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Managing the diffusion of pharmaceutical innovations: conclusions from a literature review¹

The diffusion of pharmaceutical innovations is a complex process. Its success is crucial for both pharmaceutical companies and patients and is determined by the marketing efforts of pharmaceutical companies, drug characteristics, government policies, and the behaviour of both medical professionals and patients. This article explores the literature on prescribing behaviours for factors influencing new drug uptake in both primary and secondary care. Four quantitatively measurable categories of variables are analysed in terms of prediction of early adoption—prescriber, patient, practice, and drug characteristics. Four major qualitatively accessible categories of variables are also analysed—the perceived attributes of new drugs, the role of professional information sources and evidence, the influence of commercial information sources, and the role of the social system. Although early adoption of new drugs is not a personal trait independent of drug type, early adopters do have some characteristics in common. Understanding the socio-demographic and professional characteristics of early adopters of new drugs—and the interactions among them—might speed up the diffusion process, promote cost-efficient prescribing habits, forecast utilisation, and develop targeted intervention strategies.

In most industrialised countries, drug expenditure as a percentage of the overall healthcare cost is increasing rapidly. Changing demographics—ageing population with increased morbidity²—and a rise in the number of drugs per patient contribute obviously to growing prescription costs. However, the key factor in rising drug expenditure is the greater variety and availability of new, expensive drugs and the higher relative cost of pharmaceuticals. The use of new drugs might explain up to 40 per cent of annual increases in expenditure in Canada, while displacement of old drugs with new drugs at higher costs accounts for over 60 per cent of the rise in the UK (Tamblyn et al. 2003; Walley, Mrazek, and Mossialos 2005).

Pharmaceuticals are a research and development (R&D)-intensive industrial sector. Innovation and the successful diffusion of new drugs are critical for the financial performance of pharmaceutical companies—as well as the health of patients. In the UK, the pharmaceutical industry R&D represented 36 per cent of sales in 2009, a level approached by only a small number of defence contractors

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² The rate of incidence of a disease.

(ONS 2009). Governments are also major influences, both through regulatory and approval agencies—such as the Food and Drug Administration (FDA) in the US and the National Institute for Clinical Excellence (NICE) in the UK—and through budgetary allocations. The diffusion of innovation is thus determined by the strategies of pharmaceutical companies, by government policies, and by the behaviour of medical professionals. This article concentrates on the last, through a detailed review of the literature on doctors' prescribing patterns. Doctors have to strike a balance between using new drugs—and potentially exposing patients to side effects—and delaying the use of new drugs—and depriving patients of their possible benefits (Jones, Greenfield, and Bradley 2001). The ensuing diffusion process is a complex interaction that reflects attributes of the new drugs as well as characteristics of the potential prescribers and patients. This article analyses the socio-demographic and professional characteristics of early prescribers and users of newly marketed drugs—as compared to majority and late users. It focuses on four quantitatively measurable categories of variables—doctor, patient, practice, and drug characteristics—and differentiates between variables consistently predicting new drug uptake and those producing inconsistent results. This article also analyses the role various information sources and the social network play in the adoption process.

Understanding the mechanisms leading to prescribers' early adoption of new drugs is of major importance for several reasons.

First, it *speeds up diffusion*. Although companies are increasingly innovative and efficient in producing new drugs, the implementation of pharmaceutical innovations is often delayed (Berwick 2003). Where new drugs expand therapeutics in areas of yet unmet clinical need, accelerated adoption benefits both medicine and society—innovative new drugs should be offered fast and homogeneously to the population in need.

Second, it *promotes cost-efficiency*. In many cases, newly marketed drugs only bring a marginal or insignificant contribution to the conventional therapeutic arsenal, often at a substantial cost increase. However, healthcare systems worldwide operate with limited financial resources. Given such budgetary constraints, inappropriate use adversely affects availability of use. When the same pharmacological therapy is available as different brands at different prices, the prescriber selects the new, more expensive brand on socioeconomic constructs rather than medical grounds (Ohlsson, Chaix, and Merlo 2009; also, see pp. 60–75).

Third, it *forecasts utilisation*. Accurate prediction is not only important for pharmaceutical companies, but also for healthcare professionals and policy makers in charge of healthcare budget planning.

Fourth, it *develops targeted detailing and continuing medical education*. Where the adoption of new prescription drugs varies across doctors, there is significant

potential for targeted intervention. Distinguishing between doctors who prescribe new drugs early and those who prescribe them late or never enables targeted intervention through relevant, tailored information—as well as economies of both time and money (Strickland-Hodge and Jepson 1982). Groves et al. (2010) argued that healthcare policy makers should focus on high-volume early prescribers. By virtue of their characteristics—and, possibly, reputation—high-volume early prescribers may have the greatest likelihood of generating peer influence. Detailing and education should promote appropriate use of new drugs, through prescription of the most efficient / least expensive of available alternatives.

This article is structured into five sections. Following this introduction, the second section disputes the doctors' early adoption of new drugs as a personal trait, independent of drug type. The third section presents the research strategy adopted to identify relevant literature. Where early adoption of newly marketed drugs is concerned, research shows considerable variation across prescriber, patient, and practice characteristics. This article differentiates between variables consistently predicting early adoption and those producing inconsistent results. The fourth section analyses characteristics of early adopters and users with the aid of population-based quantitative studies of prescription data and registers. Although they capture the complex realities of prescribing decisions, without survey questionnaires and in-depth interviews, such studies fail to encapsulate the aspects of prescribing decisions comprehensively. To compensate, the fifth section summarises the key findings of the qualitative studies.³ Finally, the sixth section concludes this article by summarising the research findings and suggesting unexplored questions.

Doctors' early adoption of new drugs—personal characteristic independent of drug type?

Some doctors adopt new drugs early—others adopt them late or never. The implicit assumption is that—irrespective of the drug type—some doctors are more predisposed to adopt new drugs than others. Early adoption behaviour is associated with factors such as the doctor's age and gender, the doctor's personality, and the characteristics of the practice (Coleman, Menzel, and Katz 1959; Williamson 1975b; Strickland-Hodge and Jepson 1982; Weiss et al. 1990;

³ The qualitative studies referred to in this article are based on data collected through in-depth interviews, focus groups, or survey questionnaires, regardless of data analysis technique, while the quantitative studies referred to in this article are based on prescription data or registers.

Prosser and Walley 2003). Early adopters are believed to influence other doctors' adoption of new drugs significantly.

To identify patterns of early adoption, several recent studies used prescription data in lieu of in-depth interviews, focus groups, or survey questionnaires. Prescription data has the advantage of reflecting the realities of a doctor's practice—including the influences associated with external environments, marketing and regulatory activities, and the nuances of individual patients—as well as the personality and behavioural traits of the doctors (Groves, Flanagan, and MacKinnon 2002).

A rigorous review of the prescription-based literature suggests that 'pure' early prescribers and users do not generally exist—no groups of doctors or patients emerge as prescribers or users of all potentially relevant, newly introduced drugs. Steffensen, Sørensen, and Olesen's (1999) was the first quantitative study to explicitly question the assumption that doctors can be grouped into adopter categories that are likely to share specific characteristics—early adoption was not consistent across drug groups, and the shape and slope of the diffusion curve were dependent on both doctor and drug characteristics. Similarly, Dybdahl et al. (2004) found that general practitioners' adoption of one group of drugs was poorly associated with adoption of others—doctors' early adoption of new drugs was not a personal trait independent of drug type. Two years later, Florentinus et al. (2006) examined the adoption of five drugs by a sample of approximately one hundred general practitioners and identified a small group of innovative general practitioners responsible for a large part of early prescriptions for new drugs. However, the early prescriptions were very much drug dependent—heavy prescribers of one drug were not heavy prescribers of the other four drugs—and varied strongly across general practitioners. Kozyrskyj, Raymond, and Racher (2007) came to similar conclusions.

In contrast, Bourke and Roper (2012) found significant and consistently signed effects with relation to portfolio width across the six drugs under examination—the wider the doctor's prescription portfolio, the shorter the doctor's adoption time. Moreover, where doctors had already adopted one of the six new drugs early, early adoption of one of the other five was significantly faster. However, the argument that doctors with a track record of early adoption generally tend to be early adopters of any new drug was disproved by the sample under scrutiny—none of the doctors adopted all six drugs within six months of their introduction. Besides, out of more than ten, portfolio width was the only variable that consistently predicted early adoption across the six study drugs. Whilst the authors clearly favoured the image of early adopters, their findings rather supported the idea that doctors' early adoption is heavily dependent on the new drugs in question.

To conclude, prescribing data shows inconsistencies in the uptake of study drugs—heavy early prescribers of one new drug may be late prescribers or even

non-prescribers of another. Doctors seem to consider each new drug on its individual merits, and adoption may also be influenced by personal and patient-related characteristics.

The search strategies behind the literature review

The review at the core of this article focuses on literature assessing the prescription of new medicines in both primary and secondary care, with time and geography of no specific interest. In January 2012, several search strategies were run on Google Scholar—each search strategy included at least one keyword from each of the four major categories summarised in Table 1.

Table 1: Summary of keywords for the search strategies

Category	Keywords
object	new drug / new medicine
process	adoption / diffusion / uptake
actor	doctor / general practitioner / physician / specialist
method	population-based / prescribing data / prescription data / registry / quantitative

Since prescription data has the advantage of reflecting the realities of prescribing decisions, only quantitative studies were deemed relevant. Prescription data necessarily includes the influences of sales representatives, advertisement activities of pharmaceutical companies, peer-reviewed journals, scientific meetings, peer pressures, and regulatory environments. Prescription data also reflects individual patient characteristics as well as the personal and behavioural characteristics of the prescribing doctor.

The first 30 records of each search strategy were downloaded and screened for eligibility—thus, of a total of 720 records, 16 studies were included in the review. Their citations were also screened through Google Scholar—and their bibliographies were rigorously checked—to identify further relevant quantitative studies. This process resulted in an additional four studies. The key features of these 20 studies—location and size of sample population, type and number of study drugs, factors that might influence new drug uptake, and methodology—may be summarised as follows. The studies were conducted in developed countries, mostly Northern American and Northern European. The sample populations varied greatly—from 32 healthcare centres to 28,402 general practitioners, for example. The study drugs also covered a wide range—cardiovascular drugs, coxibs, antihypertensives, and antidepressants, for example, with several studies focusing

on more than ten new drugs. The variables under consideration also varied greatly, with some studies focusing only on doctor characteristics, while others also assessed patient, practice, and drug characteristics—their most popular method of analysis was logistic regressions.

There are several possible limitations to this review of the literature. First, it was undertaken by a single reviewer, heightening the potential for errors in the coverage and synthesis of the literature. Second, the search strategies through Google Scholar may have failed to identify quantitative studies where new drug uptake was considered, but not as key focus. Third, quantitative studies have advantages as well as disadvantages. They assess relationships based on huge data sets—however, without specific research questions, outcomes of interest might be completely disregarded, as the structure and content of the data collected by health insurance funds for health insurance purposes may not allow it. Fourth, the interview and questionnaire-based studies reviewed here may have been subject to self-reporting bias—missing independent validation, the quality of their evidence might be suboptimal. Fifth, whether quantitative or qualitative, the studies reviewed here cover a range of drugs, prescribers, geographic regions, and nations—variance in results may simply stem from differences in drugs, prescribers, or locations. In some cases, for example, the lack of concordance among study findings was evidently a straightforward consequence of the different attitudes of general practitioners and specialists. In others, findings were assumed generalisable across prescribers, drugs, patients, and practices.

Factors influencing new drug uptake

In both primary and secondary care, diffusion of pharmaceutical innovations is subject to interacting influences. The idea that early prescribers do not generally exist does not necessarily mean that adoption of new drugs is random. Rather, adoption varies across prescribers, with the prescriber, patient, practice, and drug characteristics summarised in Table 2 (p. 61) and found significant in the adoption process in at least one of the studies. Their number highlights the complexity of pharmaceutical innovation diffusion.

The studies identified several—mostly overlapping—socio-demographic and professional characteristics that prove crucial in the adoption process, and that predict—seemingly consistently—new drug uptake. This article will clearly indicate the characteristics constant across drug types. However, in a number of cases, there is contradiction within the literature. Whilst some studies found one particular variable significant, others found no evidence for the predictive power of that variable. Also, reported correlation between one particular variable and new

drug uptake was not always consistent in terms of direction. These anomalies will also be clearly indicated in this article.

Table 2: Summary of characteristics influencing the diffusion of pharmaceutical innovations

Prescriber Characteristics	Patient Characteristics
<ul style="list-style-type: none"> - gender - age - training location - board certification - clinical and therapeutic area - hospital affiliation - clinical trial participation - prescribing characteristics <ul style="list-style-type: none"> - total prescribing volume - portfolio width - prescribing volume of drugs by the same pharmaceutical company as the new drug - prescribing volume in the therapeutic class of the new drug 	<ul style="list-style-type: none"> - age - gender - socioeconomic characteristics <ul style="list-style-type: none"> - income - education - health insurance - race / ethnicity - marital status - health
Practice Characteristics	Drug Characteristics
<ul style="list-style-type: none"> - solo / group - location (urban / rural) - size <ul style="list-style-type: none"> - number of patients - prescribing volume - number of diagnostic and therapeutic activities - composition of employees - private / public 	<ul style="list-style-type: none"> - medical characteristics <ul style="list-style-type: none"> - unmet clinical need - suboptimal response to existing therapies - improvement over existing therapies - relative therapeutic / economic advantage - safety versus perceived risk - perceived efficacy - cost - marketing budget of the pharmaceutical company

To explain the mechanisms leading to associations between variables and new drug uptake, the findings from the quantitative literature are discussed in conjunction with the most important observations from the qualitative literature—without any claims to comprehensiveness. However, methodological drawbacks render heavy reliance on the qualitative studies problematic. A retrospective study

based on self-report is at risk of recall bias—rather than what actually occurs in practice, surveys and interviews may simply capture normative responses and expressed attitudes. Decision making may involve subconscious factors or factors which prescribers—for whatever reason—choose not to disclose (Prosser and Walley 2006).

Prescriber characteristics

Gender. Gender seems to play an influential role in the early adoption of new drugs—male prescribers are much more likely to adopt new drugs than female prescribers—and the finding seems to be consistent across drug types. In a large-scale quantitative study of British doctors, Inman and Pearce (1993) observed that male doctors had much higher rates of new drug utilisation than female doctors. In the group that prescribed new drugs most heavily, women accounted for only 9 per cent. Later studies came to similar conclusions (Steffensen, Sørensen, and Olesen 1999; Tamblyn et al. 2003; Helin-Salmivaara et al. 2005; Groves et al. 2010). Other studies found that the most likely explanation lies in the difference between the levels of confidence of male and female prescribers with regard to the initiation of new medical treatments to achieve desired health outcomes (Bensing, van den Brink-Muinen, and de Bakker 1993; Tamblyn et al. 2003).

Age. Age also seems to be associated with new drug uptake. Qualitative research suggested unambiguously that early prescribers are younger than the majority (Coleman, Katz, and Menzel 1966; Weiss et al. 1990; M. Y. Peay and E. R. Peay 1994). The quantitative research came to similar conclusions (Tamblyn et al. 2003; Glass and Rosenthal 2004; Groves et al. 2010). Recently, Bourke and Roper (2012) also reported that the age of the general practitioners had a small—but statistically significant—positive effect on time to adoption in four of the six study drugs. Other studies found that the most likely explanation lies with the young doctors' propensity for more aggressive intervention and the older doctors' more established prescribing practices—as well as with targeted marketing practices (Lurie, Rich, and Simpson 1990; Tamblyn et al. 2003). These findings contrast with other studies, some of which found that early prescribers were likely to be older (Kozyrskyj, Raymond, and Racher 2007; Groves et al. 2010) and some of which found no correlation between prescriber age and early adoption of new drugs. However, in general, younger prescribers seem to favour early adoption of new drugs more than older prescribers.

Training location. So far, due to data constraints, only four quantitative studies have assessed the impact of training location on new drug uptake. With the exception of Groves et al. (2010), these studies found that the training location plays an influential role in early adoption of new drugs. From British (Inman and Pearce 1993) and Northern American (Kozyrskyj, Raymond, and Racher 2007)

perspectives, more new drugs are prescribed by doctors with overseas qualifications. At the same time, Tamblyn et al. (2003) found that the generalists and specialists who had graduated from the most recently formed medical school had higher relative rates of new drug use. More likely than not, unmeasured aspects of the training environment influence new drug use in all three studies—basic pharmacological training, policies related to drug detailing, relative financial contribution by the pharmaceutical industry in training and research, or the educationally influential practices of attending doctors during the formative training years (Tamblyn et al. 2003). All in all, the training location does exert a significant influence on new drug uptake.

Board certification. Board certification was found consistently associated with adoption in some qualitative (Weiss et al. 1990) and quantitative (Glass and Rosenthal 2004) studies, but not in others (Majumdar et al. 2001; Corrigan and Glass 2005).

Clinical and therapeutic area. A number of qualitative studies found that doctors are more likely to prescribe new drugs in clinical and therapeutic areas where they feel familiar or have a special interest (Coleman, Katz, and Menzel 1966; Jacoby, Smith, and Eccles 2003; Prosser and Walley 2003; Tobin et al. 2008). In line with these findings, Fendrick, Hirth, and Chernew (1996) reported faster adoption among specialists in secondary care than among generalists in primary care. In contrast, Dybdahl et al. (2011) found no clear association between the general practitioners' self-rated clinical interest and their prescribing of new drugs. Such mixed results were reflected in several quantitative studies. Majumdar et al. (2001), Ruof et al. (2002), Glass and Rosenthal (2004), and Helin-Salmivaara et al. (2005) found that specialists were more likely to adopt new drugs than generalists, while Kozyrskyj, Raymond, and Racher (2007) found mixed evidence. In contrast, Groves et al. (2010) found that generalists were more likely to adopt new drugs than specialists. However, on the whole, the clinical and therapeutic area seems to play a role in the adoption process, with specialists more likely to adopt special-purpose new drugs early and generalists more likely to adopt new drugs used for a spectrum of therapies early.

Hospital affiliation. Hospital affiliation is the subject of many qualitative studies (Strickland-Hodge and Jepson 1988; Feely et al. 1999; Jones, Greenfield, and Bradley 2001; Jones et al. 2001; McGettigan et al. 2001; Prosser, Almond, and Walley 2003; Tobin et al. 2008). Hospital-affiliated doctors are restricted by hospital formularies (Glass and Rosenthal 2004), on the one hand, but exposed to specialist influence, on the other, with specialist influence seemingly outweighing hospital formulary restrictions (Kozyrskyj, Raymond, and Racher 2007).

Clinical trial participation. Clinical trial participation increases early adoption of new drugs according to both qualitative (Denig et al. 1991) and quantitative

(Corrigan and Glass 2005) studies, due to proximity to research and understanding of the evidence base (Chauhan and Mason 2008).

Prescribing characteristics. Prescribing characteristics seem to exert a significant influence on the adoption process. To address the unfulfilled medical needs of some of their patients, doctors with a high patient flow seem particularly alert to new drugs, irrespective of therapeutic novelty (Glass and Rosenthal 2004)—the higher the *total prescribing volume* and the higher the *portfolio width*, the higher the likelihood of early adoption of new drugs. Bourke and Roper (2012) found that such doctors are more aware of alternative options and adopt new drugs early. For First-in-Class⁴ drugs, Glass and Rosenthal (2004) found that the higher the *prescribing volume of drugs by the same pharmaceutical company as the new drug*, the higher the doctor's likelihood of early adoption of other drugs from that pharmaceutical company—either due to increased detailing by that pharmaceutical company to the doctor, or to the doctor's confidence and trust in that company / company's sales representatives. For all other new drugs, Glass and Rosenthal (2004) found that the higher the *prescribing volume in the therapeutic class of the new drug*, the higher the likelihood of early adoption of that new drug—new but non-novel drug prescription may be due to pre-existing drugs' failure to fulfil the medical needs of the patients. Non-prescribers in a therapeutic class may not have patients suitable for that therapeutic class, or may not be convinced of that therapeutic class' medical value.

Patient characteristics

Patient characteristics such as age, gender, socioeconomic status, and the presence of comorbidities⁵ seem to influence new drug uptake. On the one hand, the empirical evidence is vast—on the other, characteristics of early receivers vary from drug to drug, with the therapeutic goal and the target audience of the drug. An exhaustive review of the relevant literature is therefore impossible.

Age. Doctors' likelihood of continuing to prescribe a particular medication seems to be influenced by patients' age—since elderly patients are more likely to experience side effects, doctors are less likely to prescribe new drugs to older patients (Tamblyn et al. 2003; Álvarez and Hernández 2005) and more likely to prescribe new drugs to younger patients (Mark et al. 2002; Hansen et al. 2004; Greving et al. 2006; Ohlsson, Chaix, and Merlo 2009). Drugs generally designed for the elderly—to treat Alzheimer's disease or arthritis, for example—are of course an exception (Florentinus et al. 2005a, 2005b, 2006; Helin-Salmivaara et al. 2005).

⁴ Pioneering drugs in their respective treatment category.

⁵ The presence—or effect—of diseases other than the primary disease of a patient.

Gender. While patient gender might influence the likelihood of starting new medications, new drug characteristics and therapeutic goals usually determine the main gender target group (Mark et al. 2002; Florentinus et al. 2005a, 2005b, 2006; Roer et al. 2010).

Socioeconomic characteristics (income, education, and health insurance). By definition, the socioeconomic status of patients reflects their economic and social position in relation to others, based on income, occupation, and education (Winkleby et al. 1992). An increasing body of registry-based literature suggests that the socioeconomic status of the patient influences doctors' prescribing behaviour irrespective of medical considerations (Mamdani et al. 2002; Roer et al. 2010). High-income patients seem more likely to receive new drugs early (Kozyrskyj, Raymond, and Racher 2007; Ohlsson, Chaix, and Merlo 2009), not least because of their ability to pay for out-of-pocket treatments. Privately insured patients also seem more likely to receive new drugs early (Florentinus et al. 2005a). In addition, elderly patients with a high level of formal education have a higher probability of being dispensed new drugs than those with a low level of formal education, irrespective of gender, age, type of residential area, comorbidity, and number of drugs used (Haider et al. 2008). While the literature is generally homogenous in that patients with high socioeconomic status seem more likely to receive new drugs early, some studies found no association (Hansen et al. 2004).

Race / ethnicity. Correlation between race / ethnicity and socioeconomic status suggests correlation between race / ethnicity and new drug uptake. For example, non-African-Americans are more likely to be treated with new medications than African-Americans and Hispanics (Mark et al. 2002; Daumit et al. 2003; Van Dorn et al. 2006; Wang et al. 2006).

Marital status. Marital status might influence new drug uptake, but the pattern varies from drug to drug. Prescription of new-generation antidepressant drugs is more likely among single patients than among married or cohabiting patients (Hansen et al. 2004), for example, whilst prescription of new drugs against high cholesterol is more probable among married or cohabiting patients than among single patients (Ohlsson, Chaix, and Merlo 2009).

Health. A patient's health status—self-reported health, poor response to existing therapies, previous use of certain medications, and presence of comorbidities—evidently plays an influential role in new drug uptake (Florentinus et al. 2005a, 2005b; Greving et al. 2006; Kozyrskyj, Raymond, and Racher 2007). Doctors seem to consider individual contexts seriously, and patient convenience seems to influence new drug uptake and promote earlier adoption among patients in desperate stages.

Practice characteristics

Solo / group. In group / partnership practices, continuous professional stimulation and other social factors seem to accelerate the early adoption of new drugs. Joint responsibility for patients promotes the circulation of medical notes and allows for cross-fertilisation of therapeutic information (Williamson 1975b), while daily personal contact with colleagues provides an efficient channel for information transfer and evaluation.⁶ As a result of working closely together, doctors may even become conformist in their prescribing habits (Williamson 1975b).

The empirical literature is ambiguous on the impact of group / partnership practices on new drug uptake. In their classic study, Coleman, Menzel, and Katz (1959) reported that doctors who practice in partnerships introduce new drugs on average 2.3 months earlier than doctors who practice on their own. Williamson (1975b) came to a similar conclusion and demonstrated that the difference in adoption times is a direct consequence of the difference in speed of information evaluation, partially accounted for by contact time with peers. Weiss et al.'s (1990) questionnaire study also concluded that membership in a group practice is a powerful variable in discriminating between doctors who innovate and doctors who do not. One registry-based study supported these findings (Steffensen, Sørensen, and Olesen 1990), while another found the difference disappeared after adjustment for practice size (Dybdahl et al. 2004). The higher the number of patients a practice has, argued Dybdahl et al. (2004), the higher the probability to consult a patient who might be a candidate for a new drug—a conclusion Steffensen, Sørensen, and Olesen (1990) may have drawn too, had they adjusted for practice size. M. Y. Peay and E. R. Peay (1988, 1994) did not support the contention that doctors practising in partnership differ from their solo counterparts. Furthermore, Florentinus et al. (2006) found that doctors who practise on their own prescribe more new drugs than those in group practices, possibly because such doctors interact with specialists much more than with other generalists, and because hospital consultants have much more influence over the adoption process (M. Y. Peay and E. R. Peay 1994; Prosser, Almond, and Walley 2003). Adjusting for practice size is essential in determining whether early adoption of new drugs stems from high number of patients or from continuous professional stimulation. Previous empirical research rather suggests the former contention—group practices adopt new drugs early because they are (much more) likely to meet patients in need of the new drugs.

⁶ For a discussion of the role of social networks in the early adoption of new drugs, see pp. 74–5.

Location (urban / rural). Urban practice locations might result in early new drug adoption, while late new drug adoption in rural areas might be due to the personal characteristics of doctors who elect to practice in rural communities. Besides, in contrast with their urban colleagues, rural doctors have fewer opportunities for professional interactions with peers, an important factor in the decision to initiate new treatments (Coleman, Menzel, and Katz 1959; Williamson 1975b; M. Y. Peay and E. R. Peay 1994; Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001). The lower utilisation rates might also be explained by the differential intensity of visits by pharmaceutical industry representatives related to geographic inaccessibility (Tamblyn et al. 2003). According to a questionnaire study, rural doctors are less likely to prescribe new drugs than their urban colleagues (Cutts and Tett 2003)—the prescribing data reflected doctors' self-reported behaviour (Tamblyn et al. 2003; Bourke and Roper 2012). Groves et al. (2010) also found that the upper quartile of high-relative doctors might be best classified as doctors with urban practices. In contrast, the mail survey of Buban, Link, and Doucette (2001) found no apparent influence of location on oncologists' adoption of a new agent, suggesting a reassuring efficiency of information dissemination. Four other quantitative studies also found no support for the early new drug adoption of urban areas (Majumdar et al. 2001; Álvarez and Hernández 2005; Behan, Cutts, and Tett 2005; Ohlsson, Chaix, and Merlo 2009). Moreover, at the other extreme, Groves et al. (2010) found that doctors classified as high-total new drug prescribers were more likely operating in rural areas, possibly due to high patient and elderly patient loads.

In sum, the majority of the studies indicated effective methods of information dissemination across geographical boundaries (Majumdar et al. 2001; Álvarez and Hernández 2005; Behan, Cutts, and Tett 2005; Ohlsson, Chaix, and Merlo 2009; Groves et al. 2010). Modern communication technology most probably enables rural doctors to be as up-to-date as urban doctors—with abundant possibilities for continuing education and exchanges with colleagues, and with full access to information from pharmaceutical companies.

Size (number of patients and prescribing volume). Number of patients is one potential measure of the size of the practice, and of the likelihood to adopt new drugs early—the higher the number of patients, the higher the likelihood (Strickland-Hodge and Jepson 1982; Weiss et al. 1990). Some quantitative studies supported these observations (Steffensen, Sörensen, and Olesen 1999), others did not (Álvarez and Hernández 2005). Strickland-Hodge and Jepson (1982) offered three explanations for the association between patient list size and new drug uptake. First, the higher the number of patients, the higher the probability of patients with conditions targeted by the new drugs. Second, the more innovative a doctor is perceived, the higher the doctor's likelihood to attract patients. Third, doctors busy with patient management do not have time for critical evaluation of

advertisements and take favourable drug information for granted. At practice level, no association was found between high prescribing volume and early adoption of new drugs (Glass and Rosenthal 2004; Ohlsson, Chaix, and Merlo 2009). Similarly, Dybdahl et al. (2005) found few, weak, and inconsistent associations between early adoption of new drugs and previous prescribing of drugs belonging to the same therapeutic class. Whether measured by number of patients or prescribing volume, the size of the practice does not play an influential role in the early adoption of new drugs. This conclusion is not only counterintuitive, but also at odds with individual doctor's prescribing characteristics (see pp. 62–4). However, the innovative and conservative behaviours of the individual doctors may only cancel one another out, when summed up at practice level.

Number of diagnostic and therapeutic activities. Steffensen, Sørensen, and Olesen (1999) and Álvarez and Hernández (2005) found that a high volume of diagnostic and therapeutic activity is associated positively with early adoption of new drugs—at least for generalists, if not for specialists (Tamblyn et al. 2003). A high volume of diagnostic and therapeutic activity may be indicative of the severity of the patients' health, and of the need for early adoption of new drugs

Composition of employees. Ohlsson, Chaix, and Merlo (2009) found that healthcare practices employing specialists as well as generalists are more likely to adopt new drugs early than practices employing generalists only. Bourke and Roper (2012) found similar results for practices employing the assistance of a nurse or secretary.

Private / public. Ohlsson, Chaix, and Merlo (2009) found that private healthcare practices are more likely to adopt new drugs early than public healthcare practices.

Drug characteristics

The majority of drug characteristics—the suboptimal response of patients to existing therapies and the safety and perceived efficacy of new drugs, for example—can be measured only qualitatively. The two drug characteristics measurable quantitatively are the cost of a new drug and the marketing budget of the pharmaceutical company introducing it.

Medical characteristics. *Unmet clinical need, suboptimal response to existing therapy* (Jones, Greenfield and Bradley 2001; Prosser and Walley 2003), *improvement over existing therapies* (Jones, Greenfield and Bradley 2001; Prosser and Walley 2003), and *relative advantage—therapeutic or economic—over existing therapies* all influence the early adoption of new drugs.

Safety versus perceived risk. Safety—including adverse side effects and interactions with other drugs prescribed to the patient—is the primary concern in early adoption of new drugs (Ruof et al. 2002; Mason 2008; Tobin et al. 2008),

while Williamson (1975a), Jones et al. (2000), and Jones, Greenfield, and Bradley (2001) stressed the impact of the perceived risk. In general, the higher the risk, the longer the average early adoption time. However, M. Y. Peay and E. R. Peay (1994) found that highest-risk drugs are adopted fastest, suggesting that the doctors' tolerance of risk depends on the severity of the illness.

Perceived efficacy. The higher the perceived efficacy, the higher the early adoption of new drugs (M. Y. Peay and E. R. Peay 1988; Jones et al. 2000; Buban, Link, and Doucette 2001; Jones, Greenfield, and Bradley 2001; Groves, Flanagan, and MacKinnon 2002; Ruof et al. 2002; Jacoby, Smith, and Eccles 2003; Prosser and Walley 2003; Greving et al. 2006; Tobin et al. 2008).

Cost. Although cost is a quantitatively measurable variable, no study has analysed systematically the influence of the relative price on the early adoption of new drugs. In general, cost is less important than both safety and perceived efficacy (Chauhan and Mason 2008), and does not represent a significant barrier in the early adoption of new drugs (Mason 2008). Doctors try to balance efficacy and cost, but they are not reluctant to prescribe higher cost, more effective drugs (Jones, Greenfield, and Bradley 2001; Prosser and Walley 2003; Tobin et al. 2008). Jacoby, Smith, and Eccles (2003) found that the most frequent early adopters of new drugs are the least cost conscious. However, in general, doctors feel high-cost new drugs constrain their routine prescribing to cases where the cheaper alternatives were either not tolerated or ineffective (Booth-Clibborn, Packer, and Stevens 2000; Ruof et al. 2002; Prosser and Walley 2003).

Marketing budget of the pharmaceutical company. The marketing budget of the pharmaceutical company put behind the new drug influences early adoption (Glass and Rosenthal 2004; Booth-Clibborn, Packer, and Stevens 2000). However, neither the qualitative study of Jones, Greenfield and Bradley (1999) nor the quantitative study of Tamblyn et al. (2003) identified a relation between advertising intensity and early adoption of new drugs. Thus, per se, the marketing budget does not influence early adoption of new drugs. However, the marketing budget specifically assigned to a new drug does exert a significant, consistently signed influence (Glass and Rosenthal 2004).

Other factors

Early adoption of new drugs occurs in complex environments, subject to numerous influences. A substantial amount of qualitative research has addressed the channels of information concerning new drugs and the factors that influence

individual doctors' early adoption.⁷ The list of factors reviewed herewith is comprehensive, even if the review itself is far from comprehensive. Doctors may become aware of new drugs from commercial sources, while the ultimate sanction to prescribe may stem from professional sources such as medical journals (Strickland-Hodge and Jepson 1980). This section focuses on the role these various sources of information play and discusses the role of the social network by highlighting the influence of interpersonal communication on early adoption.

General practitioners and specialists differ in the extent to which they use various information sources (Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001). Objective sources of information—journal articles and evidence-based information from independent organisations, for example—seem underutilised by general practitioners (M. Y. Peay and E. R. Peay 1988, 1994; Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001; Tobin et al. 2008). Instead, general practitioners rely on the commercial information provided by pharmaceutical companies through sales representatives. Prosser, Almond, and Walley (2003) described general practitioners as largely reactive and opportunistic recipients of new drug information, rarely undertaking an active information search. In contrast, specialists are close to new drug development and likely to be aware of new drugs before their official approval (M. Y. Peay and E. R. Peay 1994). For them, colleagues—from their own speciality or from other specialities—and clinical meetings are of greatest practical importance. Marked differences in the working environments of the two groups of prescribers may explain these behavioural differences (McGettigan et al. 2001). General practitioners work often alone—or with just a few colleagues—for them, sales representatives and consultants may represent the main channel to exchange professional ideas. In contrast, specialists work in hospital settings—for them, regular interactions with peers facilitate the diffusion of ideas and innovations.

Professional information and evidence

A drug launch is accompanied by a large volume of information, both commercial and professional. Doctors for whom drug safety and efficacy are paramount rely on established, scientific, non-commercial evidence—in general, specialists represent the subgroup of doctors who rate independent research as the key source of empirical validation for new drugs (Jones et al. 2000; Jones, Greenfield, and Bradley 2001; Prosser and Walley 2006).

⁷ Interviews and questionnaire surveys rely on the doctors' subjective recalls of prescribing events, possibly prejudiced by social desirability bias. This is a caveat worth remembering in interpreting the results, especially since sources considered important in theory are not of greatest practical utility (McGettigan et al. 2001).

Many research studies highlighted the role *peer-reviewed journals* play as sources of information on new drugs (Coleman, Menzel, and Katz 1959; M. Y. Peay and E. R. Peay 1990; Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001; Jacoby, Smith, and Eccles 2003). Sometimes, specialists even ask sales representatives to provide information from the scientific literature (Jones, Greenfield, and Bradley 2001), journal articles on *randomised clinical trials* and *meta-analysis* being judged the best (Prosser and Walley 2006). In both primary and secondary care, sound research evidence was reported to be very influential in reaching prescribing decisions (Coleman, Menzel, and Katz 1959; Jones et al. 2000; Jacoby, Smith, and Eccles 2003). However, some researchers contested the value of peer-reviewed journals, considered excessively time consuming, out of date, and overly complex by some doctors (Prosser and Walley 2003).

Several studies indicated that *drug bulletins* represent an important channel of information about new drugs (McGettigan et al. 2001; Groves, Flanagan, and MacKinnon 2002)—in theory, general practitioners most frequently rate drug bulletins together with medical journals as important (McGettigan et al. 2001).

Specialist meetings, presentations, conferences, and symposia provide a highly valued source of information, facilitate interaction among doctors, and may influence the early adoption of new drugs (Coleman, Menzel, and Katz 1959; Buban, Link, and Doucette 2001; Jones, Greenfield, and Bradley 2001)—early information might act as a catalyst for early awareness and positive evaluation, through interactions with professionals at national and international events (M. Y. Peay and E. R. Peay 1994). . . Most probably, doctors more sensitive to new developments attend more such forums, although attendance may be expensive (Groves, Flanagan, and MacKinnon 2002).

Some degree of *association with an academic centre*—through teaching, publishing, or holding an academic appointment, for example—shows a heightened professional orientation and results in early adoption of new drugs (Weiss et al. 1990).

Guidelines, hospital formularies, and protocols might also exert influence on new drug uptake. In theory, specialists consider the national formulary as the second most important source of information on new drugs, senior colleagues being the first (McGettigan et al. 2001). In practice, Wathen and Dean (2004) found that best practice guidelines have little impact on new drug uptake in the UK. Nevertheless, technological guidelines accompanied by other sources of information or personal experience trigger an increase in prescribing new drugs. Of course, new drug uptake might be constrained as well as facilitated by guidelines, hospital formularies, and protocols (Prosser and Walley 2006). Similarly to *government policy* (Griffin 1995), guidelines might promote therapeutically innovative, cost-effective new drugs, whilst prohibiting expensive

new drugs (Jones et al. 2000). (However, specialists can overcome formulary restrictions by recommending new drugs to general practitioners.)

Prescribing decision support systems provide evidence-based recommendations and help doctors identify patients who might benefit from pharmaceutical innovations. They may increase the early adoption of therapeutically advanced, cost-efficient new drugs—general practitioners who use them are less inclined to prescribe cost-inefficient new drugs (Greving et al. 2006).

Finally, *personal experience* has a high impact on doctors' prescribing behaviour (Buban, Link, and Doucette 2001; Jones, Greenfield, and Bradley 2001; Prosser, Almond, and Walley 2003). Individual trialling might be urged by exhaustion of other possibilities, by the doctors' personal curiosity, or by patients. Trialling is essentially a reflective process that allows doctors to test therapeutic outcomes and interpret evidence in the light of experience (Prosser and Walley 2006)—positive experiences with a new drug induce changes in prescribing behaviour, while negative experiences most likely lead to the rejection of the new drug.

Commercial information

Although they place more emphasis on professional information, specialists might rely on commercial information for drugs outside their speciality. In contrast, general practitioners indicate greater preference for commercial information—time constraints and the broader range of conditions they treat do not allow general practitioners to review satisfactorily all relevant professional information. However, for both specialists and generalists, information from sales representatives is often the first source of information.

The commercial information is provided by pharmaceutical companies. Pharmaceutical companies aim to boost profits by incorporating new drugs early in their lifecycle, by raising awareness among top professionals, and by maintaining the new drugs' first-choice statuses within their respective therapeutic groups (Groves, Flanagan, and MacKinnon 2002). Pharmaceutical marketing not only raises awareness—it evidently influences decision making too.

The prominence of *commercial information* in early adoption of new drugs was shown—for example—by Avorn, Chen, and Hartley (1982), M. Y. Peay and E. R. Peay (1988), and Prosser, Almond, and Walley (2003). Interactions with *sales representatives* have a particularly strong impact (M. Y. Peay and E. R. Peay 1988, 1994; McGettigan et al. 2001; Jones, Greenfield, and Bradley 2001; Jacoby, Smith, and Eccles 2003; Prosser, Almond, and Walley 2003; Tobin et al. 2008)—early prescribers use sales representative information intensively (Jones, Greenfield, and Bradley 2001; Prosser, Almond, and Walley 2003; Tobin et al. 2008). Three-quarters of US doctors consider pharmaceutical marketing information useful

(Kaiser Family Foundation 2002). In general, sales representatives are viewed as an expedient means of keeping up-to-date and acquiring and processing drug information—even when doctors intend to minimise the importance of sales representatives, to avoid distorted, selective, and overly positive information (Prosser, Almond, and Walley 2003; Chauhan and Mason 2008).

Pharmaceutical companies facilitate new drug awareness in many other ways, including through *direct mail*, *conferences*, and *journal advertisements*—in peer-reviewed medical journals, controlled-circulation journals, or pharmaceutical prescribing reference guides (Strickland-Hodge and Jepson 1982; M. Y. Peay and E. R. Peay 1994)—or through *sponsoring of continuing education* and *funding of clinical trials*.

If allowed, *direct-to-consumer advertising* in the mass media influences early adoption of new drugs through patient requests. Promoting the potential benefits of new medications may stimulate unmet demand to treat certain conditions or may raise expectations of better relief than available products—empirical evidence showed that the percentage of patients who had requested a treatment for which they had sought outside information was positively associated with early adoption of new drugs (Buban, Link, and Doucette 2001). The role of patients should therefore not be underestimated, especially since general practitioners report that patients often request new medications—time constraints and the desire to avoid conflict and increase patient role in decision making being quoted as reasons for granting them (Prosser, Almond, and Walley 2003). However, Chauhan and Mason (2008) reported little evidence of patients influencing prescribing decisions, but forecasted increasing patient impact on new drug uptake, as self-care and patient-choice agendas gain increasing prominence. Whether direct-to-consumer advertising is actually effective in getting doctors to write prescriptions is still a matter for debate in the literature (Glass and Rosenthal 2004).

Finally, pharmaceutical *samples* influence new drug uptake, since doctors who receive new drug samples are more likely to adopt it than the others (M. Y. Peay and E. R. Peay 1988).

In sum, pharmaceutical companies provide knowledge, increase product awareness, and direct further information acquisition—they have a direct impact on prescribing. In an environment of growing emphasis on evidence-based medicine, does professional information counterbalance commercial information? Greiving et al. (2006) found that general practitioners who rely on commercial information are more likely to prescribe new drugs in preference to other drugs from the same therapeutic class. Promotional information—they concluded—continues to determine the early adoption of a new therapeutic class.

Communication among professionals

A wide variety of research showed that *interpersonal communication* between opinion-leading doctors and their peers is a critical factor in the rapid, wide-scale acceptance of innovative drugs (Coleman, Menzel, and Katz 1959; Williamson 1975b; M. Y. Peay and E. R. Peay 1994; Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001). Personal contacts provide a real stimulus, since key opinion leaders present reliable, easy-to-digest assessments of new drugs. While other sources of information provide the nurturing groundwork of necessary knowledge, behavioural change requires the legitimising power of personal advice from informed and respected colleagues (Weiss et al. 1990).

Coleman, Menzel, and Katz (1959) argued that the *network of informal relations* among doctors is highly effective in transferring information and influencing the diffusion of pharmaceutical innovations—socially integrated doctors introduce new drugs quicker than their more isolated colleagues. The finding was found valid for all three social structures of the medical community studied (advisor, discussion, and friend networks), with one caveat—the channels of influence among doctors operate most powerfully during the first few months after the release of a new drug.

A significant amount of literature addressed the *influence of specialists on their specialist colleagues* (Weiss et al. 1990; M. Y. Peay and E. R. Peay 1994; Buban, Link, and Doucette 2001; Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001). Consultants rely heavily on the advice of colleagues regarding the utility of new medications (Weiss et al. 1990; Jones, Greenfield, and Bradley 2001)—they rate their senior colleagues most frequently as important for new drug uptake (McGettigan et al. 2001). In both theory and practice, the number of contacts with other doctors is the most consistent predictor of early awareness and prescription (M. Y. Peay and E. R. Peay 1994). However, although doctors who serve as information sources for colleagues (whether as sources of advice or recipients of referrals) learn about a new drug earlier, they do not prescribe the drug earlier. In contrast, doctors defined as information seekers (whether as seekers of drug advice, sources of referrals, or conference attendees) are not only aware of a new drug earlier, but also prescribe it earlier (M. Y. Peay and E. R. Peay 1994).

Composition matters too, not just the number of contacts. Beside the number of specialist colleagues inside the main practice setting, interactions with specialist colleagues outside are also significantly associated with new drug uptake (Weiss et al. 1990; Buban, Link, and Doucette 2001)—informal communication channels outside the main practice setting raise the likelihood of learning about therapeutic advances.

Local opinion leaders play a particularly influential role in the diffusion of pharmaceutical innovations (Greer 1988; Soumerai et al. 1998). Their evaluations form the basis for consensus among their groups—a prerequisite for diffusion.

A vast amount of literature emphasised the *influence of specialists on new drug uptake in general practice*, through *advice* or *example* (Strickland-Hodge and Jepson 1988; Feely et al. 1999; Jones, Greenfield, and Bradley 2001; Jones et al. 2001; McGettigan et al. 2001; Prosser, Almond, and Walley 2003; Tobin et al. 2008). A significant amount of general practice prescribing is hospital-initiated or hospital-led (Jones et al. 2000; Jacoby, Smith, and Eccles 2003). New drugs seem to diffuse into general practice through a two-step process, with hospital consultants as innovators and general practitioners as followers, with perceived uncertainty of new drug prescription thus significantly reduced (Prosser and Walley 2003). However, Florentinus et al. (2009) found no supporting evidence for this model—general practitioners are responsible for a considerable amount of early prescription of new drugs.

Consistency of evidence reduces uncertainty and promotes new drug uptake (Prosser and Walley 2006). Perceived *local consensus* and *conformism* with consultants—or other respected professionals—or with other group norms is also likely to shape prescribing behaviour (Jacoby, Smith, and Eccles 2003). In contrast, lack of consensus over best use slows down the diffusion of pharmaceutical innovations (Chauhan and Mason 2008).

Finally, *doctors who sit on decision-making bodies*—such as the drug and therapeutic committees (DTCs) in the UK, for example, which evaluate drugs for introduction in formularies—appear to have a special influence, due to proximity to research and understanding of evidence base (Chauhan and Mason 2008).

Summary and discussion

For patients to receive the best possible care, doctors have to consider the risks and benefits of new drugs in conjunction with patient characteristics. However, healthcare budget limitations cannot be ignored—initiating treatment for one patient adversely affects therapy availability for other patients. Efficient prescribing is a complex exercise, and early adoption of new drugs is the outcome of interactions among prescriber, patient, drug, and the interpretation of evidence. The determinants of the decision to prescribe are interconnected in many—often conflicting—ways. However, a rigorous review of the literature revealed a number of variables that produce consistent prediction of early adopters.

At prescriber level, male general practitioners typically prescribe new drugs earlier than female general practitioners. Foreign qualifications and graduation from most recently formed medical schools are also associated with higher rates of

new drug use. Similarly, interest in particular clinical or therapeutic areas also exerts influence on new drug uptake. Early adoption of special-purpose drugs is more likely among specialists than among generalists, while drugs used for a wide spectrum of therapies diffuse faster among general practitioners. Partly related to clinical interest, clinical trial participation is also a powerful predictor of early adoption. Finally, prescribing habits exert a significant influence on the adoption process. Not surprisingly, the greater the number of total prescriptions written for all types of drugs and the wider the prescribing portfolio, the greater the chances of writing prescriptions for new drugs.

At patient level, consistent predictors of new drug uptake include young age and high socioeconomic status—high income, high level of formal education, and being member of the majority race / ethnicity of the country. Furthermore, poor health status—either self-reported or due to comorbidities or unsatisfactory response to existing therapies—also promotes new drug uptake.

At practice level, the volume of diagnostic and therapeutic activity is consistently associated with new drug utilisation—the higher the number of healthcare services delivered, the more severe the health status of the patients is likely to be, urging adoption of new drugs.

Most drug characteristics can only be measured qualitatively, through in-depth interviews and survey questionnaires. One exception is the marketing budget a pharmaceutical company puts behind a new drug. In line with expectations, the higher the marketing budget, the faster the adoption.

However, categorising early and late prescribers for a number of other variables is not possible, due to inconsistent results.

At prescriber level, the age of the doctor is a debated characteristic—in the majority of cases, no association was found. Where association was found, young age favoured early adoption, in line with intuition. At the same time, neither board certification nor hospital affiliation associates consistently with new drug uptake.

At patient level, characteristics of early receivers vary from drug to drug, mostly depending on the therapeutic goal and the target audience of the drug. In line with this, neither the gender nor the marital status of the patient produces consistent prediction. However, of course, old age favours adoption of drugs designed specifically for the elderly.

At practice level, several variables yielded inconsistent results in quantifying the likelihood of new drug uptake. Group practices associate with new drug uptake in some studies—most probably due to high numbers of patients in need of such therapies rather than professional stimulation from colleagues—but not in all. Practice location (rural or urban) also does not predict consistently new drug uptake. Drug-related information and marketing activity have good reach across geographic areas—the immediate demand for new drugs is stimulated to a similar extent in both urban and rural areas. Practice size—measured either by number of

patients or prescribing volume—also does not associate consistently with new drug utilisation. Presumably, the innovative and conservative behaviours of the individual doctors can only cancel one another out, when summed up at practice level.

Prescribing decisions cannot be captured without in-depth interviews and survey questionnaires—the list of factors identified in the previous section was comprehensive, even if the review itself was not. A new drug launch is accompanied by a large volume of information. In general, to judge drug safety and efficacy, specialists place emphasis on established, professional information, while general practitioners rely more upon commercial information. Pharmaceutical companies disseminate commercial information and provide knowledge, increase product awareness, and direct further information acquisition.

Integration—professional and social—appears to be an important influencing factor, with information relayed through direct, personal contacts proving particularly powerful in new drug uptake (Coleman, Menzel, and Katz 1959; Greer 1988; M. Y. Peay and E. R. Peay 1994; Weiss et al. 1990; Jones, Greenfield, and Bradley 2001; McGettigan et al. 2001; Tobin et al. 2008). Specialist peers are the most powerful contacts among hospital consultants, while both sales representatives and hospital consultants drive new drug uptake among general practitioners. This possibly richest medium of communication—and of influence over new drug uptake—has important implications for both pharmaceutical companies and healthcare strategists. Pharmaceutical companies should continue to devote significant proportions of their marketing budgets to sales representatives, and should target customised and scientifically valuable information at key opinion leaders. At the same time, healthcare strategists should be very careful with projects that rely on electronic databases—efforts to utilise objective information to improve prescribing had ambiguous outcomes (Chauhan and Mason 2008), and healthcare strategists should preferably rely on specialists to systematically disseminate new drug information and prescribing guidelines.

This article has shown that early adoption of new drugs is an extremely complex process. The diffusion of pharmaceutical innovation is the outcome of interactions among doctors' prescribing behaviours, doctors' social networks, and pharmaceutical companies' product strategies, within healthcare institutional settings—outside the US—established largely by governments. Due to data constraints, only Glass and Rosenthal (2004) controlled for the impact of pharmaceutical marketing on early adoption of new drugs. However, their product strategy variable was an aggregate reflecting the size of the marketing budget, not a prescriber demographic or a practice characteristic—an issue for examination by future research.

Doctors' individual characteristics and social interactions are of particular importance in their prescribing behaviour, principally among specialists. Predicting doctors' prescribing behaviour is a complex and multifactoral exercise in itself—just as much a challenge for research in the future as it has been in the past. So far, researchers have failed to make accurate and consistent predictions regarding doctors' early adoption of new drugs. Henceforth, research into early adoption of new drugs should most probably be directed not only towards the specific characteristics of doctors, patients, pharmaceutical companies, and the drugs themselves, but also towards the interactions among characteristics and social networks. To this end, Iyengar, Van den Bulte, and Valente (2011) carried out pioneering research by combining individual-level new drug adoption data, demographic data, social network data on discussion and patient referral ties among doctors, and individual-level sales call data provided by a pharmaceutical company. The authors found evidence of social contagion in new drug adoption (after controlling for doctor-level marketing efforts) and argued that targeting heavy users (a practice common in the industry) is a good pharmaceutical company strategy—doctors not only have a higher customer lifetime value, through exerting more social contagion, but also a higher network value.

The recent availability of administrative data from health insurance funds (Pham et al. 2009; Barnett et al. 2011; Landon et al. 2012) might also enable researchers to construct and combine social network data with the socio-demographic and professional characteristics of doctors. Such data allows researchers to construct patient-sharing networks where a link between two doctors represents caring for the same patient—due to referral, patient self-selection, administrative rule, or even chance (Barnett et al. 2011). In general, to coordinate patient care, doctors have to communicate regularly and effectively with the other doctors who share responsibility for the same patients (Pham et al. 2009), enabling them to influence the early adoption of new drugs.

The model for understanding the diffusion of pharmaceutical innovations is not pharmaceutical company–doctor–patient, but a model of the doctor as the node of a network involving pharmaceutical companies, other doctors, especially specialists, patients, and features of the drugs themselves. Prescribing is a form of social action, which involves understanding the network within which the individual doctor is embedded.

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