 120 words (average 110). Finally, all messages were double-checked by the first two authors, once in the MS-Excel® 2013 file and then in the MS-Word® template to prevent errors or missing phrases or unstructured text. All letters were posted by registered mail, and STMs were sent by the official short message server of MDAO.

2.4. Merging the required data

There were several tasks required for pre-processing the raw data files from the registry to prepare them for analysis. First, we extracted files in MS-Excel® format (file extension = .xls) as built-in reports of the "Tamin Comprehensive Medical Documentation System" (TCMDS). TCMDS is the integrated system in SSO to collect and retrieve the prescription data in the province. We had one .xls file for each PS in each month containing the data of monthly prescriptions. For each intervention, we extracted data of the three previous months to prepare the feedback messages. After the third intervention, we waited for another five months to be able to extract the last required data. Finally, 165 .xls files, containing individual records of more than 12 million recorded prescriptions, were all merged



b

Note:

- ***Sent:*** Letters that were sent to postal addresses.
- ***Reverted***: Due to incomplete or incorrect address, some letters reverted in two weeks after postal date.
- ***Not Sent***: Due to missing address, some of letters were not sent at all.
- ***Completed***: Sent letters that did not revert by completion of the study.

- ***Delivered***: STMs that were successfully sent via the SMS server and the delivery report got back
- ***Not Sent***: Due to unknown mobile number or no prescription, some of STMs were not sent at all.
- ***Resent***: STMs that had no successful delivery report but were successfully sent again.

Performed procedures during the study to complete the trial:

1-Getting official approval and registering the protocol in IRCT
2-Arrangement with SSO directors to have a working place
3-Preparing basic data files from TCMDS (physician's list, mobile numbers, postal addresses, randomization of samples, etc.)
4-Preparing the templates for letters and setting up the SMS-Server
5-Sending feedbacks for the 1st, 2nd, and 3rd intervention
6-Extracting final data files, merging the files, calculating DDDs.
7-Statistical analysis

All GPs were inquired about study (N=1886)

Met eligibility criteria: More than 10 monthly prescriptions average (N=984)

Randomized selected samples (N=906)

TPL Arm = 302 GPs

1st Feedback
Sent = 215
Not Sent = 87
Undeliverable = 24
Delivered = 191

2nd Feedback
Sent = 227
Not Sent = 75
Undeliverable = 20
Delivered = 207

3rd Feedback
Sent = 210
Not Sent = 92
Undeliverable = 19
Delivered = 191

STM Arm = 302 GPs

1st Feedback
Delivered = 228
Resent= 1
Not Sent = 74

2nd Feedback
Delivered = 240
Resent= 0
Not Sent = 62

3rd Feedback
Delivered = 225
Resent= 0
Not Sent = 77

Control Arm = 302 GPs
65 cases of Letter group and 54 cases of STM group were analyzed as control, because they did not receive the feedback letter or STM at all.
Total=302+65+54= 421

Fig. 1. (a) Study timeline and interventions. (b) Procedure of the study and flow diagram of participants.

into a single long .xls file. The extracted data cover the period from August 23rd, 2012 to November 21st, 2013.

2.5. Managing missing data

We planned to provide the intervention, i.e., sending feedback three times, to all GPs. But not all information about some of the physicians was available, like mobile phone numbers and valid postal addresses. Multiple reasons for this missing information existed, and we did our best to collect as much data as possible; by searching related official and hand-written documents, medical council data and contacting some centers by phone. Despite our efforts, in each of the three times of the intervention, we had some loss to follow up cases. Some of participants in TPL arm did not receive one or two of three feedback messages, because of e.g., a postal address error, or due to leaving their practicing place during the study period. All of these cases were treated in mixed model analysis considering in a new variable (count of delivered messages) as a fixed-effect covariate. Note that due to our inclusion criteria some GPs may not have been included at specific interventions when they did not have enough steroid prescriptions for the corresponding months. Finally, there were certain GPs in our two intervention arms who did not receive even one letter or STM, so in the final analysis, these cases were treated as participants in the control group.

2.6. Outcome measure and statistical analysis

The main outcome measure was the monthly total sum of drug usage calculated as the sum of Defined Daily Dose (DDD) for PSs. Merging data files was done in several steps by SPSS® Clementine® 12. After these steps, calculating the DDD for all 10 different PSs was done based on the standard definition operationalized by a formula in Microsoft Excel® 2013. Since the main outcome variable was not normally distributed (one sample Kolmogorov–Smirnov test: $P < 0.001$) we used the logarithmic transformation of DDD instead, which did not deviate from a normal distribution ($P > 0.1$). One-way ANOVA was conducted to check whether the DDD is similar in the three study arms, and an independent samples t-test to compare DDD for males and females before the study. Paired samples t-test was done to compare DDDs before and after the study in each of three study arms. We compared the effect of the two interventions (TPL and STM) versus the control arm. The repeated records of each GP were treated as a cluster with random effect in a linear mixed effect model. In order to quantify the cumulative effect of multiple messages, in the final model the number of sent messages to each physician was treated as a fixed effect covariate. Also, we performed an intention to treat analysis to find out how excluded cases (see methods: part e. and Fig. 1b) can affect the results of the trial. In all of these analyses, regression coefficients and their 95% confidence intervals were computed. All analyzes were conducted using IBM® SPSS® 22 (IBM Corp., Armonk, NY) and all reported P values less than 0.05 were considered statistically significant.

2.7. Ethical issues

This study was approved by the Ethical Committee for Research in Mashhad University of Medical Sciences (Reference no. 91/561378, date: 2/2/2013). All collaborators were blinded for names and indices of prescriptions, except for the first and second authors who must be informed in order to set the letters and STMs. During the study, no one knew about the procedures except for the research team, so the probability of contamination between cases and controls was low.

3. Results

3.1. Participant flow and intervention

Nine hundred and six GPs were randomly recruited for the study. The basic characteristics of the participants in all three arms of the trial were similar after randomization (Table 2). The GPs worked in 14 different cities and counties of Kerman Province (39.3% in Kerman city itself, 50.5% in other cities, and 10.2% in the counties) and the male to female ratio was 1.4. According to the official records, the participants had different levels of clinical experience ranging from several months to several years. We did not assess the association between experience and other variables.

Because of missing initial valid data for postal addresses or mobile numbers, in the first intervention, only 191 letters and 228 text messages were sent successfully. This inevitably happened again in the 2nd and 3rd intervention and finally, as for the TPL arm, a total of 589 letters throughout the study were successfully delivered, and, for the STM arm, a total of 693 short text messages were sent via the web-based short message server and were verified for delivery (See Fig. 1b).

3.2. Defined Daily Dose measures and cost benefit assessment

As shown in Table 1, the most frequently prescribed PS was “Dexamethasone Phosphate 8 mg/2 ml Ampule” and the second one was “Methylprednisolone Sodium Succinate 500 mg vial”. The average monthly DDD was similar in the three study arms at the beginning of the study and was quite different after the last intervention. Fig. 2. shows the trend of prescribed steroids by participants (in terms of DDD). The results of the three months before starting the intervention were used for comparing the temporal changes. The period from September to November 2012 were considered as a baseline for this comparison. The last three months of the records (in the similar months of 2013) were used to assess the effect of feedback. There was no difference between the study arms at baseline ($P > 0.5$) (Table 4), but we found a significant difference between them after all three interventions ($P < 0.0001$). One-Way ANOVA and Tamhane’s post-hoc test were performed showing the difference was only in TPL vs. CG ($P < 0.001$) and STM vs. CG ($P < 0.0001$), but no difference in TPL vs. STM ($P > 0.9$). Comparing the mean of DDDs in these two periods between cases against control groups showed a relative decrease of around 32.9% and 34.8% in TPL and STM groups respectively. (Fig. 2) The intention to treat analysis did not lead to any differences in the final results.

The evaluation of cost shows that about $11,340 were spent on all 10 drugs (Table 1) during September–November 2012. The cost during the parallel period after the 3rd intervention shows a total cost amounting to about $9260. The expenses for sending STMs (a total of about $60) and TPLs (a total of about $490) implies that spending around $550 in total for the intervention costs resulted in a decrease in drug prices for about $2000 in 3 months. However, this calculation does not take into account the effort and time expended in analyzing the data.

3.3. Main effect of feedback

The linear mixed-effects model results are presented in Table 3. Fig. 2 concurrently shows the trend of the DDDs during the 15 months of the study. Our first model (considering only two variables, “study arm” as grouping variable and “monthly DDD” as dependent variable), showed that being in the TPL arm resulted in a significant yearly decrease around 36.1 in the mean DDD ($P < 0.02$) and being in the STM arm about 41.7 in the mean DDD ($P < 0.005$). But there were no significant differences between TPL and STM arms ($P > 0.7$). This reduction in DDD was due to a reduction in both

Table 1
Annual prescription of the 10 parenteral steroids with the largest Defined Daily Dose.

Name and dosage of steroids[a]	DDD (mg)	Yearly drug usage in DDD mean (SE)[b]	Rank#
Dexamethasone phosphate disodium 8 mg/2 ml, amp	1.5	1024 (66.5)	1
Methylprednisolone sodium succinate 500 mg,vial	20	433.3 (195.9)	2
Betamethasone LA, amp	1.5	127.5 (9.2)	3
Triamcinolone acetonide 40 mg/1 ml, vial	7.5	125.8 (17.9)	4
Betamethasone disodium phosphate 4 mg/ml, amp	1.5	118.1 (18.5)	5
Desoxycorticosterone acetate 5 mg/ml, amp	5	80.7 (74.2)	6
Methylprednisolone acetate 40 mg/ml, amp	20	68.5 (7.6)	7
Hydrocortisone sodium succinate 100 mg/8 ml, vial	30	66.8 (6.2)	8
Hydrocortisone sodium succinate 100 mg/2 ml,vial	30	50.4 (9.1)	9
Hydrocortisone sodium phosphate 100 mg/2 ml, amp	30	20.6 (4.4)	10

[a] Available in Iran's drug market and covered by SSO insurance regulations.
[b] Mean of yearly PS DDD which were prescribed by all 906 physicians in each month.

Table 2
Participants' baseline characteristics.

Time	Characteristic	Control	TPL	STM	Total	*P* Value
At allocation time in beginning	Gender: N (%)					
	Female	125 (33.6%)	121 (32.5%)	126 (33.9%)	372 (41.06%)	0.9
	Male	177 (33.1%)	181 (33.9%)	176 (33.0%)	534 (58.94%)	
	Age: mean (SD)	44.34 (9.91)	44.21 (9.10)	44.38 (8.27)	43.98 (9.08)	0.7
Final grouping for analysis	Gender: N (%)					
	Female	185 (49.7%)	88 (23.7%)	99 (26.6%)	372 (41.06%)	0.2
	Male	236 (44.2%)	149 (27.9%)	149 (27.9%)	534 (58.94%)	
	Age: mean (SD)	44.03 (9.83)	44.48 (9.09)	43.36 (8.30)	43.98 (9.08)	0.6

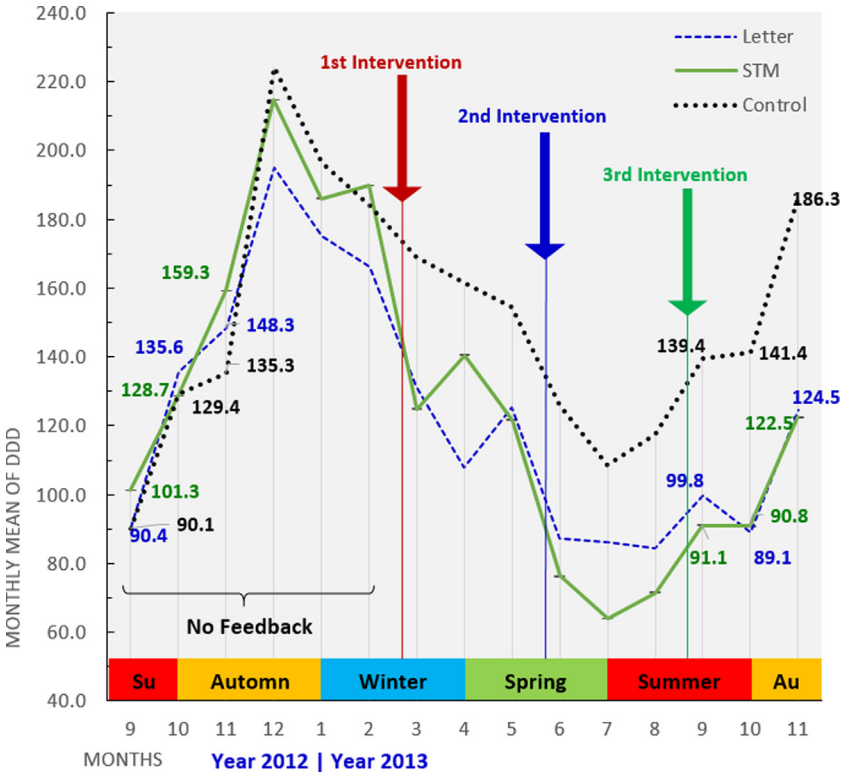


Fig. 2. Trend of prescribing parenteral steroids.

Table 3
Linear Mixed-effects model parameter estimates for DDD changes.

	Primary 0utcome model	Parameter estimate	SE	*P*	95%CI	
1st model	Intercept	129.32	9.08	<0.001	111.50	147.15
	Group (TPL)	−36.10	14.95	0.016	−65.46	−6.75
	Group (STM)	−41.70	14.69	0.005	−70.55	−12.85
2nd model	Intercept	124.60	6.58	< 0.001	111.68	137.52
	Count of messages	−17.70	2.57	< 0.001	−22.75	−12.65

Groups are coded as 0 for Letter, 1 for STM and 2 for control; count of messages were from 0 to 3.

Table 4
Comparison of drug usage (DDDs) in study arms during similar seasonal periods before and after all interventions.

Time	Study arms	Mean	St. Dev.	CI95%		*P* Value
Before	TPL	121.62	227.75	105.43	137.80	>0.56
intervention	STM	127.49	248.67	110.03	144.96	
	Control	115.68	158.40	104.41	126.94	
After	TPL	104.38	234.83	84.19	124.57	<0.0001
intervention	STM	101.90	179.50	86.47	117.34	
	Control	156.17	240.76	139.61	172.73	

Please see results part b. and Fig. 2 for extra information.

the dose prescribed and the fewer prescriptions by the GPs. To find the effect of repeating the messages, we checked the count of the messages in another simple model treating it as a fixed-effect factor. The model showed a significant overall decrease in DDD for each extra message. Table 3 (2nd model) shows that every sent message (letter or STM) during the whole period of the study is associated with a decrease of about 17.7 in DDD in prescribing PSs ($P < 0.001$).

Initially, the percentage of prescribed PS in monthly prescriptions ranged from zero to 77.9% (mean ± SD = 15.9 ± 13.8). About 50% of all prescribed PSs originated from only 5% of the physicians. Based on the MDAO conditions, there were 75 physicians (62 in the intervention arms, 30 in STM, and 32 in TPL) who have prescribed at least one type of parenteral steroids in more than 29.7% (Mean + 1SD) of their monthly prescriptions just before sending the 1st feedback. Following the first feedback, there were 33 (14 STM, 19 TPL) physicians who remained prescribing as usual despite the feedback. Also after sending the 2nd feedback, 22 (7 STM, 15 TPL) physicians still exhibited their previous behavior. In addition to these, there were 11 and 13 other GPs who increased their prescribing percentages just after the first and second feedback respectively. Of these physicians, 74.2% were male and more than 75% were under 40 years old. The majority of GPs who did not considerably react to our intervention appeared to work in areas with a low socio-economic level and it is conceivable that patient preferences influenced GPs to prescribe steroids although this conjecture needs further investigation.

4. Discussion

Our RCT showed that sending feedback about the prescription indices to general practitioners in a large province of Iran reduced parenteral steroids prescription rate by about one-third. Reduction in this outcome was unrelated to gender and age but it was associated with the number of feedback messages sent. Feedback in short text messages was demonstrated to be at least as effective as postal letters. The most frequently prescribed drug was Dexamethasone Phosphate Disodium Ampule (8 mg/2 ml) which ranked in the top 20 list of most frequently prescribed drugs in Iran in recent years [15].

To our knowledge, our study is the first randomized controlled trial to evaluate the effectiveness of Short Text Messages (STMs) as a tool for sending feedback to affect GP prescribing behavior. It also clearly confirmed the potential effectiveness of performance feedback for prescribing PSs.

Our one-year experience in this research project brought also the following insights. After each time of sending feedback, we had some early STM replies and phone calls and even face to face visits in the following weeks from participants. All questions and comments were officially answered by the second author on the phone or by face-to-face meetings. The most frequently asked questions concerned the rationale behind the feedback, the indices and their calculation, and the used criteria for the hints or advices in the messages. In some cases, there were serious discussions about the matter and the process of the work. Some of the physicians had objections about the content of the message. Some of the objections were about the measurement method, the cut-off, the related regulation, or rational about obligatory medical situations that need steroids. However, some of the physicians were actually curious about the reported indices and wanted to know how we achieved them and wanted to use them for correcting their practices. Messages were hence not only read by the participants, but they attracted considerable attention, underlining the fact that the intervention was meaningful.

A literature review showed evidence for the effectiveness of short text messages for local educational purposes [16], patient's weight loss programs and diet therapy [17,18], anti-obesity behavior modification [19], and smoking cessation or diabetes self-management or asthma management [20,21] in the general population. However, we could not find studies using a similar method applied to improve prescription behavior to compare our findings with. Bates and Gawande in 2003 wrote that information technology will play a key role in achieving major gains in quality of care [8]. In some settings, interventions like email and individual computerized feedback and even computer based reminders had weak potential positive effects in reducing medical errors [10,22]. All of this evidence, together with our findings show that STM seems an appropriate way to communicate with people (providers and patients) about health related issues.

Our results are in line with a study in the UK reporting that face-to-face visits and using a prescribing analysis workbook had promoted change in antibiotic prescribing in general practitioners [2]. Our results stand, however, in contrast to a study in Denmark [11]. That study did not show a significant effect of postal mailed feedback about prescribing volumes and costs to the physicians on 13 major drug groups during a 7-year period with semiannual interval for feedback provision. This may be explained in part by the positive engagement of the participants in our study.

The effect of feedback in the STM group was slightly better than in the TPL group, (34.8% vs. 32.9%) possibly because of the faster and more private delivery of STMs compared to letters. MDAO had been using its STM service for more than two years by sending official short news to physicians; so physicians expect official STMs from MDAO. STM is a habitual tool for many people and it is more likely that physicians do not open a letter in time, or do not receive it at all, than missing a delivered STM from a known number on their own mobile phones.

We also observed a significant change in prescribing parenteral steroids and DDD in both intervention arms after all interventions (Table 4 and Fig. 2) when compared to the parallel period in September–November two years earlier. While physicians in the control group were prescribing as usual, and even more than before, the others in both intervention arms have markedly and statistically significantly changed their prescribing behavior. Because of the randomization and the existing control group, the intervention is the most likely important factor to affect the behavior change.

We found in our preliminary analysis that sending feedback messages was not only effective but can also lead to a marked decrease in the prices of the dispensed drugs as well as the amount of DDD. More in depth health economic studies are needed to eval-

uate the effects of performance monitoring on cost and burden of drug usage in similar and other populations.

We found that STM had better effect than TPL even for the 5% of physicians who prescribed the most percentages of the drugs. This finding gives rise to the hypothesis that new technology such as STM, could be as effective in older physicians as younger ones. Also, the STM arm in our study responded better to our feedback.

There are also studies focusing on different aspects of physicians' behavior, such as test ordering. In line with our findings, there was a positive effect of computer-based feedback on test ordering behavior for general physicians [23]. Although there are many clinical practice guidelines for test ordering, physicians' adherence to guidelines is still deficient and IT based feedback and reminders may improve ordering behavior [24].

A high quality published Cochrane review on effects of audit and feedback on professional practice, states that feedback may be more effective when baseline performance is low, when the source is a supervisor or senior colleague, when it is provided more than once, when it is provided both verbally and in a written form, and when it includes both measurable targets and an action plan [6]. We intentionally tried to consider all these factors and also other effective presumptions such as encouragement of recipients, well formatted texts, simplicity and abridged individualized messages [25]. Also the contracts between MDAO and the GPs tend to make them more responsive to received messages as STMs or in letters. Finally, when sending a letter or short text message to each physician, including those with the worst pattern of prescribing, we used firm professional but respectful texts and expressions, which we believe was a positive aspect of the study.

The time and cost of feedback is an important issue. In every intervention, merging raw data and preparation of the final data files took around five working days. Some tasks like printing the names and addresses on envelopes, printing and folding the letters, putting them into envelopes, pasting scotch tapes on them, and sending the letters to the post office took another working day, in addition to the expected delay of postal service delivery. But in the STM arm, despite the similar time for preparation of data files, sending STMs by a reliable online tool took around only 4–7 min each time. The overall cost per letter was around 10 times the cost of that per STM. It is likely that the MDAO directors, and similar organizations, would prefer this cheaper tool for their future plans. We need to note that we did not take the costs of data merging and analysis into account when estimating the above mentioned costs.

Overall, we believe that the effectiveness, immediacy, lower efforts and lower cost of STM justify its use in related environments to be used instead of traditional postal letters. It is however important to have a supportive organization. In our case, the enthusiasm of MDAO directors who intended to make better control of inappropriate prescribing parenteral steroids and related disbursement, allowed for the effective organizational support for this project

5. Limitations of the study

Some of the physicians, who were randomly assigned to one of the intervention arms, did not receive the letters/STMs. This was due to inaccessibility to their mobile numbers and postal addresses. Also it was probable that some of the participants, who did not have a practice contract with the SSO at the study period, were less susceptible to SSO letters.

It was preferable to run the study for a longer time, but because of budget and time constrains, we set the duration to one year and three interventions over time. Another important limitation was the group of patients. In this study we did not have access to data of the prescriptions written for patients of other insurance companies or without insurance coverage.

Summary points

What was already known before this study:

- Audit and feedback are known as effective way to promote health care services, whether some studies have controversies about the positive effects in improving professional practice and the characteristics of audit and feedback that lead to greater impact

What this study has added:

- Using short text message to deliver official and organizational supervising materials could be as effective as traditional postal letter and even better than that, because of lower cost and higher speed and less efforts.
- Despite negative effects of feedback reported in some investigations, working precisely by considering several recommended points from published resources, such as respectful, rapid, valid, individualized, tidy and timely feedback supported and supervised by superior organizations, can lead to prominent results and successful projects.
- IT based interventions were more effective when there were more room for improvement.

6. Conclusion

In this single-blind randomized controlled trial, we aimed to assess the effects of registry based performance feedback by short text messages compared to traditional postal letters and care as usual on prescribing PSs. We achieved more than 34% relative decrease in prescribing these drugs in terms of DDDs when compared to care as usual in a similar year-period within two years. STM could be a very simple, cheap and effective way to provide performance feedback for general practitioners to enhance their prescribing behavior. It is possible that many issues pertaining to rational drug use can be effectively managed by superior organization of the communication with physicians via respectful, precise, valid, personalized and timely performance feedback.

Using short text messages to deliver official and organizational supervising materials could be at least as effective as traditional postal letters. This also comes at a lower cost, higher speed, and less effort.

Author Contribution

SE: conception and design of study, interpretation of data, and supervising the study. ASN: design, data analysis, interpretation of data, and manuscript writing. AAH: design, data analysis, and critical revision. KB: design and critical revision. AA: conception and design, and critical revision. MRF: design and critical revision. All authors read and approved the final manuscript.

Conflict of interest

The authors declare they have no conflict of interest.

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