The Seattle Evaluation of Computerized Drug Profiles: Effects on Prescribing Practices and Resource Use

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Abstract: Since 1979, all outpatient pharmacy transactions at the US Public Health Service Hospital in Seattle have been captured in a computer system which generates a profile of each patient's active and previously used drugs. We conducted a controlled trial in which patients were allocated to profile or no-profile groups while the computer continued to collect data on everyone. In all, 41,572 clinic visits made by 6,186 patients were studied.

The incidence of preventable drug-drug interactions and redundancies was very low and was unaffected by profiles. For unclear reasons, prescription of two interacting drugs on the same visit was significantly more common for patients with profiles. The duration of drug-drug interaction episodes was significantly shorter for profile group patients, perhaps due to earlier detection of the error on subsequent visits. Profiles had no effect on prescribing volume or coordination of drug refill and visit schedules, but profile group patients made about 5 per cent fewer clinic visits than those in the no-profile group.

In this setting, it appears that the prescribing of interacting or redundant drugs is more often due to inadequate provider knowledge than to inaccessible patient-specific drug data. Prevention of such errors would thus require a more active educational or monitoring program. (*Am J Public Health* 1983; 73:850–855.)

Introduction

Rapid advances in the capabilities of computer technology and dramatic declines in its cost have led to almost exponential proliferation of computer applications in many areas of contemporary life, and health care is no exception. In many institutional health care settings, the motivation for acquiring computers has come chiefly from the need to support such administrative functions as billing and inventory control. But it has also been recognized that the data captured in such systems have many potential uses in clinical care delivery and health services research.

We were afforded an opportunity to evaluate one such application when, in 1978, the US Public Health Service Hospital in Seattle, Washington installed a computerized prescription processing system in its outpatient pharmacy. The pharmacy system was designed as part of a larger computerized medical information system being developed to meet the data needs of the hospital and its seven sister institutions in other seaport cities of the United States. It was designed to maintain a data base on each patient's current and past drugs, to generate labels for medication containers, and to assist the pharmacists with inventory control and cost accounting.[1]

Although the pharmacy computer system was primarily adopted to support day-to-day operation of the pharmacy itself, several characteristics of the institutional setting suggested that the drug data thus captured might be particularly useful for clinical care delivery as well. The hospital's clinic system provided a wide range of ambulatory care services (including drugs) without charge to a relatively closed patient population. Hence the pharmacy's records were thought to contain an essentially complete record of all prescription medications being taken by these patients. Because of frequent provider turnover and referral of patients among various specialty clinics, a patient was often under the care of several providers, thus placing increased demands on the medical record to serve as a communication channel among these clinicians. The medical records were largely handwritten and, as in many similar settings, often provided incomplete or illegible information about drugs being taken. For these reasons, it was felt that using the data captured by the computerized pharmacy system to upgrade the quality of documentation in medical records could be an important service for care providers.

Accordingly, the computer was programmed to generate an updated summary or "profile" of each patient's current and past medications whenever a drug was dispensed to that patient from the pharmacy.* This profile was then filed prominently in the medical record within 24 hours. Besides reading the profiles, providers could write directly on them to change prescribing directions, to authorize refills, or to prescribe most new drugs. The profile was then carried by the patient to the pharmacy in place of a traditional prescription blank.

The profile system's developers and the hospital administration hoped that use of profiles by clinic providers would have several beneficial effects. First, it was thought that improving the accessibility and completeness of drug data would reduce the occurrence of certain prescribing errors: in particular, adding a new drug which seriously interacted with another drug the patient was already taking (a drug-drug interaction), or adding a new drug which essentially duplicated the action of another drug already being taken (a redundancy). Moreover, since the date and amount of each drug dispensation were shown on the profile, it was thought that providers could better coordinate patients' need for refills with their scheduled clinic visits.

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Editor's Note: See also related editorial, p 844 this issue.

*A sample profile is available on request from the authors.

Besides improving prescribing in these ways, it was felt that profiles might reduce the actual number of drugs being taken, due to easier elimination of drugs no longer indicated. This might also reduce clinic visit frequency, because better coordination with refill needs should lessen the need to return solely for refill authorizations. Additional hypothesized effects on how providers spent their time during clinic visits were investigated in a companion study.[2]

Methods

For evaluation purposes, the computer was programmed to collect identical drug data on all clinic patients but to generate profiles for only 80 per cent of patients, based on the medical record number. The remaining 20 per cent of patients constituted a no-profile control group. Since medical record numbers had been assigned sequentially without regard to patient characteristics, this method of subject allocation closely approximated random assignment to the two treatment groups in an 80:20 ratio. After a four-month period of passive data collection, computer generation of profiles began in January 1979 and continued until mid-September 1980, a total of 20.5 months. (Thereafter profiles were generated for all patients.) During the study period, 15,477 patients made at least one clinic visit and received a prescription, making them eligible for the study. The analysis compared all 3,089 patients in the no-profile control group with a 25 per cent random sample (i.e., 3,097 patients) of the profile group.

Because of disagreement as to what constitutes a "clinically significant" drug-drug interaction, two separate lists of interacting drug pairs or *criteria sets* were used for study of interaction frequency in the two patient groups. The first list of 16 drug pairs, shown in Appendix A, used a relatively "strict" definition and included direct pharmacologic antagonists and other interacting drug pairs known to have produced adverse effects or treatment failures in humans. According to two widely used references on drug-drug interactions,[3,4] concurrent use of pairs of drugs on this list is to be avoided. The second criteria set for interacting drugs was more liberal, including 48 drug pairs classified as "severe" or "moderate" interactions in the current edition of Hansten's *Drug Interactions*.[3] The clinical significance of many of these interactions is less well documented, and some may be circumvented if dosage or scheduling adjustments are made. We reasoned that physicians might still wish to avoid concurrent use of these drugs when possible and that profiles could assist them in doing so.

To evaluate drug redundancies, 14 classes of drugs were identified in which one would never expect a patient to be taking two drugs from within a class at the same time (e.g., oral hypoglycemics). The drug classes included in this analysis are shown in Appendix B.

An episode of drug-drug interaction or redundancy was defined as starting on the day when a given patient first had active prescriptions for the two offending drugs. The episode ended when at least one of the two drugs ran out or was discontinued. Each such episode was categorized according to whether it resulted from one drug having been added to a regimen which already included the other, or whether it resulted from both drugs having been initiated on the same clinic visit. Availability of a profile would presumably not prevent the latter type of episode.

To assess the degree of coordination between drug refill schedules and clinic visit schedules, we determined the frequency with which lapses occurred in patients' supplies of medications such as anticonvulsants, usually intended for continuous use. Twenty-three such continuous-use drugs were identified.** A lapse was defined as having occurred if, between two dispensations of such a drug to a given patient, the amount dispensed the first time would have been exhausted before the patient received the second supply. Lapses of over 60 days were regarded as possibly intentional and were excluded. The results were little affected by this exclusion, however.

All analyses were confined to drugs taken by mouth, since it was difficult to predict an accurate prescription expiration date for drugs used topically.

Both before and after implementation of the computer system, hospital pharmacists had access to drug regimen data on all pharmacy users and routinely checked for possible prescribing errors when filling prescriptions. Before the computer system was installed, this was done by consulting and updating a manual card file; later, similar data could be retrieved and viewed on a video display terminal. It was expected that this process would prevent some medication errors in both profile and no-profile groups but that it would not invalidate a test of whether remaining errors could be prevented by incorporation of profiles into medical records.

Results

Table 1 shows the number of patients in each comparison group who received prescriptions for interacting or redundant drugs during the study period. Profile-preventable interactions (those involving drugs initiated on different visits) occurred with approximately equal frequency in both groups, providing no evidence of a preventive effect of profiles. The only statistically significant difference between groups was for interactions according to the stricter criteria involving two drugs which were initiated on the same clinic visit. No profile effect would be expected for such episodes, yet they were more common in the profile group.

Table 2 shows the average duration of exposure to interacting and redundant drugs for patients so exposed. To preserve statistical independence, two or more episodes experienced by the same person were aggregated by summing the person-days for all such episodes. As hypothesized, profile group patients received interacting drugs listed in the stricter criteria set for only about one-third as long as their counterparts in the no-profile group. Additional analyses (not shown) revealed that this difference could not be accounted for by differences in the mix of preventable and non-preventable interaction episodes, as defined above. For redundancy episodes, the same pattern of results obtained but fell short of statistical significance. For interactions by the more liberal criteria set, there was no appreciable difference in exposure duration.

To summarize the experience of the study groups with regard to the incidence and duration of drug-drug interaction episodes, a statistical model was developed to estimate the probability that a randomly chosen patient from the profile or no-profile group would be receiving two seriously interacting drugs on any given day. The model, described more fully in Appendix C, allowed for the fact that new patients could be added to the population under observation at any time after implementation of the profile system. It also

**List available on request to authors.

TABLE 1—Number of Patients Who Experienced One or More Drug-Drug Interactions or Redundancies

	Number of Patients		
	Profile Group	No-Profile Group	p*
Total Patients	3,097	3,089	—
Exposed to Interacting Drugs			
By criteria set #1 (strict):			
Drugs begun on different visits	15	14	.86
Drugs begun on same visit	19	8	.03
By criteria set #2 (liberal):			
Drugs begun on different visits	161	183	.21
Drugs begun on same visit	109	108	.99
Exposed to Redundant Drugs			
Drugs started on different visits	46	56	.31
Drugs started on same visit	5	7	.56

*Two-tailed p-value showing statistical significance of difference in event frequency between profile and no-profile groups (by chi square).

allowed patients to be withdrawn from the analysis ("censored") 90 days after their last clinic visit, a cutoff point arbitrarily chosen to remove patients who were at much lower risk of receiving interacting drugs simply because they had not sought care recently. The results of this analysis are shown in Figure 1 for drug pairs in the stricter set, for which differences in interaction duration were most evident. Although there is no straightforward way of testing the differences between groups for statistical significance, the Figure suggests that the risk of receiving interacting drugs on any given day were generally lower in the profile group.

Table 3 compares the profile and no-profile groups with regard to the frequency of lapses in supply of medications usually intended for continuous use. Over 500 patients in each group took such a drug, but the number of patients experiencing a lapse in supply was almost identical. The duration of these lapses was also about the same.

Lastly, several indicators of resource use were investigated in relation to presence or absence of a profile (Table 4). As hypothesized, clinic visit frequency was slightly lower for profile group patients (about 5 per cent) but the difference was not quite statistically significant with a two-tailed test. Since the observed difference was in the predicted direction, use of a one-tailed test in this situation could be considered justified, in which case the p-value would be .04. The frequency of visits to the pharmacy, the mean number of active drugs on the last clinic visit, and the proportion of patients on more complex regimens involving four or more drugs were similar for both groups.

Discussion

Irrespective of the effect of drug profiles, one conclusion suggested by these findings is that serious prescribing errors, at least as defined by the relatively strict criteria used in this study, were rather rare in the present setting. Fewer than 1 per cent of patients receiving prescriptions were ever exposed to seriously interacting drugs, and less than 0.1 per cent of the estimated total person-time at risk was spent thus exposed. This finding may be due in part to the fact that pharmacists continued their traditional surveillance for interacting or redundant drug combinations for both groups throughout the study, and it may be that this alone is a very effective system.

Given that some drug-drug interactions and redundancies did occur, however, we found no evidence that availability of a computer-generated drug profile reduced their frequency of occurence. The only difference in the frequency of such episodes occurred for two interacting drugs initiated on the same clinic visit, when no effect of profiles would be expected. Even in retrospect, we have no ready explanation for this finding. It does not appear to have resulted from a general increase in prescribing volume, since that was measured directly and was similar for the two

TABLE 2—Duration of Exposure to Interacting or Redundant Drugs

	Mean No. of Days of Exposure per Patient Experiencing an Episode		
	Profile Group	No-Profile Group	p*
Interacting Drugs			
By criteria set #1 (strict)	22.5 (28)	66.7 (18)	.03
By criteria set #2 (liberal)	104.1 (213)	102.8 (232)	.91
Redundant Drugs	49.8 (49)	68.7 (61)	.12

*Two-tailed p-value showing statistical significance of differences in means (by t-test).
Number of patients shown in parentheses.

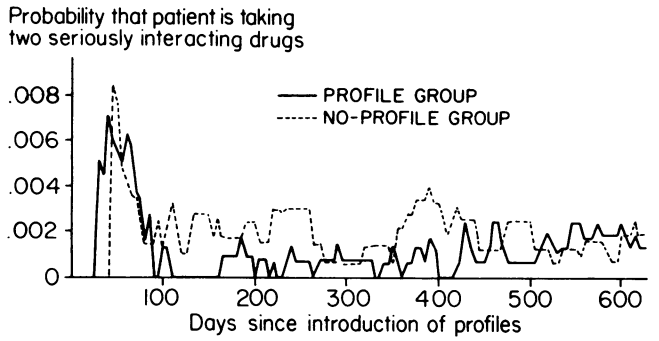

FIGURE 1—Probability that a randomly chosen patient was taking seriously interacting drugs, by time since initiation of profile system, for patients with and without profiles. (Based on a statistical model described in Appendix C.)

groups. Although profiles did not alert prescribers to avoid concurrent use of any specific pairs of drugs, they had no apparent design feature which would encourage such inappropriate use. We are forced to conclude that chance may account for this perverse result.

The pattern of findings on interaction and redundancy frequency does suggest, however, that inaccessibility of patient-specific drug data is a relatively unimportant cause of such episodes. Improving access to drug data had little effect, and it was not uncommon for two offending drugs to have been initiated on the same clinic visit. This suggests that providers either hold contrary views as to the danger of using such drugs concurrently, or that they are simply unaware of the danger. Changing this behavior would thus seem to require a more active educational or monitoring program.

As a by-product of the analysis, it was found that over 50 per cent of the interaction episodes considered most significant involved either propranolol or a tetracycline preparation (cf. Appendix A). While clearly this result depends on the criteria themselves, it is probably generally true that a small number of drugs can be shown to account for a large proportion of interaction episodes, implying that targeting of an educational or monitoring program is possible.

Despite the apparent lack of a profile effect on preventing interactions and redundancies from occurring, it appears that profiles may have facilitated earlier detection and elimination of such drug combinations. The duration of exposure to seriously interacting drugs was consistently shorter for profile group members, and this finding was confirmed by several analytic techniques. Perhaps prescribers belatedly recognized an error when both drugs appeared side by side on a computer printout at the next visit. Alternatively, since provider turnover and referrals among clinics were rather frequent in this setting, one physician often had an opportunity to review and change prescribing decisions made by another. Apparently the profile facilitated these processes.

Profiles did make it more convenient for prescribers to order and to discontinue drugs, but the net effect of profile availability on prescribing volume was negligible. However, the results suggest that profile group patients made 5 per cent fewer clinic visits than did no-profile patients. Even with our fairly large sample size, this difference was statistically significant only with a one-tailed test. But it is quite possible that some visits which might have taken place mainly to obtain a physician's authorization for a drug refill were indeed avoided. If true, even this modest reduction in visit frequency would have substantial cost implications.

Our findings are quite compatible with those of Johnson and colleagues, who studied a somewhat different type of computer-generated drug profile in a Health Maintenance Organization (HMO) setting.[5,6] The profiles they studied consisted simply of a chronological listing of prescriptions for a given patient, were inserted in the medical record only once a month, and did not substitute for traditional prescription blanks for the ordering of drugs. These authors found no effect of profiles on the frequency of drug-drug interactions or prescribing volume,[5] but they recommended that further

TABLE 3—Lapses in Supply of Drugs Usually Intended for Continuous Use

	Profile Group	No-Profile Group	p*
Number of Patients Who:			
Entered the study	3,097	3,089	—
Took a continuous-use drug	545	511	.27
Experienced a lapse in supply	143	142	.99
Mean Length of Lapse (days)	23.3	22.4	.49

*Two-tailed p-value by chi square (for frequencies) or t-test (for means).

TABLE 4—Selected Indices of Resource Utilization

Resource Utilization	Profile Group	No-Profile Group	p*
Mean annual clinic visits per patient	9.46	9.97	.08
Mean pharmacy visits per patient	5.03	5.09	.77
Mean number of active drugs after last clinic visit	.69	.70	.73
Percentage of patients on four or more drugs after last clinic visit	4.1	4.5	.44

*Two-tailed p-value by t-test (for means) or chi square (for percentages).

studies of other types of profiles be conducted in additional settings.

The findings of this study suggest that improving the formatting and timeliness of profiles over this earlier version was not sufficient to prevent prescribing errors. Achievement of this goal would appear to require a more active intervention, such as an automated surveillance system which monitors prescribing behavior concurrently and alerts users to drug-drug interactions or redundancies before the prescribed drugs are dispensed. Alternatively, an attempt could be made to improve the knowledge base of prescribers, concentrating on the prescribing errors which are empirically found to occur most frequently.

Our results do suggest that profiles alone offer benefits in areas not addressed by earlier studies: namely, in reducing the duration of interaction episodes and reducing overall visit frequency. In a companion study, we also found that profiles resulted in modest time savings for care providers in writing prescriptions and in reviewing the medical record of a complex patient.[2] A brief questionnaire survey of providers shortly after the profile system became operational indicated strong support for it. Use of profiles was reported by 93.5 per cent of respondents, with 95 per cent stating they were at least satisfied with the system and 5 per cent remaining neutral. Over 90 per cent indicated they used profiles for evaluation of therapy, and about half indicated they used profiles for detection of interactions and allergies.

Particularly in a setting where the costs of computer data acquisition can be justified on the basis of operational needs, these beneficial effects of computer-generated drug profiles may well offset the small marginal cost of their production.

REFERENCES

1. Gurtel AL, Gleser MA, Fallavolita A Jr, *et al*: PHAMIS Pharmacy System. Presented at the Third Annual Symposium on Computer Applications in Medical Care, Washington, DC, October 14–17, 1979.
2. Koepsell TD, Helfand KH, Diehr PH, *et al*: The Seattle evaluation of computerized drug profiles: Effects on provider time. Med Care 1983; 21:497–507.
3. Hansten PH: Drug Interactions (4th Edition). Philadelphia: Lea and Febiger, 1979.
4. American Pharmaceutical Association: Evaluations of Drug Interactions (2nd Edition). Washington, DC: American Pharmaceutical Association, 1976.
5. Johnson RE, Campbell WH, Azevedo DJ, *et al*: Studying the impact of patient drug profiles in an HMO. Med Care 1976; 14:799–807.
6. Johnson RE, Azevedo DJ, Campbell WH, *et al*: Examining physicians' drug order recording behavior. Med Care 1978; 16:408–416.
7. Temkin NR: An analysis for transient states with application to tumor shrinkage. Biometrics 1978; 34:571–580.

ACKNOWLEDGMENTS

A shorter version of this paper was presented at the Annual Meeting of the Robert Wood Johnson Clinical Scholars Program, San Antonio, Texas, November 11–14, 1981.

This work was supported by Grant Number HS 03892 from the National Center for Health Services Research, Office of the Assistant Secretary for Health, US Public Health Service. The authors are grateful to David Woods, John Winterscheid, and Bruce Danielson for data processing assistance.

APPENDIX A
DETAILED LIST OF DRUG-DRUG INTERACTIONS
(STRICT CRITERIA)

First Drug	Second Drug	No. of Interaction Episodes: Profile Group	No. of Interaction Episodes: No-Profile Group
Guanethidine/clonidine	Tricyclic antidepressants	3 (2)*	0 (0)
Propranolol	Methylxanthines	6 (2)	10 (6)
Propranolol	Beta-adrenergic agonists	1 (1)	0 (0)
Propranolol	Antidiabetics	6 (4)	8 (5)
Tetracycline	Antacids	13 (11)	7 (3)
Tetracycline	Oral iron supplements	5 (5)	3 (3)
Phenothiazines	Antacids	5 (4)	3 (2)
Aspirin	Warfarin-like drugs	1 (1)	0 (0)
Aspirin	Methotrexate	2 (1)	0 (0)
Aspirin	Sulfinpyrazone	1 (1)	1 (1)
Thiazides	Lithium carbonate	0 (0)	5 (1)
Phenelzine	Amphetamines, sympathomimetics	0 (0)	0 (0)
Guanethidine	Amphetamines, sympathomimetics	0 (0)	0 (0)
Phenylbutazone, oxyphenbutazone	Warfarin-like drugs	0 (0)	0 (0)
TOTAL		43 (28)‡	37 (18)

*Numbers in parentheses show number of different patients who experienced an interaction episode.
‡Differs from sum of above rows because some patients experienced more than one interaction type.

APPENDIX B
DETAILED LIST OF REDUNDANCIES

Drug Class	No. of Redundancy Episodes: Profile Group	No. of Redundancy Episodes: No-Profile Group
Narcotic analgesics	4 (4)*	8 (7)
Digitalis glycosides	0 (0)	3 (3)
Quinidine, procainamide	0 (0)	2 (2)
Thyroid and antithyroid drugs	1 (1)	4 (4)
Non-steroidal anti-inflammatory agents	13 (12)	6 (5)
Sympathomimetic amines	0 (0)	0 (0)
Beta blocking drugs	5 (3)	2 (2)
Antihistamines	1 (1)	7 (6)
Tricyclic antidepressants	6 (5)	11 (9)
Potassium-wasting diuretics	15 (14)	21 (18)
Potassium-sparing diuretics	4 (2)	0 (0)
Sedatives and tranquilizers	10 (7)	10 (6)
Aminoglycosides	0 (0)	0 (0)
Tetracyclines	3 (3)	4 (4)
TOTAL	62 (49)‡	78 (61)

*Numbers in parentheses show number of different patients who experienced a redundancy.
‡Differs from sum of above rows because some patients experienced more than one redundancy type.

APPENDIX C

Statistical Model

We considered that on each day the study was in progress, each person could be classified into one of the following groups: Group 0, defined as not yet eligible for the study; Group 1, defined as having entered the study but not taking interacting drugs; or Group 2, defined as having entered the study and taking at least one pair of interacting drugs. All patients began in Group 0. Patients left Group 0 on the first day after January 1, 1979 on which they received a prescription. They moved to Group 1 if the drug(s) they received on that day did not seriously interact with each other or with drugs received earlier and still being taken. They moved to Group 2 if the new drug(s) caused a serious interaction to occur.

A person in either Group 1 or Group 2 could, on any given day, stay in the current group or move to the other group. We assumed that individuals acted independently according to the same probabilistic rules. We also assumed that these rules gave an individual starting in Group 1 on a given day a certain unspecified chance of moving to Group 2 during that day and that the chance depended only on the calendar date, not on the individual's characteristics, the length of time he or she had been in Group 1, the number of times he or she had moved between Groups 1 and 2, etc. Similarly, we assumed that an individual in Group 2 had a different unspecified chance of moving to Group 1 during that day. A person could move between Groups 1 and 2 any number of times. We allowed for changes in prescribing practice over time by letting the chance of moving from one group to another group vary over time.

Since a person could leave the care of the hospital's clinic system at any time without that fact being noted, we decided to consider people as lost to the study after they had gone 90 days without a clinic visit. We assumed that this loss was independent of their subsequent course, i.e., that if these people had continued to receive care at the study clinics, their moves between Groups 1 and 2 would have followed the same rules as people who actually did continue receiving care there.

These assumptions led to a model similar to one described previously.[7] Modifications of arguments made in the earlier paper were used to obtain maximum likelihood estimators of each day's chance of taking seriously interacting drugs. These estimators are given by the recursive formula which can be explained as follows: the chance of taking interacting drugs on day j equals the chance of being study eligible before day j and either taking interacting drugs on day j-1 and continuing to take them through day j or taking no interacting drugs on day j-1 and getting a new prescription causing an interaction on day j, plus the chance of first becoming study eligible on day j and immediately beginning to take interacting drugs. More formally, we assumed that all loss occurred at the end of a day and let $P_1(j)$ equal the probability of being in Group 1 (i.e., of taking no seriously interacting drugs) on day j, $P_2(j)$ equal the probability of being in Group 2 (i.e., of taking interacting drugs) on day j, $f_{ab}(j)$ equal the fraction of people in Group a at the start of day j who move to Group b during the day, $n_S(j)$ equal the number of people study eligible by the end of day j, and $n_0(j)$ equal the number of people in Group 0 at the start of day j. Then,

$$P_2(j) = P_2(j-1)[1 - f_{21}(j)]n_S(j-1)/n_S(j) + P_1(j-1)f_{12}(j)n_S(j-1)/n_S(j) + f_{02}(j)n_0(j)/n_S(j)$$

and

$$P_1(j) = P_1(j-1)[1 - f_{12}(j)]n_S(j-1)/n_S(j) + P_2(j-1)f_{21}(j)n_S(j-1)/n_S(j) + f_{01}(j)n_0(j)/n_S(j).$$

To start the recursion, let $P_1(0) = P_2(0) = 0$.

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