**Who set the ball rolling? The first prescribers of OxyContin**

**Abstract:**

OxyContin is probably the most controversial new drug launched in the last twenty years. The links between this opioid-based painkiller and addiction and crime are now resulting in public controversies that are far reaching in their consequences. Applying a hazard modelling approach to prescription data, we examine the factors that first led to the adoption of OxyContin among general practitioners in the UK and compare these to summarised results for 25 new drug launches. We find that the influences on early prescription are quite different for OxyContin compared to the typical drug. It was the general practitioner pain specialists who led the early adoption of OxyContin in our data. Thus, if inappropriate prescribing was the cause of OxyContin abuse, this might at least in part be addressed by better education of the ‘expert’ general practitioners.

*Keywords: OxyContin, Hazard Modelling, Pharmaceutical Prescribing*

*Track: Innovation Management and New Product Development*

**1. Introduction**

In March 2019 the Tate Modern art gallery in London took the unusual step of refusing further donations from the Sackler family, owners of Purdue Pharma, in the face of ongoing legal action against the firm over the production and subsequent misuse of OxyContin (BBC, 2019). Oxycontin was launched in the mid-1990s as a new opioid painkiller, produced in greater strength to be a longer lasting version of the underlying molecule oxoycodone. By the year 2000 OxyContin had been linked to addiction and crime (Pacheco 2002), and the drug together with other new painkillers such as Fentanyl have since been criticised for contributing to widespread recreational abuse of opioids, as well as an upsurge in accidental overdoses and deaths.

How did all this start? OxyContin is a prescription pharmaceutical, so it requires physicians to adopt the drug in their prescribing repertoires before it becomes accessible to their patients. The physicians themselves experience a variety of influences before first prescribing a new drug, and these influences on innovative prescribing behaviour have been much studied from the early seminal work of Coleman, Katz and Menzel (1957) onwards (e.g. see Iyengar, Van den Bulte & Lee, 2015, Stern and Wright 2016).

The influences on prescriptions can be usefully framed in terms of two-step flow (Katz & Lazarsfeld, 1955) in which an initial adopter is influenced by ideas outside the social system, and then spreads influence through their connections within the social system. Related ideas can be found in Roger’s work on Diffusion of Innovations (Rogers 1962) and the Bass Diffusion model (Bass 1967). In a similar vein, Lublóy (2014), in a systematic review of pharmaceutical innovation diffusion, noted that this initial influence occurs at a micro-level, to do with physician characteristics, followed by the spread of further influence at the macro-level, to do with the flow of ideas within physician networks, and finally that all this is influenced by the broader meso-level environment of economic and policy factors.

We do not study the meso-level in the present research. Further, quite a lot is already known about macro-level diffusion among physician networks (see Manchanda et al. 2008; Iyengar et al. 2011; Liu and Gupta, 2012; Iyengar et al. 2015). However, much less is known about micro-level effects such as innovator characteristics, as these show mixed or contradictory findings for both pharmaceuticals (Lublóy, 2014) and consumer products (Bartels and Reinders, 2011). These contradictory findings may reflect differences between drugs, but also misspecification of the models used to estimate these effects.

Specifically, Bartels and Reinders (2011) address the problem of mixed or contradictory findings in the innovation literature by proposing a reconceptualization of the innovativeness construct. They build on seminal work by Midgely and Dowling (1978) to decompose the concept into three dimensions; innate innovativeness, domain-specific interest in the product category, and the actual innovative behavior. These are defined as follows:

Innate innovativeness:

“*The study by Midgley and Dowling (1978) is among the first to identify innovativeness as a generalized personality trait called “innate innovativeness.” They state that innovativeness is “a function of (yet to be specified) dimensions of the human personality” (Midgley and Dowling, 1978, p. 235) and that “all members of society possess a greater or lesser degree of innovativeness.” According to Hirschman (1980), innovativeness as a personality trait reflects an innate tendency to seek out new information, stimuli, or experiences (Hirschman, 1980)”* (Bartels and Reinders, 2011; p. 602)

Domain specific innovativeness:

*“Domain-specific innovativeness captures an individual's predisposition toward a product class and reflects the tendency to learn about and adopt new products within a specific domain of interest.”* (Bartels and Reinders, 2011; p. 604)

Innovative Behavior

*“The concept of actualized innovativeness, or innovative behavior,*

*describes a measure of early adoption: that is, the degree to which an*

*individual's purchase or use of an innovation precedes that of other*

*consumers (Midgley and Dowling, 1978).”* (Bartels and Reinders, 2011; p. 605)

Innovation research does not typically decompose consumer innovativeness in this way. In fact, the present authors have been unable to locate any large-scale empirical study using this decomposition of the concept of consumer innovativeness. Nor have we located any application of this conceptualization in the literature on pharmaceutical innovation.

**2. Research Aim**

The aim of this study is to investigate the first part of the two-step flow for OxyContin; the initial innovative prescribing behaviour. That is, how did the ball start rolling? Unlike prior work, the present study includes Bartel and Reinders’ (2011) reconceptualization, including measures of innate innovativeness and domain-specific innovativeness, as well physician characteristics and prescribing volume as covariates, and with innovative behaviour treated as the dependent variable. This approach to modelling innovative prescribing behaviour offers new methods to investigate the question: What type of physicians were the first ones to prescribe OxyContin, eventually leading to the current widespread abuse of this drug?

**3. Model and Data**

We hold data for n = 235 UK general practitioners for two years – one year prior to the launch of OxyContin, and one year following. This data includes a record of the specific week in which the physician first prescribed OxyContin (if they did so in the first 52 weeks following the drug launch). The time-dependent nature of our data makes it suitable for hazard modelling, rather than relying on less statistically powerful models such as logistic regression. We therefore apply Cox proportional hazard regression to our panel data on physician prescribing behaviour. The key variables used, and their operationalisation are:

*Innovative behaviour*  Prescribing OxyContin in the first 52 weeks following launch.

*Innate innovativeness* Number of innovative prescribing behaviours across six therapeutic categories in the year prior to OxyContin launch.

*Domain specific interest* Concentration of prior prescribing on nervous system drugs

*Prescribing volume* Total volume of prior prescribing

*Physician characteristics* Practice size, practice location, physician age, physician gender.

This present analysis is part of a larger project involving 25 new drug launches in total. Although the other 24 drug launches are outside the scope of the present research, we do report some summarised statistics for the purposes of comparison and interpretation of the results obtained for OxyContin.

**4. Results**

Preliminary work across all 25 datasets shows that age was non-significant, and this variable is therefore dropped from further analysis. The overall Cox proportional hazard regression for OxyContin then has p = 0.068 (Table 1). Although this may seem at best only marginally significant, the underlying model is known to perform well across the 25 datasets, albeit with some variation in p values. Twenty out of the 25 datasets have models with p < 0.05 and a further two have p < .10. It is therefore reasonable to assume that this is a true model with some random variation leading to a distribution of p values for individual cases. The p value of 0.068 is therefore deemed adequate for further analysis of individual variables in this particular case.

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| --- | --- | --- | --- |
| -2 LL | χ2 | d.f. | Sig. |
| 133.342 | 11.729 | 6 | 0.068 |

Table 1. Overall Model

When considering the performance of each candidate variable, we examine Wald statistics as indicators of the strength of the effect, and Exp (B) value as showing how the odds of innovation change with changes to the independent variable. The Exp (B) values are managerially meaningful, but do not assist comparisons between variables as they are not scale free. The Wald statistic, conversely, controls for the range of each independent variable and thus can be used for inter-variable comparisons.

When comparing the results from OxyContin with those for the total dataset of 25 new drug launches, we use the average drug to provide comparative Wald statistics, and all drugs in a pooled regression for comparative Exp (B) values.

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| --- | --- | --- | --- | --- | --- | --- |
|  | Prior Innovation | Category Expertise | Rx Prior | Practice Location | Practice Size | Gender |
| **Wald** | | | | | | |
| Av. drug | 4.267 | 8.258 | 6.379 | 1.635 | 0.936 | 1.990 |
| OxyContin | 0.107 | 7.094 | 0.607 | 0.004 | 1.551 | 0.891 |
| **Exp (B)** | | | | | | |
| All drugs | 1.216 \*\*\* | 1.195 \*\*\* | 1.001 \*\*\* | 1.121 \*\*\* | .970 \* | .861 \*\*\* |
| OxyContin | n.s. | 1873 \*\* | n.s. | n.s. | n.s. | n.s. |

Table 2. Hazard of Innovative Behaviour

The Wald statistic and Exp (B) for OxyContin reveal that the major and indeed only significant effect is Category Expertise, representing Domain Specific Interest (Table 2). That is, it is general practitioners with greater expertise in nervous system prescribing who first adopted this particular drug. Or more precisely; the more a physician concentrated their prescribing in nervous system drugs, the greater the odds that they would engage in innovative prescribing behaviour for OxyContin. This might seem an intuitive result but in fact from the study of 24 other new drug launches this is not the normal pattern.

Rather, the comparison with the results for all drugs shows striking variations. The pattern of Wald values for OxyContin is quite different, being dominated by Category Expertise, whereas the average drug shows a much more balanced set of influences. Similarly, when considering all drugs, we see the Exp (B) values are significant in each case, but this is not repeated for the individual case of OxyContin.

Thus, OxyContin made its first inroads amongst those who already prescribed a lot of painkillers, and these general practitioners in turn influenced others. If inappropriate prescribing has been the cause of OxyContin abuse, this might at least in part be addressed by better education of the ‘expert’ general practitioners, including informing them of their responsibility to be careful in passing on their knowledge to later adopters about such dangerous new drugs.

Meanwhile, the application of Bartels and Reinders (2011) framework for consumer innovativeness is successful. The tripartite conceptualisation of innovativeness gives significant and substantial effects across the set of 25 new drug launches, so omission of some of these variables can now be seen as likely to lead to serious omitted variable bias. Only by including these variables can the analysis reveal the unusual pattern of influence that underlay the spread of OxyContin.

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