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Investigating Physicians' Compliance with Drug Prescription Notifications

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Abstract

The objective of this study was to investigate physicians' compliance with recommendations for drug substitutes embedded within an electronic medical record, to assess factors affecting compliance, and to evaluate associated cost savings. An exploratory study of all physicians in all clinics operated by a large health maintenance organization (HMO) was conducted using a transparent computerized agent that collected 1.21 million prescriptions prescribed by 647 physicians. Compliance with HMO recommendations for substitute drugs reached a 70 percent rate. Substitute type, whether generic or therapeutic, was found to be the most significant factor affecting compliance, with physician workload and age second and third in effect magnitude, respectively. Compliance was found to be non-automatic and selective, following a thoughtful cognitive process. The HMO realized at least a 4 percent reduction in costs for prescribed drugs as a result of compliance with substitute recommendations. The results can be interpreted via the lens of Organizational Justice Theory, assuming that the broad compliance with generic substitutes was driven by perception of just procedures, whereas there was no such perception in the case of therapeutic substitutes. While more research is warranted for investigating the motivations driving physicians' compliance, we strongly feel that the results can be generalized to other HMOs and healthcare settings.

Keywords: *Health Care IT (Special Issue), Electronic Medical Record, Physician Compliance, Drug Cost Containment, Organizational Justice Theory.*

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Investigating Physicians' Compliance with Drug Prescription Notifications

1. Introduction

Healthcare costs are escalating world-wide. According to a 2006 report of the Organization for Economic and Co-operation Development (OECD) (figures for later years are yet to be published), national healthcare expenditures ranged from 15.3 percent (U.S.) to 6 percent (Mexico, Korea, Poland) of countries' Gross Domestic Product (GDP). Annual growth rates between the years 2000 and 2006 were above 10 percent in several countries, surpassing the growth of the respective economies (OECD, 2007; Schur, Berk, & Yegian, 2004). Spending on prescription drugs in the US, for example, increased by 14 percent between 2004 and 2007 (Daly, 2007), and drug expenditures exceeded 12 percent of the total healthcare expenditure in 2006 (KFF, 2007).

Interventions used by insurers to contain drug costs frequently require physicians' compliance. When compliance is not forthcoming, cost containment is not achieved. In other cases, achievement of cost containment has resulted in a decrease in quality of care (Shamliyan, Duval, Du, & Kane, 2008). While electronic medical records systems (EMR) have been advocated as a means for meeting these cost and quality challenges, recent studies have marginally substantiated this assertion (Delpierre et al., 2004; DesRoches et al., 2008; Shamliyan et al., 2008; Wolfstadt et al., 2008). Two obstacles to achieving these goals are physicians' resistance (Piderit, 2000) and their preference to maintain existing behaviors (Coch & French, 1948). In this sense, a compliant behavior has been used as evidence of reduced resistance (Sagie, Elizur, & Greenbaum, 1985), which health maintenance organizations (HMOs) strive to secure in order to achieve enhanced quality of healthcare while containing costs.

Voluntary EMR adoption by independent care providers can be regarded to some degree as compliance with governmental requests (Goldman, 2009) and is believed to enhance healthcare efficiency (Ginsburg, Doherty, Ralston, & Senkeeto, 2008; Matheny et al., 2008; Mongan, Ferris, & Lee, 2008; Reynolds, Harper, Jenner, & Dunne, 2008; Shamliyan et al., 2008; Weber, 2008; Wolfstadt et al., 2008). However, in spite of two decades of efforts, EMR adoption rates are still only around 14 percent of primary care physicians in the US (DesRoches et al., 2008). Among reasons for non-adoption of EMR technology are: questionable return on investment, risks of privacy breach or records unavailability, user interface difficulties, and questionable effectiveness (Blumenthal, 2009; Jha et al., 2009a, 2009b; Kush, Helton, Rockhold, & Hardison, 2008; Martens et al., 2008; Shachak, Hadas-Dayagi, Ziv & Reis, 2009; Vardy, Kayam, & Kitai, 2008). HMOs that have adopted EMRs encounter similar difficulties, confronting internal resistance to use the systems and comply with new organizational processes (Connell & Young, 2007; Jensen & Aanestad, 2007; Reardon & Davidson, 2007; Subramanian et al., 2007).

While the rates of EMR adoption or non-adoption is by now fairly clear, this is not the case for care provider compliance with computerized notifications embedded within implemented EMRs to improve quality of care or reduce costs. Recent studies focusing on the effectiveness of computerized reminders yielded mixed results (Matheny et al., 2008; Sequist et al., 2005), with effectiveness declining over time (Demakis et al., 2000). Most of this research was conducted in institutions where the investigated behavior involved recently implemented systems or experimental environments, hindering the generalizability of the results.

Against this background, the objective of this study was to examine physicians' compliance with a well-established intervention to contain costs of prescription drugs without decreasing the quality of care administered by a large HMO. We conducted the study in the normal organizational environment, where we transparently monitored the natural behavior of the physician population employed by the studied HMO in all its clinics. The intervention involved a notification about HMO-recommended substitutes issued to the physician by the drug prescription module of the EMR. We examined the patterns of physicians' compliance with notifications, both in general and in relation to their demographic traits, as well as the contribution of compliance to containment of drug costs. We employed an exploratory epistemology, hence, we did not attempt to test any hypotheses. Rather, we wanted to examine the actual physicians' behavior and suggest a plausible theoretical explanation for future research.

The strength and importance of this work is in the comprehensiveness of the data, which is rooted in a normal organizational setting, in the rigorous statistical analyses, and in the theoretical and practical implications derived. Furthermore, although the results represent one organization, we are confident in their generalizability and external validity under similar circumstances.

The paper is organized as follows: the next two sections present the background, including review of the literature, description of the study environment, and explanation of the theoretical lens for this paper, followed by the research method. We then present the results, leading to the discussion and conclusions.

2. Background

Drug prescription is a primary component of medical care, yet it suffers from quality and cost problems and ineffective response to administrative measures that address both these concerns (Kuperman & Gibson, 2003; Shamliyan et al., 2008). To overcome cost problems, several cost containment measures have been attempted, of which the most common are: (1) administering drug formularies (Huskamp et al., 2005); (2) shifting to generic-drug-only coverage (Patterson et al., 2005); and (3) instituting co-payments (Gibson, Ozminkowski, & Goetzel, 2005). All three measures, however, although successful in achieving cost containment (Huskamp et al., 2003a), are contingent on care providers' compliance with organizational procedures, and can also bear undesirable health consequences (Gibson et al., 2005) when patients, particularly sensitive populations such as elderly patients, deviate from disciplined drug consumption due to financial difficulties (Goldman et al., 2004; Huskamp et al., 2003b; Reed, Brand, Newhouse, Selby, & Hsu, 2008; Steinman, Sands, & Covinsky, 2001).

Prior research about physicians' compliance with various manual or computerized clinical procedures, introduced to increase quality of care, reduce costs, or minimize errors, generally revealed either marginal success or none (Matheny et al., 2008; Sanders & Satyvavolu, 2002; Sequist et al., 2005; Tamblyn et al., 2006).

Physicians' response to clinical reminders can be divided into four behavioral categories: compliance, reliance, spillover, and reactance. Compliance is defined as the tendency to perform an action when a clinical monitor issues an alert; reliance is defined as a tendency to refrain from performing an action when the warning system does not indicate that it is necessary (Meyer, 2004); spillover is defined as "the spread or expansion of responses, activities, or roles from one instance, system, or domain, to another" (Vashitz et al., 2009, p. 318); and reactance (or non-compliance) is defined as "an unpleasant motivational state, in which people react to situations [where] they feel their autonomy is threatened, in ways that reaffirm their freedom or autonomy" (Vashitz et al., 2009, p. 318). Barriers to compliance with clinical reminders identified by prior research include lack of time, poor patient compliance, and physicians' lack of knowledge of, awareness to, or disagreement with specific guidelines (Sequist et al., 2005). User interface and other usability issues were likewise identified as hindering adherence to clinical reminders (Patterson et al., 2005), as well as workload and patient characteristics (Mayo-Smith & Agrawal, 2007; Sittig, Krall, Dykstra, Russell, & Chin, 2006).

As elaborated upon next, the HMO under study here employed a combined policy of drug formulary, co-payment, and differentiated cost coverage based on the type of drug prescribed. The policy was administered via a computerized drug prescription module embedded in an EMR whose use is mandatory yet open to various levels of compliance.

2.1. Description of the Study Environment

Israeli citizens are fully insured through the Israeli National Insurance Law, and can enroll with one of four HMOs that provide full health coverage to their members. EMR systems have been widely implemented in Israel since the early 1990s. All primary care physicians, as well as practitioners in most secondary care clinics of the studied HMO have been using the studied EMR system for nearly 20 years (Pliskin, 1994; Pliskin, Glezerman, Modai, & Weiler, 1996). The other three HMOs either use this same or a similar EMR system. Thus, all primary care and the vast majority of secondary

healthcare records in Israel are fully computerized. The EMR system facilitates electronic real-time documentation of all physician-patient encounters during a visit and selective context-based data retrieval during treatment monitoring, including various clinical alerts and decision aids. In addition to order entry for drugs (via a built-in drug-prescription module), the EMR system supports such processes as laboratory referrals, expert consultation and imaging, and a bi-directional interface with administrative computerized systems, used to validate patient coverage and transmit various administrative data, for example, for cost calculation purposes. Based on DeRoches et al.'s (2008) classification, this is a comprehensive EMR.

The built-in drug prescription module, which is the only method practiced at the HMO for generating drug prescriptions, displays clinical details relevant to the prescription process, including patient clinical information, current and previous drugs prescribed to the patient, alerts of drug contradictions upon prescribing new drugs, and known allergies or sensitivities. The system also presents a list of drugs from which the physician may select. The list (see Figure 1) reflects the HMO's drug formulary, where drugs are ordered from the most to least preferred according to the HMO policy for drug coverage. The list contains ample information about each drug, some visible and some available upon clicking (e.g., administrative and pharmacological information). The first time a prescription is called for, the physicians may select any drug from the list as an initial choice. Upon prescribing a non-preferred drug, the drug-prescription module notifies the physician about available HMO-preferred generic substitutes (where the substitute is identical in chemical formulation to the patent drug) or therapeutic substitutes (where the substitute is not identical but is known to yield similar therapeutic results). More specifically, when a physician prescribes a non-preferred drug as an initial choice, the notification screen pops up and notifies the physician in real time: "Have you considered prescribing XXXX?" (See Appendix 1) The physician can then either choose the proposed preferred substitute instead of his/her initial choice. However, if the notification is ignored and the final choice is the same as the initial choice, s/he is asked to fill out an online form and explain the reasons for non-compliance (See Appendix 2). Physicians know that HMO administration can access these forms and examine their explanations. This feature is activated only for drugs with HMO-preferred substitutes that are prescribed to a patient for the first time. Clearly, the HMO's objective is to maximize physicians' compliance.

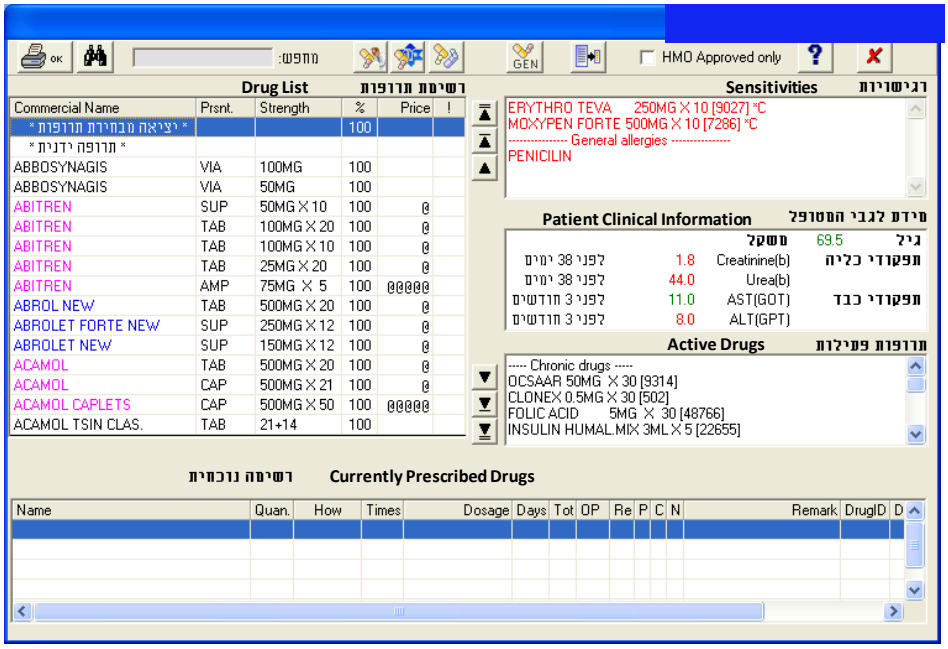

Figure 1. The Drug Prescription Module

2.2. Compliance as an Organizational Behavior–the Organizational Justice Lens

The present exploratory study aimed to examine a behavior rather than to substantiate theoretical hypotheses. Yet, there is merit in a post-hoc theoretical interpretation of the factors found to affect compliance, believed to be a desirable organizational behavior, linked to other positive organizational outcomes such as job satisfaction, organizational commitment, withdrawal, and organizational citizenship (Colquitt, Conlon, Wesson, Porter, & Ng, 2001).

Of the four types of adherence behavior defined by Vashitz et al. (2009)--compliance, reliance, spillover, and reactance--physicians in the present study could only demonstrate compliance or reactance behaviors. Thus, we define compliance as adherence to drug substitute notification, either initially (self-compliance) or in response to a notification (assisted compliance). Non-compliance or reactance is refusal to adhere to a drug substitute recommendation even after being notified.

Two quite different theories that attempt to explain compliance behavior are the deterrence model and the accommodative model (Kagan & Scholz, 1984). The deterrence theory argues that people are motivated entirely by profit-seeking, assessing opportunities and risks and disobeying when the anticipated risks are small compared with the profits to be made through non-compliance (Kagan & Scholz, 1984). Advocates of the deterrence view believe that individuals will only comply with an authority's rules and decisions when confronted with harsh sanctions and penalties. Clearly, this was not the case in the studied HMO, where physicians neither directly benefited from complying, nor were penalized for not complying. The accommodative theory maintains that attitudes and moral obligations, in addition to economic calculations or fear of punishment, are important in explaining compliance behavior and, therefore, need to be considered when managing non-compliance (Braithwaite, 2002).

Related to the accommodative model of compliance behavior is Tyler's (1990) theory on compliance, according to which, people's compliance behavior is strongly linked to views about justice and injustice. In particular, he suggests that procedural justice plays an important role in peoples' decisions to comply with rules and regulations. Procedural justice is a refinement of the organizational justice or fairness theory, which initially dealt with the fairness of outcome distribution or allocation and the fairness of the procedures used to determine this distribution or allocation (Adams, 1965). This type of organizational justice was termed distributive justice (Leventhal, 1976). Later work introduced the concept of the fair process effect into the organizational justice literature, termed procedural justice (Folger, 1977; Leventhal, 1976; Lind & Tyler, 1988).

Procedural justice concerns the perceived fairness of the procedures involved in decision making and the perceived treatment one receives from a decision maker. The procedural justice literature demonstrates that people's reactions to their personal experiences with authorities are rooted in their evaluations of the fairness of the procedures those agencies use to exercise their authority (Lind & Tyler, 1988; Tyler & Blader, 2000). A procedure should meet six criteria to be perceived as fair: a) be applied consistently across people and across time; b) be free from bias (e.g., ensuring that a third party has no vested interest in the particular settlement); c) ensure that accurate information is collected and used in making decisions; d) have some mechanism to correct flawed or inaccurate decisions; e) conform to personal or prevailing standards of ethics or morality; and f) ensure that the opinions of various groups affected by the decision have been taken into account (Colquitt et al., 2001; Leventhal, 1976).

Focusing on the importance of interpersonal treatment people receive when procedures are implemented, Bies and Moag (1986) suggested differentiating interactional justice from procedural justice. Further work (Greenberg, 1990; Greenberg, 1993) hypothesized interpersonal justice to consist of two dimensions: interactional justice, which refers to the degree to which people are treated with politeness, dignity, and respect by the authorities involved in executing procedures, and informational justice, which focuses on the explanations provided to people that convey information about why procedures were used in a certain way (Colquitt et al., 2001). There are, however, conflicting results concerning the discriminant validity of procedural justice, interactional, and

informational justice, therefore, many researchers (see Colquitt et al., 2001 for details) have operationalized procedural justice by measuring process control as suggested by Leventhal (1976) along with interactional and informational justice in one combined scale.

There is empirical evidence to show that people who feel they have been treated in a procedurally fair manner by an organization will be more inclined to accept its decisions and follow its directions (Lind & Tyler, 1988; Tyler, Degoey, & Smith, 1996). It has also been found that people are more likely to challenge a situation collectively when they believe that the procedures are unfair (Greenberg, 1987; Murphy, 2003; Tyler, 1990).

Organizational justice theory is relevant to the context of this study because the drug substitute intervention studied here affects physicians' professional autonomy and self esteem, and because the issuing HMO clearly has vested interests in the outcomes, as have the patients. Therefore, we chose to explain the results via this lens, as further elaborated in the concluding section.

3. Research Methods

3.1. Research Approach

As previously stated, the present study adopts the interpretive, exploratory epistemology, aiming to examine routine behaviors of physicians who are proficient users of a drug prescription module within an EMR that includes drug substitution notifications.

3.2. Studied Intervention

At the time of the study, the HMO's catalog included about 2,600 drugs, to which substitutes (either generic or therapeutic) were offered for 1,443 drugs in 47 pharmacological groups. In describing the studied intervention, italics highlight the terminology used:

The intervention is activated upon a physician prescribing a first-time prescription for a drug with substitutes (a satisfying prescription), as opposed to a repeat prescription, where the same drug is re-prescribed for the patient. If at start time the physician's initial choice is a preferred drug (e.g., from the top of the list), s/he is exhibiting self-compliance behavior. If not, s/he is notified about recommended substitutes (Appendix 1) and can choose a preferred drug as a final choice, thus exhibiting assisted-compliance behavior. Otherwise, an online form appears and the physician is asked to specify the reasons for the non-compliance behavior (Appendix 2). The response time is the time elapsed between the initial and final choices (which equals zero for self-compliance), including the time required to fill out the form following non-compliance.

3.3. Study Design and Administration

Data collection for the study lasted 40 consecutive weeks from June 1, 2005 to February 28, 2006. To collect data for this study, a transparent computerized agent was embedded into the drug prescription module, recording for the entire physician population in all 176 primary care clinics of the HMO, and for each prescription: the physician's ID, patient age, visit date and time, initial drug choice, final drug choice, and the time elapsed between the two. Physician demographics were provided by the HMO whose management approved the data collection. Physicians were unaware of the data collection; hence, regular work practices were not disrupted and no bias was suspected. Data recorded by the computerized agent were stored in real time in an MS-Access 2003 database and analyzed using SPSS version 17.0.

3.4. Sample

We collected about 5 million prescriptions written by 2,120 physicians. However, only about 1.2 million prescriptions, prescribed by 647 physicians, were for satisfying prescriptions, invoking the studied intervention because they were first-time prescriptions for drugs with substitutes.

3.5. Statistical Analyses

We used the following methods: cross-tab analysis for the descriptive statistics; independent-samples t-test for comparing means between self-employed and HMO-employed physicians; and multinomial logistic regression for compliance analyses, with the dependent variable being the three compliance types (1=self, 2=assisted, and 3=non) and the independent variables being substitution type (1=generic, 2=therapeutic), employment type (1=self-employed, 2=HMO-employed), domain (1=GP, 2=specialist), gender (1=male, 2=female), country of medical education (1=Eastern Europe, 2=Western Europe, 3=North America, 4=South America, 5=Israel), average number of patient visits per day, physician age, tenure with the HMO, and patient age. We standardized quantitative variables indicating years or visits to cater to unit differences. Variance Inflation Factor (VIF) values for the independent variables were around 1, indicating lack of multicollinearity. We employed a forward stepwise entry method with score as the entry criterion and Wald as the removal criterion. Additionally, we checked two-way interactions for all variables except country of education (because of numerous combinations, the reporting of which is beyond the scope of this study). None of the interaction effects was practically significant as the odds ratios were close to 1 (although all were statistically significant due to the large sample). We examined correlations using univariate two-tailed Pearson correlations. We assessed the lower bound on cost savings by calculating the difference between the costs of the initial and final choices in the assisted-compliance group.

4. Results

4.1. Sample Description

We present descriptive statistics of the sample in Table 1. Two hundred ninety-seven (46 percent) of the participating physicians were self-employed, whereas 350 (54 percent) were HMO-employed. The percentage of specialists in the self-employed group (53 percent) was significantly higher than in the HMO-employed group (22 percent), the rest being GPs. These two groups significantly differed on several traits, such as average number of work days (self-employed worked more) and average number of patients treated per day (self-employed treated more). The two groups, however, were not significantly different in terms of age, average tenure on the job, and number of patient visits yielding prescriptions.

Table 1. Descriptive Statistics

	Self-employed	HMO-employed	Total	Significance
Number of physicians	297	350	647	P<0.001
Number of General Practitioners/ Specialists	140 / 157	274 / 76	414 / 233	P<0.001
Average physician age (S.D.)[1]	48.8 (7.7)	48.06 (9.17)	48.4 (8.53)	n.s.
Average (S.D.) tenure on the job	9.17 (5.3)	9.12 (5.2)	9.14 (5.26)	n.s.
Percent of females	41%	62%	52 %	P<0.001
Average (S.D.) number of work days per physician during the study period	140.98 (55.53)	125.34 (48.72)	132.52 (52.5)	P<0.001
Average (S.D.) number of patient visits per day	28.9 (17.18)	21.92 (10.96)	25.12 (14.57)	P<0.001
Percent of visits yielding prescriptions	59.15%	60.97%	59.94%	n.s.
Number of satisfying prescriptions	667,362	547,885	1,212,247	P<0.001
Number of satisfying prescriptions per physician	2,236.91 (2380.45)	1,565.39 (1440.45)	1,873.64 (1956.93)	P<0.001

[1] All standard deviations reported are standard deviations of the original series values

4.2. Compliance Patterns

Overall, the self-compliance rate (i.e., the ratio of self-compliance to the total number of satisfying prescriptions) was 57.2 percent (Table 2). Of the remaining prescriptions (the difference between the total number of satisfying prescriptions and the number of self-compliance prescriptions), the assisted-compliance rate was 29.8 percent (13 percent of the total number of satisfying prescriptions), leading to a 30 percent non-compliance rate and a 70 percent accumulated-compliance rate (the difference between 100 percent and the non-compliance rate).

Table 2. Compliance Rate for Generic, Therapeutic and All Substitutes

	Generic substitutes			Therapeutic substitutes			All Substitutes		
	Prescribed	**Rate**	**% from total**	**Prescribed**	**Rate**	**% from total**	**Prescribed**	**Rate**	**% from total**
Self-compliance	576,907	74%	74%	115,971	27%	27%	692,878	57%	57%
Assisted-compliance	127,585	63%	16%	27,096	9%	6%	154,681	30%	13%
Non-compliance	74,864	10%	10%	289,824	67%	67%	364,688	30%	30%
Total	779,356		100%	432,891		100%	1,212,247		100%

The results in Table 2 show a significantly higher tendency to comply with HMO recommendations for generic substitutes than for therapeutic ones ($p<0.001$): for generic substitution, 74 percent self-complied and 63 percent of the others assisted-complied, bringing the accumulated-compliance rate to 90 percent. For therapeutic substitution, however, only 27 percent self-complied, 8.5 percent of the rest assisted-complied, bringing the accumulated-compliance rate to only 33 percent. Thus, the non-compliance rate was as high as 67 percent for therapeutic substitution but as low as 10 percent for generic substitution.

4.3. Compliance Patterns and the Number of Recommended Substitutes

We observed a positive and statistically significant correlation ($r=0.201$, $p<0.01$) between log time and the number of recommended substitute drugs on the list presented to the physician for therapeutic substitutions and non-compliance. Thus, physicians tended not to comply and to adhere to their initial choice when lists of recommended substitutes were longer, possibly avoiding the time required to examine a long list of drugs, particularly therapeutic ones. Hence, the optimal number of listed substitutes merits further investigation.

4.4. Learning Curves

Introduction of new drugs, one before data collection commenced, and one at Week 20 of data collection, or changes in recommended substitutes, allowed for the elicitation of learning curves over the 40 weeks of data collection. For introduction of new drugs, the learning period in Figures 2 and 3 is characterized by a continuous increase in assisted compliance, as well as in self-compliance, toward stabilization. In Figure 3, the learning curve is steeper and accompanied by a sharp climb in assisted compliance.

Also noteworthy is that a change in the drug policy of the HMO in the generic drug substitutes group resulted in a steep decrease in self-compliance, compensated for by a high and stable assisted compliance rate occurring within a week after policy change, while self-compliance remained low (Figure 4). This, however, is not the case in the therapeutic substitutes group, where the assisted compliance rate was low (Figure 5). Although self-compliance behaves similarly for the two groups, the assisted-compliance rate for the therapeutic substitute was not affected and remained low. Learning curves for drugs in drug groups where no such change occurred, show that self-compliance

increased slightly with time, whereas assisted compliance tended to remain rather stable, implying that the contribution of the system's notification capacity to compliance does not diminish over time, and there is merit in continued notifications for existing as well as for new drugs.

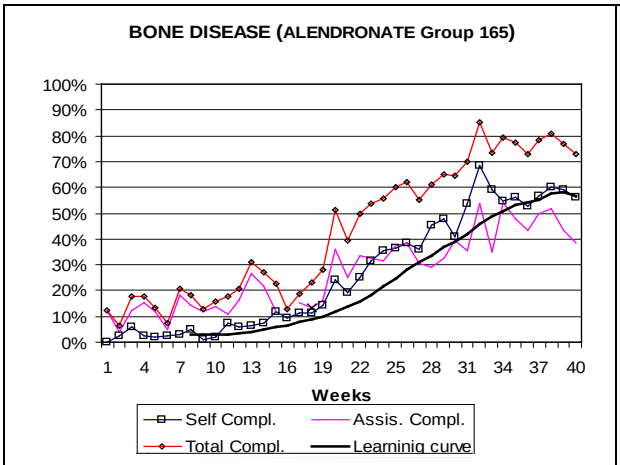

Figure 2. Learning Curve of a New Drug (Introduced Before Start of Data Collection)

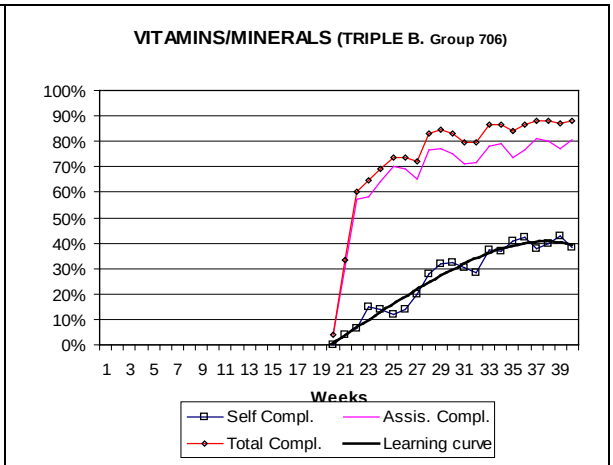

Figure 3. Learning Curve of a New Drug Introduced at Week 20

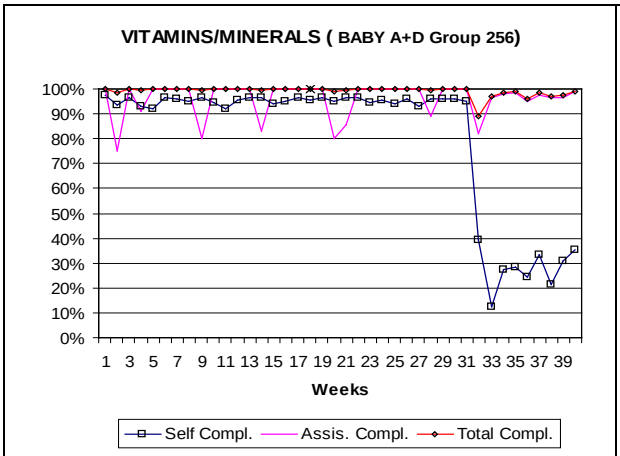

Figure 4. Reaction to Change in Recommendations (Generic Drug Substitute)

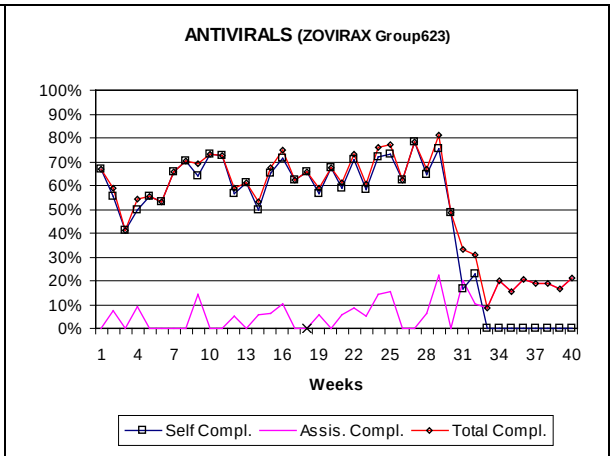

Figure 5. Reaction to Change in Recommendations (Therapeutic Substitute)

4.5. Resistance to Notifications

In certain pharmaceutical groups, efforts to impact physicians' drug prescription habits failed, as depicted, for example, in Figure 6 for the antibiotics group. In one case, the HMO's effort to shift physicians' prescription habits via notifications from one drug to another drug, which was not identical in its chemical formulation, resulted in a 5 percent self-compliance and a 2 percent assisted compliance rate. Evidently, physicians did not perceive the HMO-recommended drug as an adequate substitute. Analysis of response time, next, allows an insight into their way of thinking.

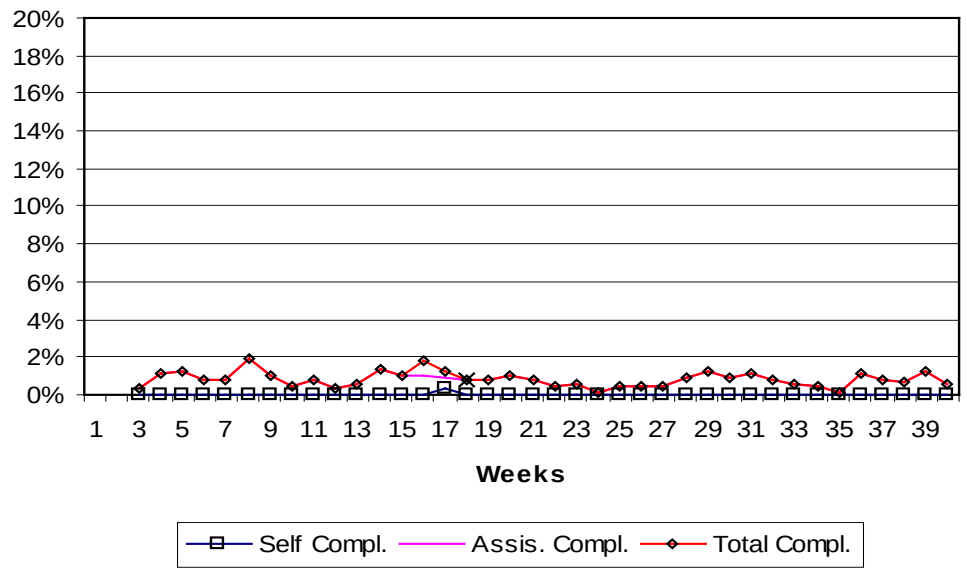

Figure 6. Resistance to Notifications (Non-Compliance)

4.6. Physician Response Time to Substitute Notifications

We calculated average response time (elapsed between initial and final choices) using two methods: 1) elimination of 10 percent of outliers (exhibiting an unrealistically long response time possibly due to pausing during the prescription process in order to accomplish another task), and 2) using log(time), an arithmetic procedure that shortens the upper tail relative to the lower tail. As displayed in Table 3, the results were quite similar for both methods: non-compliance took longer than assisted compliance in the generic substitution group ($p<0.001$), but in the therapeutic substitution group assisted compliance took significantly longer than non-compliance ($p<0.001$), in spite of the extra time required to fill the non-compliance form.

Table 3. Time to Prescription Completion

		Prescriptions	Min	Max	Mean	St. Dev.	
	Compliance	Method 1: Eliminating 10% of outliers					
Generic	Assisted-	126,532	0.08	29.99	2.61	3.05	
	Non-	74,449	0.12	29.97	2.84	2.74	
Therapeutic	Assisted-	26,390	0.11	29.99	4.48	4.62	
	Non-	286,849	0.14	29.98	3.53	3.32	
Total		514,220	0.08	29.99	3.25	3.30	
		Method 2: log(time)					Mean Time (sec)
Generic	Assisted-	127,585	-2.53	7.38	0.66	0.79	2.64
	Non-	74,864	-2.12	6.60	0.84	0.63	2.83
Therapeutic	Assisted-	27,096	-2.21	8.49	1.21	0.94	5.19
	Non-	289,824	-1.97	7.15	1.06	0.68	3.62
Total		519,369	-2.53	8.49	0.94	0.74	3.35

4.7. Compliance Patterns and Physician Demographic Traits

In a multinomial logistic regression, all independent factorial variables express odds of showing assisted compliance or non-compliance, respectively, compared to demonstrating self-compliance relative to the last category of the variable, with all other variables being equal. Continuous factors represent odds compared to an increase of one standard deviation. The model explained between 31 percent (Cox and Snell) and 36.8 percent (Negelkerke pseudo R-square) of the variance in compliance type. Although all variables were statistically significant, substitution type, either generic or therapeutic, had a dominant effect on the model likelihood ($\chi2$=392,116, df=2, p<0.001), with average visits per day with the physician ($\chi2$=2,198, df=2, p<0.001), and physician's age ($\chi2$=1,301, df=2, p<0.001) as second and third in effect size, albeit significantly smaller than substitution type. Patient age ($\chi2$=469, df=2, p<0.001) and physician's HMO employment type ($\chi2$=222, df=2, p<0.001) had a much lesser effect. All other variables had a negligible effect on the model likelihood. The odds (in the form of Exp(B)) entailed by the independent variables on assisted compliance and non-compliance compared to self-compliance are summarized in Table 4.

Table 4. Results of the Multinomial Logistic Regression

Assisted-compliance	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Intercept	-1.47	0.011	17404.36	1	0.000			
Generic (vs. Therapeutic)	-0.03	0.008	17.95	1	0.000	0.97	0.952	0.982
Male (vs. Female)	0.04	0.007	27.79	1	0.000	1.04	1.022	1.050
HMO-employed (vs. Self-employed)	0.10	0.007	194.22	1	0.000	1.10	1.085	1.115
GP (Vs. Specialist)	-0.03	0.008	17.67	1	0.000	0.97	0.954	0.983
Z-Patient age	-0.02	0.003	32.26	1	0.000	0.98	0.975	0.988
Z- Physician age	-0.13	0.004	972.75	1	0.000	0.88	0.870	0.885
Z - Physician tenure on the job	0.02	0.004	19.08	1	0.000	1.02	1.010	1.027
Z- Average Visits per day	-0.11	0.004	1070.25	1	0.000	0.89	0.886	0.898
Eastern Europe education	-0.14	0.008	326.83	1	0.000	0.87	0.858	0.884
Western Europe education	0.08	0.010	72.00	1	0.000	1.09	1.067	1.109
North America education	0.30	0.025	141.14	1	0.000	1.35	1.282	1.414
South America education	-0.14	0.019	54.95	1	0.000	0.87	0.839	0.903
Non-compliance								
Intercept	0.91	0.009	10023.63	1	0.000			
Generic (vs. Therapeutic)	-2.97	0.006	287228.91	1	0.000	0.05	0.051	0.052
Male (vs. Female)	0.05	0.006	70.57	1	0.000	1.05	1.039	1.063
HMO-employed (vs. Self-employed)	-0.01	0.006	0.67	1	0.413	0.99	0.983	1.007
GP (Vs. Specialist)	-0.01	0.008	1.84	1	0.175	0.99	0.974	1.005
Z-Patient age	0.10	0.005	415.65	1	0.000	1.11	1.095	1.117
Z- Physician age	-0.01	0.004	10.77	1	0.001	0.99	0.981	0.995
Z - Physician tenure on the job	-0.02	0.004	41.52	1	0.000	0.98	0.969	0.983
Z- Average Visits per day	0.02	0.003	37.30	1	0.000	1.02	1.012	1.024
Eastern Europe education	0.01	0.007	3.67	1	0.055	1.01	1.000	1.027
Western Europe education	-0.07	0.009	61.99	1	0.000	0.93	0.914	0.947
North America education	0.24	0.024	102.79	1	0.000	1.27	1.214	1.333
South America education	-0.05	0.016	8.08	1	0.004	0.95	0.924	0.986

4.8. Estimated Cost Savings

We calculated a lower bound on drug cost savings in millions of New Israeli Shekel (NIS), with the exchange rate during the data collection period between 4.4 and 4.7 NIS to one US dollar. Cost calculations were based on the difference between the cost of the initial and final drug choices (private pharmacy prices, since the studied HMO refused to disclose paid prices), reflecting cost savings associated with assisted compliance. The total estimated cost of drugs in the 1.21 million satisfying prescriptions was 246.67 million NIS, of which 67 percent (165.78 Million NIS) was for chronic drugs and 33 percent (80.89 million NIS) for acute ones. Table 5 displays the estimated savings in monetary and percentage terms for acute (one time) and chronic (long term) drugs, keeping in mind savings achieved for the latter have a long-term cumulative impact due to dominance (67 percent) and life-long (chronic) consumption. As evident from Table 5, savings for chronic drugs (4.7 percent) were higher than for acute ones (2.39 percent). The lower savings on acute drugs may have stemmed from the fact that physicians generally did not comply with substitutes for antibiotics, the most commonly prescribed acute drugs, but the associated savings have a short-term effect anyway. Altogether, the estimated lower bound on cost savings amounted to 1.6 million NIS (an average of 3.6 percent savings). It is plausible that higher savings are achieved assuming that physicians become accustomed to prescribing generic drugs as a result of using the system, as evident by the large proportion of self-compliance behavior.

Table 5. Savings (in Million NIS)

	Acute Drugs Cost			Chronic Drugs Cost		
	Initial choice	Final choice	Difference (%)	Initial choice	Final choice	Difference (%)
Generic substitutes	15.2	14.8	0.4 (2.39)	14.1	13.6	0.5 (4.72)
Therapeutic substitutes	22.2	22.0	0.2 (1.46)	11.7	11.2	0.5 (4.63)
Total	37.4	36.8	0.6 (1.46)	25.8	24.8	1.0 (4.68)

5. Discussion and Conclusions

The spiraling spending on healthcare, in general, and the growing relative proportion of drug costs, in particular, merit special attention to measures to contain drug costs taken by healthcare providers and insurers. Several questions guided this study, the fundamental one being whether it is possible to gain physicians' compliance with drug prescription procedures preferred by the HMO to contain costs. In other words, when so notified by the system, do physicians comply with an HMO's notification, re-think their initial drug choice, and prescribe instead an HMO-preferred substitute? Other questions stemming from the primary one are: Is compliance context-dependent? Does compliance depend on personal or environmental traits? Is such notification capacity associated with a financial contribution? In addition to addressing these issues, we reflect on the theoretical implications of the results, showing how a theory stemming from the behavioral and organizational sciences can contribute to explaining the clinical behavior of physicians. Added to the information systems aspect, it emphasizes the multi-disciplinary approach adopted in this study.

5.1. Limitations

A major limitation of this study is that the studied environment was dynamic during the data collection period, as is the case with any real business environment during a long period of 40 weeks. In this dynamic environment, changes were introduced both to drugs and to the organizational drug formulary, causing some interference. These changes were documented and eventually accounted for in the results, actually contributing to a broader understanding of physicians' behavior by allowing for example illustration and observation of learning curves. Another limitation lies in the fact that only about half of the drugs included in the HMO's formulary had recommended substitutes, yet these were the most frequently prescribed drugs. An additional limitation is related to the use of private pharmacy prices for calculating drug costs, since the HMO was reluctant to disclose prices it pays for

drugs. Therefore, drug cost savings should be regarded as demonstration rather than actual monetary cost savings. Finally, we studied only one HMO, therefore, external validity may be questionable. Although more research is called for, we believe that the results can be generalized to other HMOs and healthcare providers, and that HMOs employing a similar intervention under comparable conditions can experience parallel results, particularly because no organizational or personal characteristics were found to affect compliance as strongly as the type of substitute.

5.2. Summary of the Results

The results show that physicians tended to comply more with notifications about generic substitute drugs than with notifications about therapeutic substitutes. The fact that new drugs and new drug recommendations have been introduced during the study period allowed drawing learning curves, showing that users of the notification capacity of the system learned to comply when convinced that a recommended substitute was an identical drug, demonstrating in these cases a steep learning curve and a high rate of compliance (self-compliance and assisted compliance combined). In contrast, the level of compliance when physicians doubted the adequacy of the recommended substitutes remained low throughout. Moreover, users spent a longer time examining therapeutic substitutes, evidently contemplating the adequacy of the recommendations. This result attests to the fact that compliance is not automatic but a cognitive and calculated process. Several demographic traits were found to marginally affect the various compliance types, the most notable of which are the effects of employment type, expertise, age, and work load. Finally, a cautious estimate of drug cost savings showed that such a system holds promise for significant cost containment.

5.3. Theoretical Interpretation

The fact that physicians tended to more readily comply with notifications about generic substitute drugs, and demonstrated a rather reactant behavior when asked to substitute a prescribed drug with a non-identical therapeutic substitute, shows that issues pertaining to procedural justice may have been involved. The difference in response time between the two types of substitutes likewise lends support to this interpretation.

Substitution with generic drugs adheres more to the six criteria proposed by Leventhal (1976) for a procedure to be perceived fair, than does substitution with therapeutic drugs, because the generic drug is supposed to be identical to the patent drug. Therefore, this procedure can be perceived as free of bias (in spite of the fact that the HMO benefits from the substitute, yet seemingly at no professional or ethical harm), and it clearly conforms to prevailing standards of ethics and morality. The additional information provided for each drug on the HMO's formulary contributed to the perceptions of informational justice, and no interactional unfair conduct could have been associated with this substitution procedure.

In contrast, there is strong evidence that therapeutic substitutes invoked perceptions of unjust procedures. Physicians might not have been convinced of the adequacy of the substitution, which could be an explanation for the extra time taken for this decision. For example, they could have perceived this recommendation as merely representing the vested interest of the HMO to save money at the expense of patients. Physicians could clearly regard such a notion as hindering their professional efficacy and autonomy, rendering a rather reactant response (Vashitz et al., 2009). It may very well be that these recommendations were additionally interpreted as unfair interactional conduct between HMO's management and physicians whose voice might not have been heard, or at least not adequately regarded (Lind & Tyler, 1988). Assuming that physicians perceive themselves as representing the well-being of their patients, they may also regard therapeutic substitute recommendations as interactional injustice toward their patients, as well as an informational unjust procedure, because patients might not possess the full information concerning the nature of the drug substitute.

5.4. Implications for Research

Future research should investigate reasons for the elicited compliance behavior possibly by using scales measuring the organizational justice constructs (Colquitt, 2001) focusing on procedural, interactional, and informational justice, which are more relevant to this context. In-depth interviews with physicians who demonstrate various compliance behaviors can also greatly contribute to understanding their motivations.

Although the three types of organizational justice seem more relevant to the investigated context, the negative effect of workload on compliance possibly suggests some form of distributive justice issue. It is plausible that overloaded physicians feel that resources and outcomes are not justly distributed, hence they develop a form of resentment expressed by not complying with a recommendation that, if adhered to, would save costs for the presumably unjust employer. We suggest this topic for future research.

Further work along this trajectory will shed light on the important topic of adherence to administrative procedures. Results of such work should be of interest to researchers in healthcare administration, to management scientists who study organizational conduct in the current prevailing environments of knowledge and knowledgeable workers, and to designers of information systems who could use the results to develop organizational systems that would be more readily accepted by users if perceived as adhering to procedural, interactional, and informational justice.

5.5. Implications for Practice

HMOs and other healthcare providers, as well as providers of EMR, particularly drug prescription systems, can benefit from the results of this study in several ways. First, the results support the assertion that similar clinical information systems might be effective in reducing drug costs without impeding quality of healthcare. Nonetheless, compliance with drug notifications is neither automatic nor immediate, and physicians need to be convinced that the substitute notifications are based on good clinical practices and are not intended to promote cost savings at the expense of the quality of care. Furthermore, time is an important determinant for users when deciding whether or not to comply with a drug substitute notification in an EMR system. Hence, when designing such a system, every feature, key, and functionality needs to be carefully scrutinized for necessity, and its impact on response time must be evaluated.

Our findings relating compliance to employment type and specialty suggest that HMOs might choose to act proactively and differentially toward increasing compliance via educational programs as well as incentives aimed at driving compliance up. In addition, HMOs can revisit and change substitute recommendations that are difficult for physicians to comply with. Workload has also been found to negatively affect compliance in certain instances. Employers should evaluate the benefits of a heavier workload against lost cost savings.

In conclusion, this study illustrates the contribution of an EMR system with a substitute notification capacity built into a drug prescription module in a generally complex and difficult field, where benefits, in general, and economic impacts, in particular, are not easily obtained and demonstrated. However, more research is called for to further substantiate these results.

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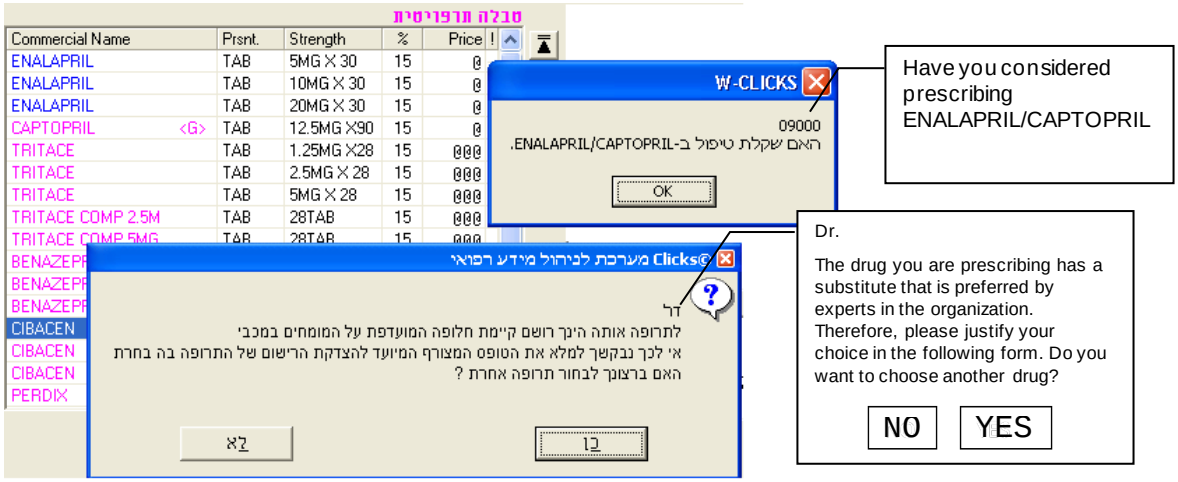
Appendices

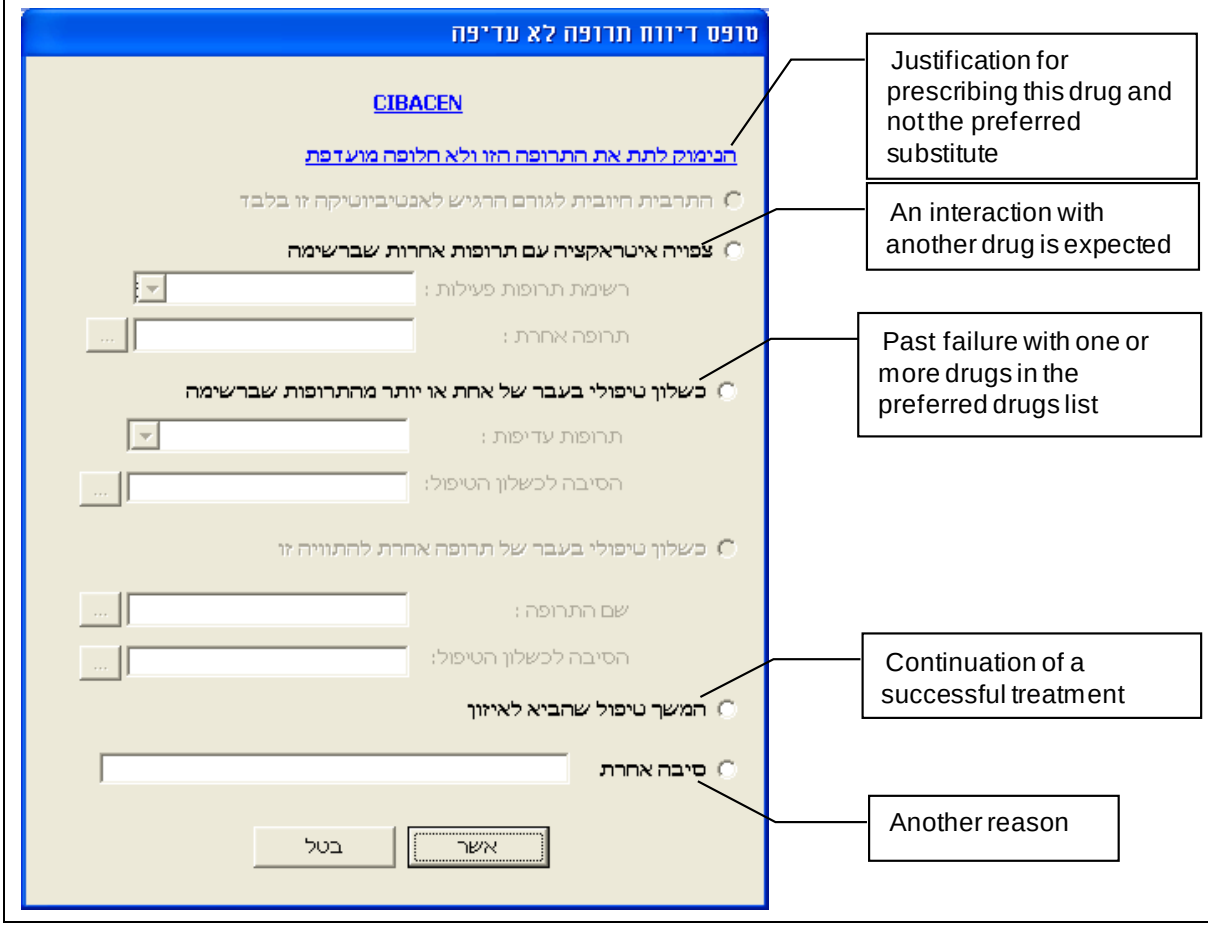
Appendix A.

Exhibit A-1. Alerts to the Existence of a Preferred Substitute



Appendix B.

Exhibit B-1. A Digital Form to Justify Drug Prescription When not Complying with Drug Substitute Recommendation



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