Research in Social and Administrative Pharmacy xxx (2017) 1–10

Contents lists available at ScienceDirect

Research in Social and Administrative Pharmacy

journal homepage: www.rsap.org

Estimating preferences for modes of drug administration: The case of US healthcare professionals

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ARTICLE INFO

Article history:
Received 4 February 2017
Accepted 4 February 2017

Keywords:
Discrete-choice experiments
Drug administration
Manufacturing
Product differentiation

ABSTRACT

Background: There are hidden drug administration costs that arise from a mismatch between end-user preferences and how manufacturers choose to formulate their drug products for delivery to patients. The corollary of this is: there are "intangible benefits" from considering end-user preferences in manufacturing patient-friendly medicines. It is important then to have some idea of what pharmaceutical manufacturers should consider in making patient-friendly medicines and of the magnitude of the indirect benefits from doing so.

Objectives: This study aimed to evaluate preferences of healthcare professionals in the US for the non-monetary attributes of different modes of drug administration. It uses these preference orderings to compute a monetary valuation of the indirect benefits from making patient-friendly medicines.

Methods: A survey collected choice preferences of a sample of 210 healthcare professionals in the US for two unlabelled drug options. These drugs were identical except in the levels of attributes of drug administration. Using the choice data collected, statistical models were estimated to compute gross welfare benefits, measured by the expected compensating variation, from making drugs in a more patient-friendly manner.

Results: The monetary value of end-user benefits from developing patient-friendly drug delivery systems is: (1) as large as the annual acquisition costs per full treatment episode for some biologic drugs; and (2) likely to fall in the "high end" of the distribution of the direct monetary costs of drug administration.

Conclusions: An examination of end-user preferences should help manufacturers make more effective and efficient use of limited resources for innovations in drug delivery system, or manufacturing research in general.

1. Introduction

Different types of resources (pre-treatment counselling and medications; patient education and training for self-administration; medical equipment and consumables; laboratory tests, post-treatment progress checks etc.) are consumed each time a drug is administered. Depending on the type of drug and the disease condition in question, administration of multiple drug doses over time could be a "silent" driver of the direct monetary costs of healthcare delivery.[1] Granted, a given mode of drug administration that incurs the lowest monetary cost to healthcare payers or providers may incur hidden indirect costs in terms of a mismatch with what is preferred by end-users[2] – the end-user here being patients or healthcare professionals acting on behalf of patients. Using modes of drug delivery that are out of tune with end-user preferences is thus associated with "intangible costs" that must be accounted for when pharmaceutical manufacturers decide on which production plans to use or research when making clinically-beneficial medicines. The argument here is: if the mode of drug administration is simply a vehicle by which the (incremental) health benefits provided by a drug are delivered to patients, then pharmaceutical manufacturers need to have some knowledge of end-user preferences for this vehicle if they are to produce patient-friendly medicines.

But if patient-friendly medicines are no more than drug products differentiated according to the mode of administration most preferred by end-users, then the obvious question is: whose preferences should be evaluated and taken into account when making these medicines? To answer this question, first consider that

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http://dx.doi.org/10.1016/j.sapharm.2017.02.003
1551-7411/

pharmaceutical R&D expenditures on medicines (including the costs of manufacturing research) for diseases that are common to both high- and low-income countries are joint global costs to be recouped from all end-users in all countries (submarkets) where a given drug is consumed.[3] This joint global nature of pharmaceutical R&D means, in theory, the preferences of all end-users worldwide should be considered, or, at least, end-users in healthcare systems that a manufacturer trades with. Given pharmaceutical R&D for global diseases is driven largely by economic demand in OECD countries; and the time and resources available for this study, we only elicit the preferences of healthcare professionals (doctors and nurses) acting on behalf of patients in the US. We focus on healthcare professionals as they are often responsible for making resource allocation and spending decisions; and because the ultimate end-users (patients) are usually less-informed, sometimes passive recipients of medical care.

In this paper, we evaluate healthcare professionals' preferences for the non-monetary characteristics (attributes) of modes of drug administration using a discrete choice experiment (DCE). Our application of a DCE is in accordance with the literature on product variety, notably Spence's[4] arguments that the most natural way of evaluating the welfare effects of product differentiation is in "attribute space". That is, if end-user preferences for a common set of attributes of a class of products or services is known for a consuming population, then the (expected) demand for or gross consumer welfare benefits gained from any set of products or services that can be described by combinations of these attributes can be estimated. In contrast to working in "attribute space", conventional welfare analysis in "product space", i.e., evaluating demands for products *as a whole* and not as a combination of attributes, do not allow estimation of demands for hypothetical, non-existent or potential products or services.

2. Discrete choices and logit demands

Proposed here is a simplified healthcare market made up of a finite number of pharmaceutical manufacturers on the supply-side and a finite number of end-users: healthcare professionals, acting on behalf of a given patient population, on the demand-side. Each manufacturer supplies drug products that are identical except for being differentiated according to their mode of administration to patients.

The decision to supply such differentiated drug products is subject to: (1) the resources available for production; (2) the state of underlying manufacturing science; (3) each manufacturer's expectation of incremental private producer surplus from doing so, i.e., the additional revenues net of any additional manufacturing costs; and (4) whether the expected producer surplus covers any additional fixed costs or sunk expenditures on R&D. The decision to consume these differentiated products is in effect an expression of preferences for a given mode of drug administration. Following characteristics theory,[5,6] or the "abstract product approach",[7] demand-side utility obtained from each differentiated drug product is derived not from the drug *per se* but indirectly from the hedonic characteristics (attributes) of drug administration embodied by that drug.

In this market, demand for a drug product (which is in effect demand for modes of drug administration) can be considered as a derived demand for a bundle of attributes of drug administration. Each drug product can be defined by various possible combinations of attributes and levels (values) for these attributes. These "treatment combinations" of attributes and attribute-levels (or profiles of the products) can be thought of as the output of a transformation matrix that turns attributes into products, and vice versa. Given the prevailing prices of drug products and depending on the resources available to a healthcare professional, i.e., the residual income or financing available after expenditure on a composite of all other healthcare goods and services, one can identify what is called an "attributes efficiency frontier" that indicates the maximum possible combination of attributes and attribute-levels (collection of drug products) that can be afforded.

This, however, assumes that production possibilities allow manufacturers to supply all drug products that all healthcare professionals want or prefer. In the case of limited production possibilities (dictated in part by the state of the underlying manufacturing science), some healthcare professionals may not get what they want or prefer, that is, the product (combination of attributes or attribute levels) that maximizes their utility. As a compromise, some healthcare professionals may choose to consume at different times different products for which a combination of profiles of selected products matches their best preferred product if it was supplied by manufacturers. What is clear here is: given limited resources available to manufacturers, and the need to minimize end-user welfare losses, it is crucial that manufacturers have some knowledge of the distribution of healthcare professionals' preferences in order for them to supply the classes of drug products (differentiated by their mode of administration) that matches closely what the average representative professional recommends or consumes.

Following random utility theory,[8] the 'satisfaction', 'benefits' or utility (U^*_{sj}) a healthcare professional, s, derives from choosing alternative product j from among a set of J differentiated products (which in this case refers to J modes of drug administration) is made of up of two parts. One, a systematic, explainable or observable component, V_{sj} that is a function of the set of attributes; and two, a random unexplained error term, ε_{sj}. We can thus write the following utility function that is linear in parameters and linear in attribute levels:

$$\begin{aligned} \mathrm{U}^{*}_{\mathrm{sj}} &= \mathrm{V}_{\mathrm{sj}}\left(\boldsymbol{\beta}_{\mathrm{jk}}\mathbf{X}_{\mathrm{jk}}\right) + \varepsilon_{\mathrm{sj}} \\ \boldsymbol{\beta}_{\mathrm{jk}}\mathbf{X}_{\mathrm{jk}} &= \beta^{'}_{\mathrm{k}}\mathrm{X}^{'}_{\mathrm{k}} + \beta_{\mathrm{p}}\mathrm{C} + \sum_{\mathrm{j}=1}^{\mathrm{J}-1}\mathrm{ASC}_{\mathrm{j}} \end{aligned} \tag{1}$$

where $\boldsymbol{X}_{jk}$ is a vector of attribute-levels decomposed into $X^{'}_{jk}$, a vector of generic non-monetary attribute-levels and C_p, the drug administration cost associated with each alternative product. $\boldsymbol{\beta}_{jk}$ is a vector of attribute-coefficients, decomposed into $\beta^{'}_{k}$, a vector of coefficients for the non-monetary attributes and β_p, coefficient for the cost attribute. The random error term (ε_{sj}) refers to the influence of unobserved or unmeasured factors whilst the alternative-specific-constant ASC_j captures any peculiar effects of each alternative product that is not reflected in the attributes. ($\sum_{j=1}^{J-1}\mathrm{ASC}_j$ may be considered as the mean of ε_{sj}.)

Because each drug product is identical except in the mode of administration, the choice of each healthcare professional is essentially a discrete one. They either chose to have the drug or not: there is no question of how many or how much. Preferences for differentiated drug products can therefore be equivalently described by a distribution of choice probabilities for different modes of drug administration.

Conditional on knowing the vector β_{jk}, the probability (P) that $j(=1)$ will be chosen by a given healthcare professional above the other $J-1$ discrete products, in each choice situation (n), can be estimated using the "mother" multinomial logit (MNL) model[9] as follows:

Please cite this article in press as: Tetteh EK, et al., Estimating preferences for modes of drug administration: The case of US healthcare professionals, Research in Social and Administrative Pharmacy (2017), http://dx.doi.org/10.1016/j.sapharm.2017.02.003