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Pricing of new vaccines

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New vaccine pricing is a complicated process that could have substantial long-standing scientific, medical and public health ramifications. Pricing can have a considerable impact on new vaccine adoption and, thereby, either culminate or thwart years of research and development and public health efforts. Typically, pricing strategy consists of the following eleven components: (1) Conduct a target population analysis; (2) Map potential competitors and alternatives; (3) Construct a vaccine target product profile (TPP) and compare it to projected or actual TPPs of competing vaccines; (4) Quantify the incremental value of the new vaccine's characteristics; (5) Determine vaccine positioning in the marketplace; (6) Estimate the vaccine price-demand curve; (7) Calculate vaccine costs (including those of manufacturing, distribution, and research and development); (8) Account for various legal, regulatory, third party payer and competitor factors; (9) Consider the overall product portfolio; (10) Set pricing objectives; (11) Select pricing and pricing structure. While the biomedical literature contains some studies that have addressed these components, there is still considerable room for more extensive evaluation of this important area.

Introduction

The commercial trials and tribulations of FluMist, since its introduction to the US Market in 2003, highlight the importance of initial vaccine pricing and how a high price can impede a new vaccine's use and success. Much optimism and anticipation accompanied the approval of FluMist, a live attenuated influenza virus intranasal vaccine that seemed to be a less painful and more convenient alternative to standard intramuscular influenza vaccine, especially among children. Focusing on these advantages and buoyed by initial year sales projections of 4 to 6 million doses, MedImmune and Wyeth sunk $50 million in marketing and advertising and established a $40 to $70 per dose price, over four-times that of the intramuscular vaccine.[1]

However, first year sales fell far (over 75%) short of initial projections, as major insurers and purchasers balked at covering and carrying the high-priced vaccine when a viable and much less expensive inactivated influenza vaccine already existed. While FluMist's relatively high price was not the only reason behind its poor adoption (e.g., skepticism remained about the live virus' safety and the 5 to 49 year old approved population), it certainly played an important role. This financial debacle left MedImmune with large inventories of unused vaccines and led to the dissolution of the partnership between MedImmune and Wyeth in April 2004.[2] Chastened, MedImmune slashed FluMist's price to $23.50 per dose the following influenza season where its price has since hovered.[3] It is quite possible that establishing a lower first year price may have encouraged first year adoption, secured a greater initial market share, and propelled FluMist to greater future success. This may have allowed MedImmune to take greater advantage of the subsequent influenza vaccine shortages of 2004 and 2005.

Companies expend considerable effort and resources to determine the optimal price for a new product (whether the product is a vaccine, drug, medical device, article of clothing or computer technology), recognizing the impact that pricing has on a new technology's adoption. **Table 1** lists key infectious disease vaccines that have reached the US market since 1990, excluding vaccines such as anthrax and plague vaccines licensed exclusively for military anti-bioterrorism use. A new vaccine price can have substantial short- and long-term adoption consequences. Changing a vaccine's price does not alter the number of people at risk for an infectious disease but may affect vaccination compliance, potential purchaser interest, third party payer coverage, and a manufacturer's profit margin.[4,5] Poor adoption of a new vaccine can have much greater ramifications than poor adoption of an article of clothing or software program. The underutilization of an important vaccine can greatly impede disease control and affect many lives for many years.[6] As the FluMist experience shows, initial pricing can have ramifications for many subsequent years. Pricing could even contribute to the eventual withdrawal of a vaccine, as may have happened with LYMErix, the Lyme disease vaccine. Therefore, understanding what is known and unknown about pricing new vaccines is important to not only business executives, marketers, product managers and finance specialists but also public health officials, scientists and clinicians.

General Components of a Pricing Strategy

Pricing strategy is an essential element of a vaccine manufacturer's overall strategy and what Borden, in the 1950s, termed the "marketing mix".[7] The marketing mix is a list of "ingredients" that should be considered when marketing a product. After Borden introduced the term and concept, McCarthy grouped the different elements of the marketing mix into four categories,

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Table 1. Infectious disease vaccines receiving U.S. food and drug administration (FDA) approval since 1990 (excluding biodefense vaccines)

Vaccine name	Infectious disease(s)	Vaccine type	Manufacturer	Year FDA approval	Starting price ($US)	Source
JE-VAX◊	Japanese Encephalitis	Inactivated	Biken	1992	NA	68
HAVRIX	Hepatitis A	Inactivated	GlaxoSmithKline Biologics (GSK)	1995	28.45*	68, 69
VARIVAX	Varicella Virus (ChickenPox)	Live	Merck	1995	41.41*	68, 69
Tripedia	Diptheria, Tetanus toxoids and acellular Pertussis (DTaP)	Toxoid	Sanofi Pasteur	1996	19.43	68, 69
ActHIB	Haemophilus type b (hib B)	Conjugate	Sanofi Pasteur	1996	14.5	68, 69
COMVAX	hib B and Hepatitis B (HBV)	Conjugate	Merck	1996	43.56*	68, 69
VAQTA	Hepatitis A (HAV)	Inactivated	Merck	1996	44.49*	68, 69
INFANRIX	DTaP	Toxoid	GSK	1997	17.05	68, 69
ENERGIX-B	HBV	Recombinant	GSK	1998	24.2	68, 69
LYMErix	Lyme Disease	Recombinant	GSK	1998	61.25	27, 70
TICE BCG	*Mycobacterium bovis*	Live	Organon Teknika	1998	NA	68
RotaShield†	Rotavirus	Live	Wyeth-Ayerst	1998	30	71
RECOMBIVAX HB	HBV	Recombinant	Merck	1999	20.37	68, 69
Prevnar	Pneumococcal	Conjugate	Wyeth	2000	58	68, 69
TWINRIX	HAV & HBV	Inactivated Recombinant	GSK	2001	78.67*	68, 69
DAPTACEL	DTaP	Toxoid	Sanofi Pasteur	2002	20.24	68, 69
PEDIARIX	DTaP, HBV, inactivated Poliovirus (IPV)	Toxoid	GSK	2002	69.41*	68, 69
FluMist	Influenza	Live	MedImmune	2003	22.50*	68, 69
ProQuad	Measles, Mumps, Rubella and Varicella	Live	Merck	2005	117.6	68, 69
Menactra	Bacterial Meningitis	Conjugate	Sanofi Pasteur	2005	82	68, 69
ADACEL	Tetanus toxoid, reduced Diphtheria toxoid, and acellular Pertussis (tdap)	Toxoid	Sanofi Pasteur	2005	35.75	68, 69
BOOSTRIX	tdap	Toxoid	GSK	2005	35.25	68, 69
GARDASIL	Human Papillomavirus (HPV)	Inactivated	Merck	2006	119.75	68, 69
RotaTeq	Rotavirus	Live	Merck	2006	63.25	68, 69
ZOSTAVAX	Herpes Zoster (Shingles)	Live	Merck	2006	174*	68, 72
KINRIX	DTaP & IPV	Toxoid	GSK	2008	48	68, 69
Pentacel	DTaP, IPV, hib B conjugate	Toxoid	Sanofi Pasteur	2008	72.91	68, 69
ROTARIX	Rotavirus	Live	GSK	2008	102.5	68, 69
HIBERIX	hib B	Conjugate	GSK	2009	22.83	68, 69
CERVARIX	Human Papillomavirus (HPV)	Inactivated	GSK	2009	-	68
Ixiaro	Japanese Encephalitis	Inactivated	Intercell	2009	-	68

All starting prices are the year of FDA approval unless otherwise noted. Excludes vaccines such as anthrax and plague vaccines licensed exclusively for military anti-bioterrorism use. *Starting price is the year after FDA approval. †Vaccine discontinued. ◊Vaccine no longer in production.

each beginning with the letter P: Product (which includes product functionality, quality and appearance), Price, Place (which includes the product distribution locations and logistics), and Promotion (advertising, public relations, message, direct sales, sales, media, budget).[8] Although some have suggested adding additional Ps (such as People) to this framework, the Marketing Mix 4 Ps framework remains widely taught in business schools and used by marketers today. All four Ps interact; decisions about each P should account for the other three Ps.[9-11]

Different companies may utilize different specific procedures in pricing a new vaccine. However most follow a general sequence of ten steps. As will be discussed, new vaccine pricing strategy aims to fulfill the manufacturer's financial goals, align with actual marketplace conditions, and support the vaccine's position in the marketplace. What follows is a description, a review of some relevant studies, and examples for each step.

(1) Conduct a target population analysis. Prior to determining a product price, companies typically compile an extensive market analysis, identifying and characterizing potential target populations, purchasers and utilizers. This includes segmenting (i.e., dividing) the market into relevant logical groups that may require different approaches, considerations and strategies. For example, pricing for the pediatric population, whose bills are covered by parents and their insurance, may be quite different from pricing for the older adult population, many of whom are covered by Medicare insurance.[12,13]

Health care workers and the thought-leaders, organizations and publications that influence their behavior are vital components of the marketplace. Endorsement of a new vaccine by influential bodies such as the Advisory Committee on Immunization Practices (ACIP) can facilitate adoption by physicians.[14-16] Conversely, failure to garner support from relevant specialty societies (which occurred for LYMErix) can greatly inhibit a vaccine's chances to flourish.[17]

Example: *West Nile Virus (WNV) Vaccine*

Over the past twenty years, the published literature has included analyses of potential vaccine target populations prior to vaccine pricing. One example is an 2006 economic model by Zohrabian, Hayes and Petersen, conducted seven years after WNV first appeared in North America and well before any WNV vaccine is close to reality.[18] This study found that the cost per case of WNV illness prevented by universal vaccination would range from US \$20,000 to \$59,000 (mean \$36,000), suggesting that targeted rather than universal vaccination would be preferable at the current WNV incidence levels.

(2) Map potential competitors and alternatives. The prices of potential competing products influence the final pricing of a new vaccine. Charging a much higher price than competing products may hurt adoption of the new vaccine, unless the new vaccine offers sizable technological advantages that translate into a recognizable clinical difference to justify the higher price. Charging a much lower price may ignite a "price war", forcing everyone to competitively lower their prices to the detriment of everyone in the industry. The new vaccine price should account for the value of the technological differences between the new vaccine and existing products.[19,20]

Existing vaccine pricing should not necessarily confine future vaccine prices. Three major "pricing revolutions" (i.e., considerable jumps in new vaccine pricing) in the vaccine industry have occurred over the past three decades:

- Early 1980s, Merck pricing its Hepatitis B virus (HBV) vaccine (HB VAX) at ≈\$100 per series.
- In 2000, Wyeth pricing its pneumococcal vaccine Prevnar at an even higher ≈\$250 per series.
- In 2006, Merck pricing its human papilloma virus (HPV) vaccine GARDASIL at ≈\$450/series.

In all three cases, pricing the new vaccine at a much higher price than other existing vaccines seemed risky but eventually led to increased investment in the vaccine industry and transformed these vaccines into "blockbusters" with sales over \$1 billion.

Example: *Adjuvanted influenza vaccine*

There have been some studies comparing vaccines close to the market with existing competitors. An economic model developed by Lee, Ercius and Smith attempted to capture the economic value of an influenza vaccine adjuvant for older adults by comparing the cost-effectiveness of an adjuvanted-influenza vaccine with standard influenza vaccine at different price points and adjuvant efficacies.[21] The study found that an adjuvant which could completely overcome immunosenescence would be economically dominant as long the price of the adjuvanted vaccine were within \$65 of the standard vaccine.

(3) Construct a vaccine target product profile (TPP) and compare it to projected or actual TPPs of competing vaccines. Vaccine developers and manufacturers have long used Target Product Profiles (TPPs) to plan their research and development processes. The TPP is a list or inventory of characteristics, features and attributes (e.g., target disease, mechanism of action, comparative efficacy, routes of administration, possible side effects, contraindications, etc.) that the new vaccine will have in optimistic, realistic and pessimistic scenarios once it reaches the market. TPPs help all stakeholders focus on a common set of aims and understand the potential end results of their efforts.

A TPP can also be vital in pricing. Comparing a new vaccine's TPP with those of current and potential competitors can identify the new vaccine's relative strengths and weaknesses and answer the following questions: what can the vaccine offer to its patients and purchasers, how is the vaccine superior and inferior to its competitors, and how sustainable is the technology? Most vaccines compete on the basis of improved efficacy in a patient group (e.g., conjugated vs. unconjugated Hib for infants under 2 years), improved safety/tolerability profile (e.g., acellular pertussis) or improved convenience (e.g., fewer doses, combined vaccines with fewer injections, intranasal vs. injected vaccines, etc.). However, other more subtle vaccine aspects (e.g., package size which may affect supply chain operations) may affect vaccine adoption as well.[6]

Example: *Fendrix, second generation adjuvanted hepatitis B vaccine*

In 2005, GlaxoSmithKline's Fendrix, a new adjuvanted hepatitis B virus (HBV) vaccine, received licensure in Europe for patients with renal insufficiency.[22] Pricing reflected the advantages that Fendrix had over the first generation HBV vaccines: conferring faster, more robust and longer-lasting protection. Although Fendrix tended to precipitate more local side effects, the side effects (e.g., injection site pain, fatigue and gastrointestinal problems) were not major enough to be a significant disadvantage.

(4) Quantify the incremental value of the new vaccine characteristics. Once the differences between the new vaccine's characteristics and current or potential competing products' characteristics are elucidated, the next step is to quantify the added value that the new vaccine provides. This added value then can translate into incrementally higher prices. In other words, what is the incremental value of a vaccine that is more efficacious, safe, or convenient? Such "value-pricing" may require constructing an economic model.

Example: *Staphylococcus aureus* (*S. aureus*) *vaccine*

An example is an economic model by Lee and colleagues that found pricing a *S. aureus* vaccine for the orthopedic surgery population up to \$1,000 per dose would still be cost-effective from the third payer perspective.[23] In fact, a \$100 vaccine could still be cost-effective at fairly low (≤50%) efficacy. *S. aureus* vaccines are still far from the market but initiating such early health economic discussions may benefit eventual vaccine success.

(5) Determine vaccine positioning in the marketplace. Once the vaccine market and technology analyses are completed, the next step is choosing how they best fit together. Vaccine positioning is the manner in which the vaccine is introduced and oriented in the marketplace and depends on the nature of the available market, the strengths and weaknesses of the vaccine, and the manufacturers' needs and interests. Will this vaccine be a lower cost alternative, a superior product, or a complement to existing products? There are a multitude of ways a new vaccine can be positioned. Examples include:

• *Target disease or functional indication*: e.g., GARDASIL positioned as a anti-cancer vaccine versus Recombivax HB positioned as a antiviral vaccine.

• *Safety*: e.g., whole cell being safer than acellular pertussis, injected polio (IPV) being safer than oral polio virus vaccine (OPV).

• *Convenience/Comfort*: e.g., intranasal FluMist causes less discomfort than intramuscular influenza vaccine.

Example: *LYMErix (Lyme disease) Vaccine*

Most studies of specific new vaccine positioning have occurred after the vaccine has already been positioned. For instance, after SmithKline Beecham's LYMErix's introduction to the U.S. market in December 1998, vague market positioning, likely compounded by its relatively high price, hampered its adoption and probably contributed to its poor sales and withdrawal from the market in 2002. Although not the only factor hampering its success (e.g., complaints of autoimmune arthritis from the vaccine may have played a primary role), LYMErix suffered from an ill-defined approved target population (i.e., 15 to 70 years old individuals who live or work in grassy or wooded areas) and lukewarm support from key physician groups and public health organizations, due in part to SmithKline Beecham's focus on direct-to-consumer marketing.[17,24,25] Patients did not clamor for a high-priced vaccine that was not advocated by key opinion leaders, especially with alternative measures such as tick control available.[26] Several economic studies confirmed LYMErix's woes but may have been too late to save the vaccine.[26-29]

(6) Estimate the vaccine price-demand curve. The next step is understanding how vaccine price will affect demand for the vaccine. *Price elasticity of demand* measures how use or interest in a product changes with the price. Demand for a product is *perfectly inelastic* when demand remains constant despite changes in product price. The more demand changes with price, the more elastic demand is. Demand is *highly elastic* when it dramatically shifts as price increases or decreases. Typically, more competitors or alternatives lead to higher demand elasticity. Mandatory products with few other options tend to have less elastic demand.

Numerous studies have delineated the relationship between pricing and medication use. In general, increasing prices tend to lower medication use. However, the degree to which this occurs varies significantly by type of drug, population and circumstances. Major changes in insurance drug coverage have offered opportunities to study better characterize this relationship. For instance, in February 2002, the Department of Veterans Affairs (VA) increased drug copayments from $2 to $7 per 30-day drug supply of each medication for many veterans. Doshi and colleagues found that this copayment increase adversely affected lipid-lowering medication adherence among veterans, including those at high coronary heart disease risk.[30]

Example: *Influenza vaccine*

Studies of vaccine price-demand relationships have been less common. Much of the work has been done for influenza vaccine, since it's been on the market for a fairly long time. A study by Galvani, Reluga and Chapman suggests that higher vaccine cost may dissuade younger adults from getting vaccinated.[31] However, a study by Kondo and colleagues found that price elasticity of demand among older adults in Japan was essentially zero.[32]

(7) Calculate vaccine costs (including those of manufacturing, distribution, and research and development). A vaccine's profit margin equals the vaccine's unit price minus its unit cost (i.e., of each vaccine). To ensure profitability, the unit cost is the lower limit of the potential vaccine price and includes research and development (R&D), manufacturing and distribution costs attributable to that vaccine.[33] However, it can be difficult to quantify a vaccine's R&D costs, which in sum can be sizable. For every vaccine that reaches the market, many candidates succumb in preclinical and clinical stages, generating substantial costs which are rolled into the prices of successful vaccines. Matching the R&D costs of unsuccessful candidates with the price of successful candidates is not always straightforward. Moreover, the many mergers, acquisitions and exchanges of intellectual property that occur in the biotechnology and pharmaceutical industry complicate R&D cost accounting.[34,35]

The literature is short on detailed estimates of the true vaccine R&D and manufacturing costs.[36-38] Manufacturers tend to hold such knowledge closely as it may impact negotiations with purchasers. Additionally, these costs fluctuate with time, vaccine type, chance obstacles, and the concomitant development and production of other products. However, it is clear that vaccine manufacturing costs, including specialized personnel and the high fixed costs of establishing and maintaining a vaccine manufacturing plant, are considerable and comparable to those of other biologics, which tend to have much higher prices.[39,40] Personnel and facility depreciation adds greatly to vaccine costs and price. Therefore, unless a manufacturer already has facilities already operational and is selling a very high volume of vaccines, lowering vaccine prices for developing countries may be difficult.

Example: *Adenovirus vaccine*

Vaccine costs played a prominent role in the withdrawal of Wyeth's original adenovirus vaccine.[41-43] Although the vaccine had been highly successful in preventing the adenovirus outbreaks that had previously plagued military recruits, Wyeth ceased production in 1996 after the Department of Defense balked at Wyeth's request for additional funding to upgrade their production facilities. Therefore, manufacturing costs were paramount when the Department of Defense sought and eventually identified additional manufacturers.

(8) Account for various legal, regulatory, third party payer and competitor factors. Manufacturers rarely have complete leeway in new vaccine pricing, as governments, different legal authorities, regulatory bodies, third party payers, and competitors help limit the potential range of prices.[4,34,44-47] Laws in different jurisdictions may prevent prices from being too high (price gouging) or too low (predatory pricing or price "dumping", i.e., an effort to drive competitors out of the market), too different for different people (price discrimination), or too similar to competitors (which raises suspicion of collusion). The prices of existing competing or alternative products can set precedents for new vaccine pricing. In fact, manufacturers may base their pricing strategy heavily on these precedents.

Example: *GARDASIL (human papilloma virus) vaccine*

These factors have been fairly well-studied in the case of Merck's GARDASIL vaccine. Prior to GARDASIL's approval for 9- to 26-year old females in June 2006, Merck constructed an extensive strategy to lobby state legislatures throughout the US to mandate HPV vaccination as a condition for school entry, require insurance companies to cover HPV vaccine, or allocate state funds for vaccination or to promote awareness of the vaccine.[48,49] Although the intense lobbying spurred a backlash among certain vaccine stakeholders including physicians and public health officials and may have slowed adoption, it did galvanize numerous legislative initiatives to help support the relatively high price of GARDASIL. As mentioned earlier, GARDASIL's commercial success in both the US and the European Union constituted a pricing revolution in the vaccine industry, demonstrating that much of the world can support such a price point. However, its high price may be the biggest barrier to adoption in lower income countries.[50]

(9) Consider the overall product portfolio. Many manufacturers develop and sell a portfolio of products, which may include other vaccines, medications, medical devices, and over-the-counter products that are associated or interact with the new vaccine. A new vaccine's price could either enhance or upset the dynamics of other products' development, marketing, distribution or sales. Pricing similar products similarly could simplify accounting. Pricing similar or associated products differently could shift demand for each product in different directions.

Example: *GlaxoSmithKline's vaccine portfolio*

Over the past decade, GSK has rapidly expanded its vaccine portfolio through internal development, licensing and acquisitions so that it now markets over 30 vaccines and has over two dozen more in clinical development, distributing over 1.1. billion vaccine doses in 2008.[51-53] GSK's vaccine pricing has accounted for and taken advantage of its broad vaccine portfolio. GSK has offered volume discounts and price bundling (i.e., discounts if different vaccine products are purchased together) to encourage payers to purchase across its portfolio. The company also has platform vaccine adjuvant technologies, such as MPL and QS-21, that are being applied to multiple vaccine candidates and products.[54] This allows GSK to spread some developmental costs across different vaccines and parlay experience in pricing each adjuvanted vaccine to others.

(10) Set pricing objectives. Although a common goal of manufacturers is to maximize profits, the road to profits can take a variety of paths. An important strategic decision is choosing between short-term and long-term gains (i.e., attempting to maximize short-term profitability by raising the initial vaccine price may sacrifice long-term profitability whereas aiming to maximize long-term adoption by lowering the initial price may sacrifice short-term profitability). Moreover, different possible pricing objectives, such as vaccine profits, profit margin, adoption and revenues, may not correlate with each other. So a manufacturer has to select among the following pricing objectives:[55,56]

• *Maximize adoption of new vaccine:* This is frequently one of the goals when the potential target population is large (e.g., higher volumes of vaccine production help the manufacturer achieve economies of scale, i.e., producing vaccines in bulk or large quantities is less expensive per vaccine).

• *Maximize profit-margin:* This is often the choice when potential sales volume is low (e.g., manufacturing capacity is severely constrained or the target population is small).

• *Maximize profits:* Greater profits can come from a higher profit-margin, more adoption, or both.

• *Maximize revenues:* When costs increase out of proportion with revenues, maximizing revenues may not equate to maximizing profits initially (e.g., costs drop in subsequent years after the initial investment in setting up production).

• *Recover costs:* Sometimes the goal is to simply recoup some or all of the costs of developing and manufacturing the vaccine, especially when these costs are very high.

• *Signal quality:* In many other industries, higher prices can connote higher quality to consumers. While this is less pervasive in the vaccine industry, prices well-below those of analogous vaccines may raise quality concerns among purchasers, especially if the manufacturer does not have an established reputation.

• *Facilitate product survival:* A manufacturer may benefit just by having a certain vaccine (even a non-profitable one) on the market to maintain relationships with important purchasers or smooth introduction of other more profitable products (e.g., only manufacturers currently making US licensed seasonal influenza vaccine could sell H1N1 influenza vaccines to the US Government).

• *Benefit associated products:* The new vaccine price may facilitate the rest of a manufacturer's product portfolio, especially when products are bundled (i.e., sold together) with other products,

• *Maintain status quo:* Manufacturers may be very satisfied with the current marketplace, fear any potential upheaval, and avoid pricing a vaccine too low (stimulating price wars) or too high (driving away purchasers or attracting competitors).

Example: *Prevnar (pneumococcal conjugate) vaccine*

Conflicting pricing objectives may have been an issue with the 2000 introduction of Wyeth's heptavalent pneumococcal conjugate vaccine (PCV7). A survey by Davis and colleagues suggested that the initial high prices relative to other childhood vaccines, which also may have impaired insurance coverage, hindered physician use of PCV7 for the pediatric population.[57] Although PCV7 was extensively adopted, use may have been higher with a lower vaccine price. The authors indicated that their findings may foreshadow obstacles for future pediatric vaccines that may be even more expensive. Manufacturing capacity constraints during the several years post-launch further confounded pricing. Wyeth was not able to produce enough vaccines to meet the higher demand that would have accompanied a lower vaccine price, in essence perturbing the vaccine price-demand curve.

Table 2. Examples of pricing strategies

Strategy	Price	Circumstances/Comments
Cost-Based (pricing based on cost of product)		
Cost-Plus	*Cost + Desired Profit Margin*	• Guarantees profit • Inelastic-demand and little competition
Target-Return	*Cost x Desired Return on Investment*	• Guarantees profit • Inelastic demand and little competition
Geographic/ Seasonal/Population	*Different price for different locations, groups or seasons*	• Different costs for different locations, groups or seasons
Competitor-Based (pricing based on prices of competing products)		
Price-Matching	*Price = competitors*	• Other advantages (e.g., lower cost) over competitors • Large target population • May want to maintain status quo
Price-Undercutting	*Price << competitors*	• Elastic demand • Maximize quantity sold
Demand-Based (pricing based on customer demand)		
Skim Pricing	*High for customer segment that has inelastic demand*	• Customer segment with inelastic Demand • Maximize profit margin
Penetration	*Low to maximize adoption*	• Large Target Population with highly elastic demand • High production capacity
Premium (prestige)	*High to signal quality*	• Quality important to customers • Variable quality among competing products
Economy	*Low to maximize quantity sold*	• Highly elastic demand • Low costs
Captive Product	*Very High for Customers who must have the product*	• Essential product with few alternatives • Maximize profit margin
Geographic/ Seasonal/Population	*Different price for different locations, groups or seasons*	• Different demand for different locations, groups or seasons
Portfolio-based (pricing based on other products in the manufacturer's portfolio)		
Price Lining	*Similar price for all product offerings*	• Simplifies accounting • Less flexible
Bundle	*Price for combined package of several products*	• Products naturally fit together • Similar customers demand similar products
Product Line	*Price different products in portfolio based on their relative value*	• Easy to assess differential value of different products • Elastic demand
Goldilocks (Framing)	*High so that lower priced products looks better by comparison*	• Lower priced similar products in portfolio • Elastic demand
Loss Leader	*Very low to draw customers to portfolio*	• Goal is sell other products • Customer loyalty to portfolio
Optional Product	*Offer "extras" for additional price*	• Product has accessories/options (e.g., vaccine administration devices)

(11) **Select pricing and pricing structure.** The final step is to select the new vaccine's price, which may be different for different purchasers, locations and situations.[58] Information from Steps 1 through 10 delineate the vaccine's price structure. Typically, the vaccine price will fall somewhere between the cost-driven price floor (below which the manufacturer cannot recoup its costs) and demand-driven ceiling (above which no one wants to purchase the vaccine). In some cases, this window may be very wide, and in others, fairly narrow.

Table 2 lists examples of common pricing strategies used in various industries. Some pricing strategies focus more heavily on vaccine costs (e.g., in cost-plus pricing, the price is simply the vaccine cost plus a desired profit margin; in target return pricing, the price level is set to achieve a specific return-on-investment) while others more on vaccine demand (demand-based pricing). *Demand-based pricing* includes value-based pricing (i.e., the price reflects the calculated value of the vaccine to purchasers) and psychological pricing (which accounts for how the price may affect demand). Other strategies focus more on competitors or other products in the manufacturer's portfolio.[55]

Discounts are a major part of new vaccine pricing structures.[59] The *effective price* is the net price following various discounts, promotions and incentives. High volume vaccine purchasers frequently try to negotiate effective prices that are lower than the new vaccine list price, particularly when the new vaccine fills an urgent need in lower income countries. Discounts may be specific to certain geographic regions, populations, purchasers, times of the year (e.g., initial FluMist prices tumbled near the end of the influenza season), or other circumstances. Purchase volume is not the only motivation for discounts. *Trade discounts* may apply for certain key populations or purchasers that may not procure large numbers of vaccine but greatly affect how the vaccine is adopted or distributed.

Example: *RotaTeq and ROTARIX (rotavirus vaccines) vaccine*

Over the past decade, a number of studies have helped devise possible price and discount structures for low income countries including arrangements (e.g., advanced market commitments) that share greater risk among government and non-governmental organizations.[60-66] Many new vaccines over the past two decades spent time on high-income country markets before entering lower income country markets. Two exceptions are GlaxoSmithKline's Rotarix and Merck's RotaTeq, licensed to begin filling the great global need for oral live attenuated rotavirus vaccines. Drawing from the lessons provided by the brief stint of Wyeth's Rotashield on the US market, Merck and GlaxoSmithKline actively pursued a global introduction strategy. (Rotashield's withdrawal from the US market amid safety concerns within its first year of introduction precluded its introduction to the global market since many lower income countries did not want a vaccine "rejected" by the US In anticipation of introducing the vaccines to Central and South America, the companies agreed to provide bulk discounts to the Pan-American Health Organization (PAHO).[67]

Conclusions

New vaccine pricing is a complicated process that could have substantial long-standing scientific, medical and public health ramifications. Pricing can have a considerable impact on new vaccine adoption and thereby either culminate or thwart years of R&D and public health efforts. While the biomedical literature contains some studies that have addressed the components of vaccine pricing, there is still considerable room for more extensive evaluation of this important area. A vaccine that falls short of reaching its full potential on the market can have global health ramifications for many years. Better understanding these areas is likely to benefit all involved in vaccine development, distribution, administration and policy-making.

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