Diffusion of Innovation II: Formulary Acceptance Rates of New Drugs in Teaching and Non-Teaching British Columbia Hospitals - A Drug Development Perspective

Mel M. D'Sa, David S. Hill and Timothy P. Stratton

ABSTRACT

Diffusion theory was used to examine differences in adoption rates of new drugs by British Columbia teaching and non-teaching hospitals. Surveys were mailed in September 1990 to 41 hospital pharmacies (response rate=88%), requesting hospital pharmacy directors to provide formulary inclusion dates of 29 study drugs marketed between July 1987 and March 1990. Of the 36 initial responses, 31 were suitable for further analysis and these were surveyed again in April 1993 (response rate=100%) as to the formulary status of drugs not initially approved. The second survey ensured that all study drugs would have at least 36 months on the Canadian market when determining formulary acceptance times. Of the 29 study drugs, six were not approved for use in any of the 31 study hospitals. The six teaching hospitals had a median formulary approval time of 8.0 months compared to 12.8 months in the 25 non-teaching hospitals for the 23 study drugs. Although 21 of 23 study drugs were approved for use earlier in teaching hospitals than non-teaching hospitals, only alfentanil was found to be adopted significantly earlier ($U=11$, $n_1=5$, $n_2=19$, $\alpha=0.05$). Variations in formulary approval times for new drugs have a bearing on patient care, Pharmacy and Therapeutics Committees, hospital budgets, and pharmaceutical firm revenues.

Key Words: *Diffusion of innovations, Drug technology, Formulary, Pharmacy and Therapeutics Committee*

RÉSUMÉ

La théorie de la diffusion a été utilisée pour étudier les différences dans les taux d'adoption de nouveaux médicaments dans des hôpitaux universitaires et non-universitaires de Colombie-Britannique. À cette fin, des sondages ont été postés, en septembre 1990, à 41 pharmacies d'hôpitaux (taux de réponse de 88 %). On demandait aux chefs de ces départements de pharmacie de fournir les dates auxquelles avaient été inclus au formulaire d'hôpital, 29 médicaments qui avaient été commercialisés entre juillet 1987 et mars 1990. Des 36 hôpitaux répondants initiaux, 31 ont satisfait les critères permettant de passer à une analyse subséquente, et ont fait l'objet d'un nouveau sondage en avril 1993 (taux de réponse = 100 %), relativement à la position au formulaire de certains médicaments qui n'y avaient pas été acceptés initialement. Ce deuxième sondage s'assurait que tous les médicaments de l'étude étaient sur le marché canadien depuis au moins 36 mois, pour pouvoir déterminer la date d'inscription au formulaire. Des 29 médicaments, six n'ont pas été acceptés aux formulaires des 31 hôpitaux sondés. Quant aux six hôpitaux universitaires, leur temps moyen d'inscription au formulaire était de 8,0 mois, comparativement à 12,8 mois pour les 25 hôpitaux non-universitaires et les 23 autres médicaments de l'étude. Bien que l'adoption de 21 des 23 autres médicaments ait été plus précoce dans les hôpitaux universitaires que dans les autres hôpitaux, seul l'alfentanil a été adopté significativement plus tôt ($U=11$, $n_1=5$, $n_2=19$, $\alpha=0,05$). Les différences dans le temps d'adoption d'un nouveau médicament au formulaire ont des conséquences sur les soins aux patients, les décisions des comités de pharmacologie, les budgets hospitaliers et les revenus des sociétés pharmaceutiques.

MOTS CLÉS : *Comité de pharmacologie, Diffusion des innovations, Formulaire, Technologie pharmacologique*

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INTRODUCTION

This paper is the second of a two-part series describing the responsiveness of Pharmacy and Therapeutics Committees to new drugs in a sample of British Columbia hospitals.[1] In this second paper, the hospital formulary adoption pattern of selected drugs introduced to the Canadian market from July 1987 to March 1990 is examined. Based upon aspects of diffusion theory,[2] insight is provided into the factors influencing the formulary acceptance of new drugs by hospital Pharmacy and Therapeutics Committees of teaching and non-teaching hospitals. In addition, implications of variations in formulary approval times are discussed.

Diffusion and Adoption

New drugs are developed for any one or a multiplicity of reasons. They may be developed to replace existing drugs, to complement existing drugs in multi-drug treatment protocols, to treat emerging diseases, to treat previously untreatable diseases or health problems, or for any combination of the above. The existence of thousands of drugs on the Canadian market necessitates a rational and organized approach for drug selection by potential users. Cost, efficacy, and safety of a drug are among the primary criteria considered in determining whether a new drug will be accepted for use within a hospital. The acceptance process of new drugs for contemporary practice involves a form of technology diffusion and ultimately adoption from industry to user physicians and hospitals.

The process by which a new technology is introduced and adopted by users is complex. Rogers refers to the overall process as the diffusion of an innovation. Diffusion is defined as the spread of a new concept, product, or service from an innovation source to its ultimate adopter. For a new technology a sequence of events occurs over a given time period. This sequence includes the initial innovation or discovery stage, subsequent communication of the existence of a technology through a social system of adopters, and the ultimate adoption or rejection of the new technology.

When viewed as a technological innovation originating from a pharmaceutical manufacturer to eventual acceptance by hospitals, a new drug can be characterized by a number of important attributes. The following attributes are derived from Rogers' diffusion theory.[2] Adoption of a new drug is greatly influenced by its relative advantage or superiority over currently available drugs. The degree to which a drug is consistent with existing community values is termed compatibility. For example, the introduction of oral contraceptives in a country that prohibits any form of birth control would not demonstrate compatibility. Complexity refers to a drug's ease of use, such as method of administration or frequency of dosing. Trialability is the degree to which a drug may be used on a limited basis. New drugs have a greater chance of being adopted over alternatives if users can try them before deciding to adopt them. Finally, observability refers to how visible the beneficial features of a drug are to its users. Drugs with clear and observable therapeutic effects will diffuse quickly among hospitals.

Rogers describes a classification system which characterizes market users such as hospitals by the speed with which they accept a new technology. This classification displays a bell curve distribution in which distinct groups are described as: innovators [approximately 2.5% of the population of users], early adopters [13.5%], early majority [34.0%], late majority [34.0%], and laggards [16.0%].[3] New drug formulary approval practices by hospital Pharmacy and Therapeutics Committees may be categorized in a similar fashion.

The hospital formulary represents a compilation of local technology-assessment activities as well as a restricted drug list that has been reviewed by a hospital's Pharmacy and Therapeutics Committee and reflects the preferred agents available for use.[4,5] The formulary process provides a service to patients, prescribers, and even pharmaceutical firms who are provided with an audience to examine their data.[6] Pharmacy and Therapeutics Committee formulary decisions may be considered as the penultimate measure of a technology adoption process for new drugs in an organized setting. The ultimate indicator is actual prescribed use of the new drug by the medical staff.

The objective of this second paper in this two part series is to describe the hospital formulary adoption pattern of selected drugs introduced to the Canadian market from July 1987 to March 1990. This study asserts that adoption patterns for new drugs should significantly differ between hospitals of a teaching type versus hospitals of a non-teaching type. Variations in adoption patterns will be examined, since these have consequences for patient care, Pharmacy and Therapeutics Committees, hospital budgets, and pharmaceutical firm revenues.

METHODS

At the time of the survey in October 1990, there were a total of 64 pharmacies in hospitals licensed by the College of Pharmacists of British Columbia.[7] This total represented all hospital pharmacies in the province. Entry criteria required that the hospital operate a pharmacy department with at least 125 beds. Hospitals with pharmacies and fewer than 125 beds (thirteen hospitals), serving as extended-care or rehabilitation facilities (four), or specialty agencies (seven) were excluded from this study. This was to ensure that study hospitals would have sufficient patient care scope to likely use a majority of the study drugs. With these exclusions the total number of eligible hospitals was reduced to 40. One pharmacy

department provided service to two hospitals, thus requiring a separate analysis of each site. Teaching or non-teaching hospital status was confirmed with the 1992 Canadian Hospital Association Directory.[8]

In Canada, a Notice of Compliance (NOC) issued by the Health Protection Branch of Health Canada signifies that a drug may be released by a manufacturer for general distribution to the Canadian market. Drugs receiving a NOC during the period July 1987 through to March 1990 were selected to be surveyed. To be included in this study, a drug had to be a new chemical entity released on the Canadian market for human therapeutic use only, or had to be an existing drug which had received approval for a new therapeutic indication. In addition, a study drug had to be adopted by at least two study hospitals in order to be included in the analysis. Table I lists specific inclusion and exclusion criteria with 29 drugs meeting the inclusion criteria. Table II provides the NOC dates for all study drugs. The Health Protection Branch was contacted to verify NOC dates for all study drugs.

A survey instrument was constructed and subsequently mailed to the 41 hospital pharmacies in October 1990. Respondents were given two months to reply. To maximize the response rate, each survey was accompanied by a personally addressed letter eliciting support, and a stamped, addressed return envelope.[9] A second mailing to non-responders was conducted one month after the initial mailing. Confidentiality was assured for all hospitals.

The survey instrument was addressed to the pharmacy director, with questions relating to the 29 study drugs as follows: hospital consideration of the new drug for formulary addition (yes or no); month and year of drug approval; any conditions, restrictions, or time limits placed on the formulary approval of the drug; and whether the drug had been subsequently removed from formulary and the date of such removal.

At the time of the first survey in October 1990, enalapril had been on the Canadian market for 39 months, while cefotetan had been on the market for only seven months. To adjust for this discrepancy, a second mailing of individualized surveys was conducted in April 1993 to ensure all study drugs initially surveyed in October 1990 had received at least 36 months on the Canadian market for formulary consideration. It was felt that 36 months was a reasonable time period in order to allow for formulary consideration of a new drug given the research time frame of this study. Hospitals responding to the original survey were asked about the formulary

Table I: Inclusion and Exclusion Criteria for Study Drugs (n=29)

Total entries in HPB list (For human use only)	590
Drugs selected for study from HPB list[a]	23
Drugs excluded from study:	
diagnostic agents	2
blood products	3
topical products, anti-parasitic, anti-malarial, anti-helmintic	8
new anti-neoplastic and related drugs	8
new dosage form, strength, packing, expiration date, raw materials, discontinued products, generics, reviewed product monograph, name changes, different company but same drug	546

[a] Source: 23 drugs were chosen from the Health Protection Branch (HPB) Bulletins for the July 1987-June 1989 period. The NOC dates for 6 other study drugs chosen from July 1989-March 1990 were obtained directly from HPB, Ottawa, Ontario for a total of 29 study drugs.

Table II: NOC Dates for Study Drugs (n=29)[a]

Generic Name	Notice of Compliance Date
Enalapril maleate	July 7 1987
Imipenem-cilastin sodium	July 7 1987
Alfentanil hydrochloride	July 10 1987
Bacampicillin hydrochloride[b]	August 11 1987
Midazolam hydrochloride	October 22 1987
Propafenone hydrochloride	October 30 1987
Buserelin acetate[b]	November 4 1987
Alteplase	November 12 1987
Flecainide acetate	December 31 1987
Nizatidine[b]	December 31 1987
Ceftizoxime sodium	March 15 1988
Flurbiprofen sodium (ophthalmic)	March 22 1988
Mecillinam[b]	May 26 1988
Lovastatin	June 30 1988
Vancomycin (oral capsules)	August 8 1988
$Alpha_1$-antitrypsin (human)	September 19 1988
Dronabinol[b]	October 27 1988
Fluoxetine hydrochloride	November 30 1988
Ciprofloxacin hydrochloride	January 1 1989
Terazosin hydrochloride	January 9 1989
Ticarcillin clavulante	May 29 1989
Procaterol hydrochloride[b]	May 30 1989
Omeprazole	June 13 1989
Cisapride monohydrate	August 29 1989
Buspirone hydrochloride	October 4 1989
Cefixime	November 11 1989
Nimodipine	September 22 1989
Selegiline hydrochloride	January 2 1990
Cefotetan disodium	March 8 1990

[a] Source: 23 drugs were chosen from the Health Protection Branch (HPB) Bulletins for the July 1987-June 1989 period. The NOC dates for 6 other study drugs chosen from July 1989-March 1990 were obtained directly from HPB, Ottawa, Ontario for a total of 29 study drugs.

[b] Drugs not approved for use by any study hospital.

status of study drugs which had received NOC after September 1988, but had not been approved for use by the time of the initial survey.

The relatively small sample size and the non-normal data distribution precluded the use of parametric tests. Thus, the non-parametric Mann-Whitney U Test (two tailed, corrected for ties, α=0.05) was used to test for significant differences in the rates of new drug adoption between teaching and non-teaching hospitals.[10]

Assumptions and Limitations

The assumptions on which this study are based are important. It was assumed that study drugs would have a potential use in all study hospitals, but this may not be necessarily true. At some hospitals the high acquisition cost of certain new drugs may have prevented formulary inclusion and subsequent use. Significance of the cost of the new drugs was not tested. It was assumed that all hospitals would receive similar attention from pharmaceutical firms in order to ensure awareness of the introduction of any new drugs. However, different geographical areas of the province as well as the teaching or non-teaching status of the hospital may affect the extent to which manufacturers will promote and inform prospective hospitals of the merits of a new drug.

This study has several limitations. Hospitals were not surveyed regarding their investigational use of study drugs prior to NOC date. Hospitals participating in clinical trials to determine the usefulness of certain investigational drugs may have had an advantage in gaining experience with a drug compared to hospitals that had no pre-market release access. By the time a NOC for an investigational drug was issued, investigating hospitals would have already acquired information about the relative advantage, compatibility, complexity, trialability, and observability of this new drug. Therefore, an investigational drug found to be acceptable could be added to a hospital's formulary within a short approval time. No effort was made to control for hospital investigational drug activities. Also, no effort was made to control for new drugs that may have been denied Pharmacy and Therapeutics Committee approval, but were subsequently made available for use through a non-formulary drug use process.

Another limitation involves data analysis. The second survey of study hospitals was undertaken to ensure all 29 study drugs initially surveyed in 1990 would receive 36 months on the market. However, even with this extended time frame, study drugs could still have been in the process of being considered for formulary inclusion at the time the second survey was being circulated. Finally, formulary approval times were assigned to four month intervals for graphical presentation. Changes in this scale of reference lead to corresponding changes in the observed frequencies of approval times.

RESULTS

From the 41 surveys mailed in September 1990, 36 responses were received, representing an 88% return rate. On further review of the responding hospitals, five were omitted from the study. Two of these reported having fewer than 125 beds and thus failed to meet the original inclusion criteria. The remaining three hospitals were classified as extended-care facilities. This reduced the number of eligible hospitals to 31. Analysis of non-responders revealed all five hospitals were non-teaching and located in different geographic regions of the province. Of the 31 responding hospitals, six were teaching and 25 were non-teaching.

The second survey of the initial 31 responding study hospitals in April 1993 yielded a 100% response rate. Bacampicillin, buserelin acetate, dronabinol, mecillinam, nizatidine, and procaterol were study drugs not approved for use by any responding hospitals. This reduced the number of drugs for analysis to 23.

To compensate for differences in Pharmacy and Therapeutics Committee meeting times, a consistent time frame was utilized to minimize underestimation or overestimation of drug approval times in hospitals. Although respondents were requested to provide the month and year of formulary addition, the date reported was assigned to the fifteenth day of the month. Thus, the formulary approval time was calculated to be the number of months from the actual NOC date to the fifteenth day of the reported month of formulary addition.

Table III summarizes the formulary approval times for all study drugs surveyed in the responding hospitals based upon both surveys. Of the 23 study drugs in the 31 hospitals, the median formulary approval time for a new drug was 11.5 months [range, 4.5 months for propafenone to 33.0 months for ticarcillin-clavulanate]. Although 21 of 23 study drugs were approved for use earlier in teaching hospitals than non-teaching hospitals, only for the drug alfentanil was this adoption time difference found to be significant ($U=11$, $n_1=5$, $n_2=19$, $\alpha=0.05$). Of the 23 study drugs only eight drugs were approved for use in more than 75% of the responding hospitals: ciprofloxacin [31 hospitals], fluoxetine [29 hospitals], midazolam [29 hospitals], omeprazole [28 hospitals], enalapril [26 hospitals], alfentanil [24 hospitals], cisapride [24 hospitals], and selegiline [24 hospitals].

Figure 1 shows that the median formulary approval time was 8.0 and 12.8 months for the 23 study drugs in six teaching and 25 non-teaching hospitals, respectively. Positively skewed curves are evident for both teaching and non-teaching hospitals. Figures 2 to 4 depict the adoption patterns of selected study drugs by

teaching and non-teaching hospitals. Approval patterns may be explained in terms of Rogers' theory of diffusion of innovations.

DISCUSSION

Figure 1 reveals positively skewed curves for both teaching and non-teaching hospitals, with teaching hospitals possessing a shorter median formulary approval time. However, significance was not detected using the non-parametric Mann-Whitney U Test. Based upon the descriptors of Rogers, several teaching hospitals could be considered to be innovators, with the remainder falling into the early adopter or early majority groups. Several non-teaching hospitals could be considered to be in the early to late majority categories, with the remaining hospitals falling into the laggard group requiring two to three years to approve newly marketed drugs for their formularies.

Table III: Formulary Approval Intervals[a]

Drug	All Hospitals (n=31) Median (months)	Teaching Hospitals (n=6) Median (months)	Range (months)	Hospitals Approving	Non-Teaching Hospitals (n=25) Median (months)	Range (months)	Hospitals Approving
Propafenone	4.5	3.5	2.5-4.5	5	7.5	1.5-24.5	18
Ciprofloxacin	6.5	3.5	1.5-15.5	6	8.5	1.5-24.5	25
Lovastatin	7.5	8.0	1.5-26.5	6	7.5	1.5-26.5	13
Selegiline	8.5	7.5	1.5-12.5	6	9.0	1.5-34.5	18
Vancomycin (oral)	8.7	6.2	1.2-18.2	5	9.2	1.2-20.2	15
Cefotetan	8.8	3.3	3.3	1	9.3	3.3-27.3	9
Nimodipine	9.3	3.8	1.8-13.8	3	11.8	4.8-32.8	7
Fluoxetine	9.5	5.5	1.5-39.5	6	9.5	3.5-41.5	23
Flurbiprofen (ophthal)	9.8	6.8	5.8-11.8	3	12.8	5.8-31.8	12
Cisapride	10.0	7.5	5.5-39.5	6	12.5	2.5-42.5	18
Midazolam	10.8	16.8	4.8-21.8	5	9.3	2.8-34.8	24
Omeprazole	11.5	6.5	3.0-15.0	6	13.5	2.0-31.0	22
Buspirone	11.6	9.6	6.1-29.1	4	11.6	5.1-40.1	14
Flecainide	12.0	8.0	5.5-10.5	2	13.5	8.5-21.5	8
Enalapril	14.3	9.3	2.3-20.3	4	14.3	2.3-28.3	22
Alfentanil	15.1	9.1	7.1-11.1	5	20.1	7.1-38.1	19
Imipenem	15.3	6.3	2.3-20.3	5	17.3	3.3-35.3	14
Alteplase	18.0	14.0	3.0-24.0	5	18.0	11.0-36.0	15
Ceftizoxime	21.0	18.5	17.0-20.0	2	22.0	18.0-27.0	7
Cefixime	23.6	22.1	22.1	1	25.1	12.1-37.1	3
Terazosin	29.3	14.3	14.3	1	39.8	29.3-50.3	2
Alpha$_1$-antitrypsin	30.0	30.0	21.0-40.0	3	30.5	5.0-51.0	6
Ticarcillin-clavulante	33.0	17.5	17.5	1	35.5	30.5-41.5	3

[a] Interval measured from NOC date to fifteenth day of the month of formulary approval.

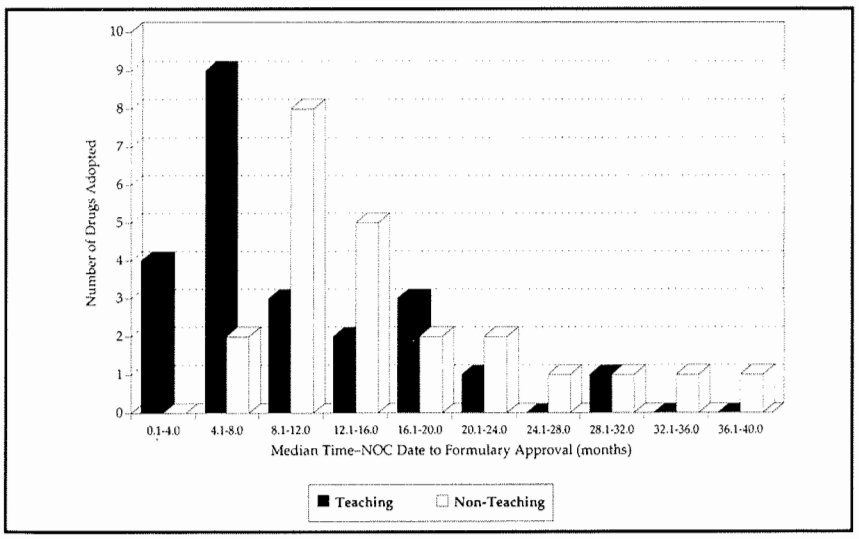

Figure 1: Median Approval Time for New Drugs (n=23 in 6 Teaching and 25 Non-Teaching British Columbia Hospitals).

Table III shows that relatively lengthy median adoption times can be observed for the following study drugs: alpha$_1$-antitrypsin (human), cefixime, ceftizoxime, imipenem, terazosin, and ticarcillin-clavulanate in both teaching and non-teaching hospitals. Quite possibly these particular drugs did not possess a 'relative advantage' in terms of superiority over other drugs in their respective pharmacological class. In addition, high cost or a questionable need for a new drug compared to existing therapeutic agents may have been another limiting factor. Consequently, the rate of acceptance of these drugs by British Columbia hospitals was longer relative to that of other study drugs.

Alfentanil was found to be approved for use significantly earlier in teaching hospitals versus non-teaching hospitals, although approximately 83% of both hospital types adopted this drug. While contributing reasons for this significant difference are difficult to ascertain, diffusion theory may offer some explanations.

Alfentanil and its alternative fentanyl are strong narcotic analgesics used as adjuncts in anesthesia. Initial enthusiasm for the use of alfentanil in short surgical procedures and minor surgery arose because of alfentanil's short duration of action.[11,12] Further, alfentanil can be administered by constant variable infusion, a less common route for fentanyl. These relative advantages for alfentanil manifest themselves in the form of convenience, better analgesic control, and a decreased risk of nausea and vomiting from surgery. However,

fentanyl is the less expensive of the two analgesics. In the teaching hospitals, it is apparent that the clinical advantages of alfentanil over existing agents were considered sufficiently important to justify the added expense. In the non-teaching hospitals, satisfaction with the use of fentanyl may have prevented a more rapid switch to a more costly alternative. Perhaps also, either the full utility of alfentanil had not yet been established, or it was still undergoing small scale trial use. Hospitals could have also been taking a wait and see approach in order to determine visible efficacy of the drug via peer hospital use or literature reports of clinical trials.

From Figure 2, only one hospital approved alteplase within four months of NOC. However, it was subsequently learned that alteplase was undergoing investigational trials in this teaching hospital. Familiarity with this agent resulted in it being added to formulary within a relatively short period of time. Remaining hospitals approved alteplase over a one to three year period. A likely reason for this delayed approval is alteplase's relatively high cost: nine to ten times the cost of an alternate agent, streptokinase. This high cost may have forced British Columbia hospitals to evaluate important therapeutic advantages of alteplase over streptokinase in the context of budgetary factors before approving alteplase.

Figure 3 demonstrates rapid diffusion and formulary approval for ciprofloxacin, with the majority of responding hospitals (81%) approving it within one year. This may reflect a relative advantage over existing formulary drugs, in addition to ciprofloxacin being a potential drug of choice in its pharmacological class. Ciprofloxacin, due to its broad spectrum of activity and potency, is efficacious in the treatment of various types of infections,[13] reduces antibiotic regimen costs attributable to savings in ancillary materials and laboratory

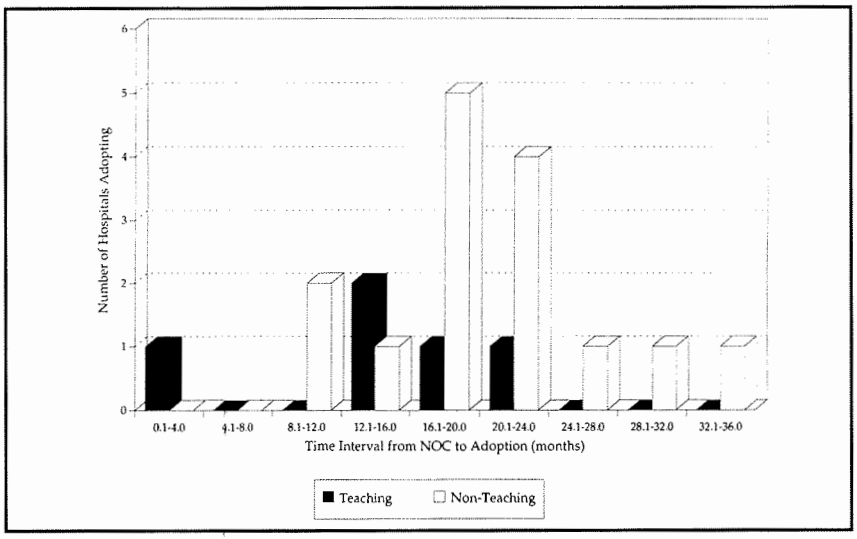

Figure 2: Alteplase Adoption in 6 Teaching and 25 Non-Teaching British Columbia Hospitals

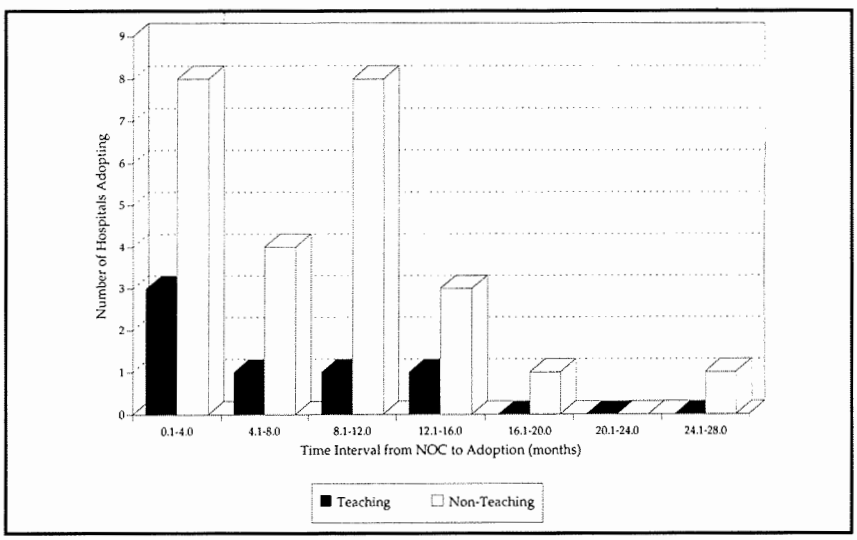

Figure 3: Ciprofloxacin Adoption in 6 Teaching and 25 Non-Teaching British Columbia Hospitals.

tests,[14] and possesses greater clinical efficacy over norfloxacin.[15] The approval pattern of ciprofloxacin in replacing its precursor norfloxacin may be similar to the cimetidine-ranitidine displacement, in which the former was displaced by the latter. When compared to cimetidine, ranitidine, the newer but more expensive agent, became the histamine receptor antagonist drug of choice in the eighties for patients with gastric acid hypersecretory states, due to its greater potency and lower incidence of adverse effects and drug interactions.[16,17]

Fluoxetine and selegiline represent two novel drugs well known to the public by extensive media coverage and exhibiting similar drug adoption patterns in this study. Fluoxetine was the most frequently prescribed of all antidepressants in the short time after its release.[18] Selegiline represented a novel therapeutic agent in the treatment of Parkinson's disease. Both drugs may be considered breakthrough drugs in their respective pharmacological classes. Hospitals may, therefore, have been eager to adopt these two novel agents, possibly due

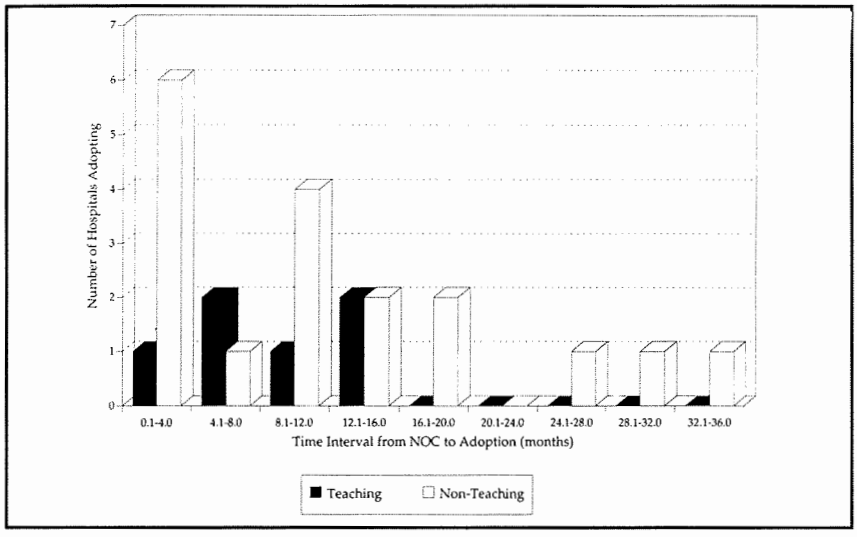

Figure 4: Selegiline Adoption in 6 Teaching and 25 Non-Teaching British Columbia Hospitals.

to pressure from physicians or patients.

The anti-arrhythmic drug, flecainide, was issued a NOC in December 1987. By the end of 1988, two teaching and eight non-teaching hospitals had adopted this drug. By the end of 1989, one teaching and three non-teaching hospitals had stated that it had been removed from their formularies. One hospital attributed its disenchantment to the Cardiac Arrhythmia Suppression Trial (CAST study), a multicenter, randomized, placebo-controlled study designed to determine if suppression of mild to moderate premature ventricular contractions could affect survival after a myocardial infarction with use of flecainide.[19] Flecainide was reported to have caused 56 deaths or cardiac arrests compared to 22 deaths or cardiac arrests with placebo. The widely-publicized results from this clinical trial may possibly have influenced the post-adoption actions towards flecainide.

The data from this study suggest that Pharmacy and Therapeutics Committee decisions contribute to broad ranges in formulary approval times by hospitals in a province or country, and that a number of patient care consequences should be recognized. Clearly, for drugs of marginal therapeutic value or those with closely similar characteristics to existing formulary drugs, the impact to patient care resulting from delays in formulary status of the new drug may be inconsequential. It would also appear that such marginal therapeutic agents would have a minimal impact on a hospital's drug budget.

Speedy approval patterns may improve patient outcomes by providing needed drugs in a more timely manner. Conversely, hasty approval patterns may jeopardize the health of hospitalized patients as these drugs may not have been evaluated completely by local clinicians for safety, efficacy, or toxicity. Since new drugs often exhibit premium pricing over existing therapies, faster approval patterns than the average of similar hospitals have the potential to deleteriously effect hospital drug expenses in the short-term and perhaps those ancillary costs of other hospital departments.

Slow or delayed approval patterns may enhance patient outcomes by mitigating harm to patients resulting from use of drugs that have a potential for causing adverse drug reactions or other drug misadventures. Conversely, the effect of delayed formulary approval patterns on the care of patients may be important as these patients may be denied new and useful drugs necessary for improved patient care outcomes. Relatively slow approval patterns, however, may reduce drug costs in the short-term by delaying expenditures for new drugs over a longer period of time than that experienced by other hospitals.

The consequences described may not occur in all hospitals. One or a combination of these consequences may occur within the same hospital or even at the same point in time. For example, teaching hospitals tend to be larger, research-based facilities that receive more acutely ill patients or patients referred from other hospitals. The data in this study suggest that although teaching hospitals exhibit relatively early adoption of new drugs, ranges in approval times across a group of new drugs are likely similar to those evident in non-teaching hospitals.[1] This study has tried to draw attention to some considerations underlying formulary approval times in a sample of British Columbia teaching and non-teaching hospitals. Other hospital Pharmacy and Therapeutics Committees must identify and assess their own relative speed of new drug formulary approvals.

From a pharmaceutical manufacturer's perspective, a new drug represents future revenue for the company and its shareholders. Due to enormous research and development costs, excessive delays in acceptance of new drugs by hospitals will result in reduced profits for the manufacturer. Identification of hospitals by their relative formulary approval practices, i.e., innovator and early majority hospitals versus the late majority are prudent strategies that may enhance the rate and extent of market acceptance of a new drug. For pharmaceuticals, the ease of introduction can be expected to be affected by the relative success of any previous

efforts in their respective product class.[20] Therefore, it would seem critical that manufacturers identify innovator and early adopter type hospitals and apply product launch marketing efforts to these hospitals that show the greatest acceptance to their products. For innovator firms, successful new drugs are necessary for corporate survival. No firm can afford the luxury of sitting back following the development and introduction of a new drug. History has proven that competing firms will quickly make such rest very short due to the rapid influx of new competitive drugs.[20]

In conclusion, based upon the results of this study, it is difficult to offer a conclusive statement about the adoption patterns of new drugs in teaching and non-teaching hospitals in British Columbia. It is equally difficult to offer definitive reasons that may be responsible for the reported adoption patterns. However, it does appear that British Columbia teaching hospitals approve new drugs for formulary relatively earlier than non-teaching hospitals in the province. Formulary approval times have varied consequences for patient care, Pharmacy and Therapeutics Committees, hospitals, and pharmaceutical manufacturers.

The data in this study are an aggregation of hospital formulary approval times of selected study drugs over a three-year time period. Variation in approval times has been observed among study hospitals leading to the categorization of hospitals as innovators, early adopters, early majority, late majority, or laggards. In some respects, these terms may be misleading. One should be careful in drawing inferences derived solely from hospital adopter type. Rather, it would seem reasonable to accept the sincerity, concern, and judgement of individual Pharmacy and Therapeutics Committees as they try to meet and cope with drug use requirements within their hospital.

To some observers, extreme variation in formulary approval times may suggest flaws in the formulary approval process. However, in some hospitals actual organizational and operational aspects may contribute to such variation. For example, infrequent Pharmacy and Therapeutics Committee meetings, lack of medical staff initiated requests for a new drug, minimal drug company marketing attention due to remote hospital geographic location, or satisfaction with current drugs on formulary may contribute to the length of time from NOC to formulary approval. At best, comparisons of formulary approval times serve as guideposts to steer Pharmacy and Therapeutics Committees on the course of providing cost-effective, efficacious, and safe drug therapy.

Further research is required to examine formulary approval practices in other Canadian provinces. Correlations between formulary approval times and drug company marketing, advertising, or other financial outlays would be insightful. It would be helpful if future research could examine specific structure and process variables responsible for early or delayed formulary drug approval.

Additional questions remain to be explored. To what degree do Pharmacy and Therapeutics Committees of innovator hospitals consider cost, efficacy, and toxicity when adopting new drugs? Do high rates of adoption necessarily indicate some flaw in the formulary approval process? Does the rapid acceptance of new drugs by innovator hospitals place strains on health care budgets? If so, are outcome measurement procedures in place to evaluate effects of rapid adoption of new drugs? Do more conservative hospitals jeopardize the health of their patients as a result of the delayed availability of potentially beneficial drugs? Should pharmacoeconomic assessments be mandatory for the ensuing market release of new drugs, and, if so, who should conduct them? What external factors can be identified that influence the adoption of new drugs by Pharmacy and Therapeutics Committees? Will the formulary approval process change in the next five to ten years? Finally, should different criteria for formulary approval be utilized by teaching and non-teaching hospitals?

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