Economic evaluation of quadrivalent versus trivalent influenza vaccine use in Colombia

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Replacing TIV with QIV in Colombia during an average influenza season can prevent 5005 influenza cases, 651 hospitalizations, and 43 deaths with influenza as the underlying cause.
QIV is a cost-effective strategy with ICERs of $13,466 and $11,342 per additional QALY from third-party payer and societal perspectives, respectively.

Background

- Epidemics of influenza are a big burden on the Colombian health care system and society[1]. The vaccination program in Colombia covers children between 6 and 35 months of age, pregnant women from week 14 of gestation, adults ≥60 years of age, and people >3 years of age at risk. To date, trivalent influenza vaccine (TIV) has been used for the prevention of influenza.[2]
- Co-circulation of two lineages of influenza B strains and failed prediction of dominant strain by the World Health Organization (WHO) result in high percentage of mismatched cases. Aiming to improve the effectiveness of influenza vaccines, WHO started to support the development of quadrivalent influence vaccine (QIV) for both B/Yamagata or B/Victoria lineages.[4,5]

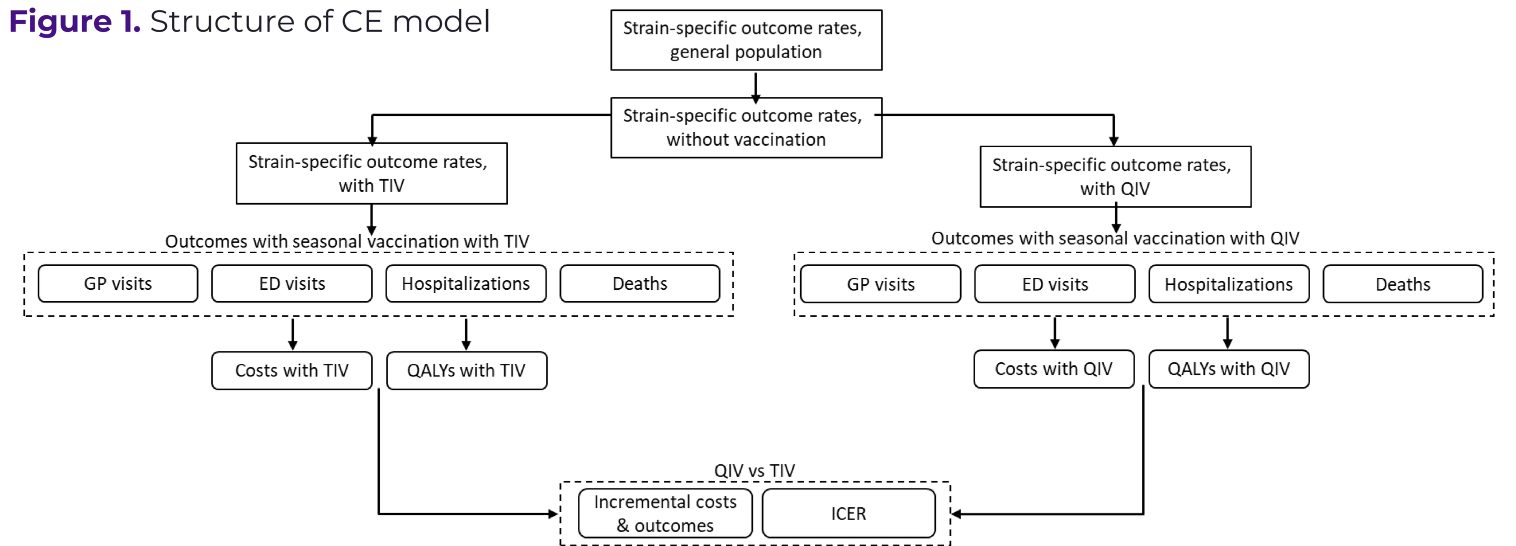
Objectives

- The objective of this analysis was to assess the cost-effectiveness (CE) of replacing a TIV with a QIV in the national immunization program in Colombia. The analysis was performed from the payer and societal perspectives.

Methods

- Previously developed CE model[3] was adapted to the Colombian settings (Figure 1). The model projected influenza-related outcomes during an average influenza season in a population fully vaccinated with the TIV versus QIV.
- The same coverage rate and target population were considered for TIV and QIV; thus, the difference in outcomes was driven only by the difference in vaccine efficacy and costs.
- The total costs were obtained by multiplying each outcome by its unit cost estimate. To estimate QALYs, outcome data were combined with the utility values associated with each outcome. For long-term health outcomes, a 5% annual discounting rate was applied[10].

Figure 1. Structure of CE model



CE, cost-effectiveness; ED, emergency department; GP, general practitioner; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life year; QIV, quadrivalent influenza vaccine; TIV, trivalent influenza vaccine

Input data

- The distribution of circulating influenza strains in Colombia was derived from the FluNet database,[4] based on tropical South America data.
- Strains recommended for inclusion in TIV were based on the WHO recommendations data[5].
- The strain and lineage distribution are presented in Table 1.

Table 1. List of strains included in TIV and distribution of influenza lineages and strains of influenza by year

Season	B lineage in TIV	Influenza A	B/Victoria*	B/Yamagata*	B lineage mismatch
2013/14	Yamagata	76.4%	56%	44%	56%
2014/15	Yamagata	78.6%	27%	73%	27%
2015/16	Yamagata	76.1%	4%	96%	4%
2016/17	Victoria	88.3%	42%	58%	58%
2017/18	Victoria	68.2%	41%	59%	59%
2018/19	Victoria	83.9%	22%	78%	78%
2019/20	Victoria	76.2%	63%	37%	37%

TIV, trivalent influenza vaccine. *% of the lineage among B strains

- Vaccine efficacy and the level of cross-protection were based on the *Clements et al. 2014* study.[6] Vaccine efficacy against B strain in QIV was assumed equal as against B strain in matched TIV
- Coverage rates were based on the information received directly from the Ministry of Health and Social Protection[2].
- Data regarding population size and life expectancy were obtained from the Colombian National Administrative Department.[7]
- Country-specific utilities for selected age groups were derived from a recent study (*Bailey et al. 2021*).[8] The impact of influenza and its complications on the quality of life was estimated based on Sander 2010.[9]

Table 2. Model inputs: population & vaccination coverage/efficacy

	0-4 years	5-19 years	20-49 years	50-64 years	≥65 years
Population size	3,808,866	11,927,778	21,090,651	7,183,835	4,247,364
Life expectancies	75.61	66.08	46.53	25.79	13.09
Utility norm	0.97	0.97	0.96	0.93	0.93
QALYs lost due to influenza episode	0.0146	0.0146	0.0174	0.0174	0.0293
Vaccination coverage	33.00 %	1.82%	2.71%	8.58%	20.75%
VE against influenza A	59.00%	61.00%	61.00%	61.00%	58.00%
VE against matched B	66.00%	77.00%	77.00%	73.00%	69.00%
VE against mismatched B	44.00%	52.00%	52.00%	49.00%	47.00%

QALY, quality-adjusted life year, VE, vaccine efficacy

- The data on consultations and hospitalizations were obtained from the Ministry of Health and Social Protection.[2]
- Mortality data were derived from the Colombian National Administrative Department of Statistics[7] Influenza as an underlying cause of death was considered in the base case and as a direct cause in the scenario
- Country-specific costs of vaccination and its administration as well as GP, ED and hospitalizations were included.[2] The cost of the vaccine, was $2.86 for 0.5 mL of TIV and $5.14 for 0.5 mL of QIV.
- Costs are expressed in 2018 United States dollar [exchange rate of Colombian Peso $2,956 per USD]
- The productivity loss utilised for the societal perspective was based on the human capital approach.
- The model inputs were validated by local experts.

Table 3. Model inputs: outcomes rates&costs

	0-4 years	5-19 years	20-49 years	50-64 years	≥65 years
GP visit rate*	3707	411	336	633	1655
ED visit rate*	1494	157	114	197	715
Hospitalisation rate*	1384	124	78	160	696
Mortality rate*	12.29	1.15	3.21	15.08	161.01
GP visit cost, $	41.12	45.23	51.66	69.36	107.64
ED visit cost, $	34.44	32.04	39.21	46.57	54.68
Hospitalisation cost, $	567	564	940	1,230	1,299
Daily productivity, $	-	6.60	26.24	31.06	30.81
Absenteeism, days	-	0.62	2.47	2.23	0.93

ED, emergency department; GP, general practitioner; VE, vaccine efficacy. *Per 100,000 general population

Results

- Replacing TIV with QIV during an average influenza season in Colombia resulted in 5005 less cases of influenza, and consequently reduced the use of health care resources by avoiding 1765 GP and 711 ED consultations, 651 hospitalizations, and 43 deaths.
- Additional health effect was translated into 454 workdays saved, 489 life years gained, or 547 QALYs gained.
- Lower use of healthcare resources (medical consultations, hospitalization) and lower cost of productivity lost generated savings, which can partially offset additional drug acquisition price.
- The incremental cost-effectiveness ratio (ICER) was equal to $13,466 per QALY from the payer perspective and $11,342 per QALY from the societal perspective. The ICER was considerably lower in the ≥65 years age group and highest in children above 5 years of age (Table 5).
- The considered threshold is a triple value of the per capita gross domestic product (GDP) ($18,000) of Colombia suggesting QIV vaccination to be a highly cost-effective strategy.

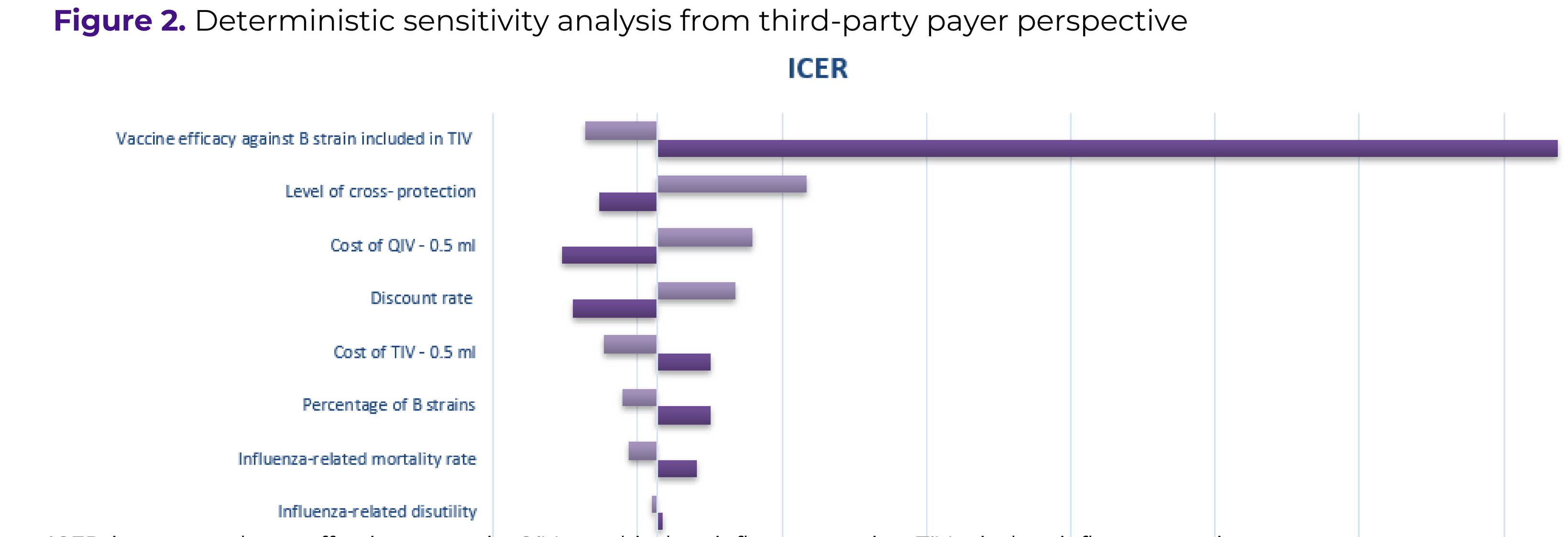
Table 5. Incremental QALYs and cost-effectiveness ratio in particular age groups

	0-4 years	5-19 years	20-49 years	50-64 years	≥65 years	All groups
Incremental QALYs	130	2	11	37	368	547
Incremental costs (Payer perspective)	$2.5mln	$0.5mln	$1.3mln	$1.4mln	$1.7mln	$7.4mln
Incremental costs (Societal perspective)	$2.3mln	$0.5mln	$1.2mln	$1.2mln	$0.9mln	$6.2mln
ICER: Payer perspective	$19,189	$226,870	$121,404	$37,042	$4710	$13,466
ICER: Societal perspective	$17,852	$224,869	$117,209	$33,461	$2515	$11,342

QALY, quality-adjusted life year; mln. million

- Assuming influenza as the major cause of excess death proved to be a sensible assumption of the model, as denoted by an alternative scenario analysis (ICER = $22,084 from the payer perspective).
- Deterministic sensitivity analysis were performed. Range for vaccine efficacy was based on confidence intervals[6] and the other inputs were tested within a range of +/-20% from the base case.
- Similar results were observed for both perspectives. Key drivers were vaccine efficacy against the B strain, levels of cross-protection, and cost of the vaccine.

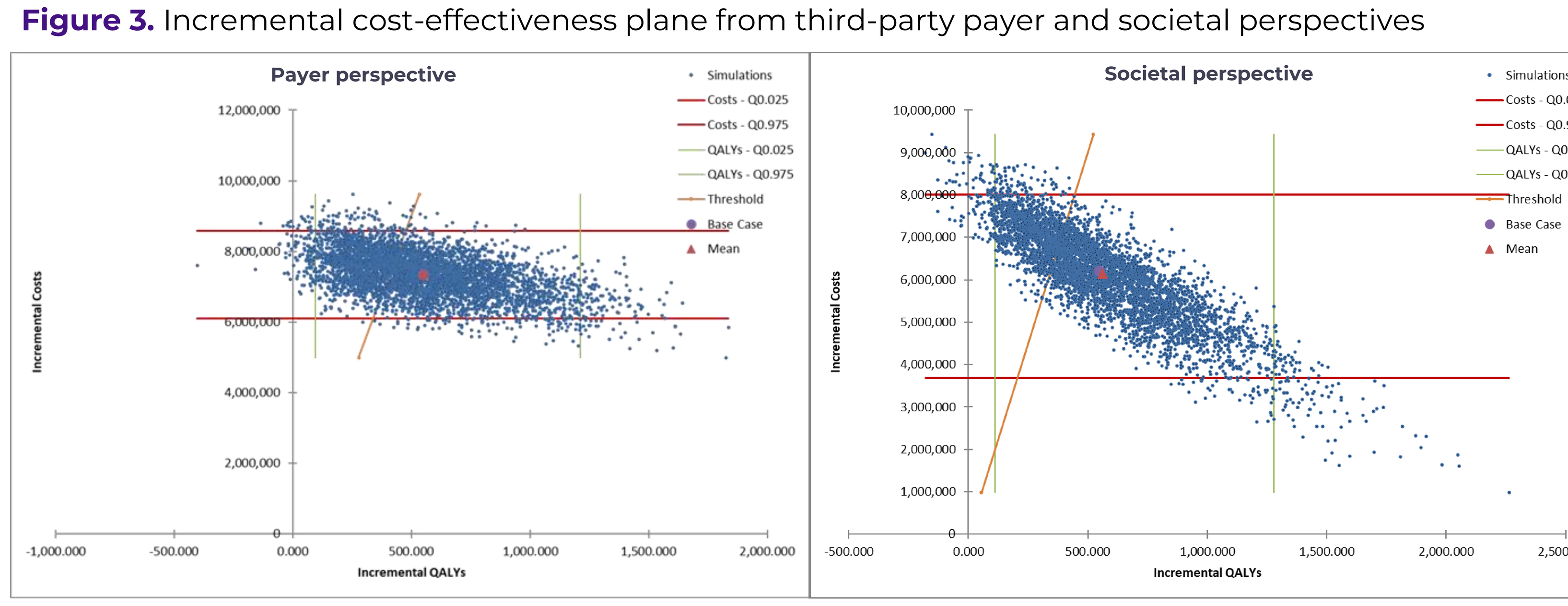
Figure 2. Deterministic sensitivity analysis from third-party payer perspective



ICER, incremental cost-effectiveness ratio; QIV, quadrivalent influenza vaccine; TIV, trivalent influenza vaccine

- Within the probabilistic sensitivity analysis (PSA), 5000 simulations were performed.
- The PSA confirmed that the study results were robust. Mean ICER calculated from the third-party payer perspective, was equal to $13,360 per QALY, and was very close to $13,466 per QALY calculated in the base case. From the societal perspective, the ICER was equal to $10,926 per QALY versus $11,342 per QALY in the base case.

Figure 3. Incremental cost-effectiveness plane from third-party payer and societal perspectives



Conclusions

- Protection against a larger number of circulating influenza strains offered by QIV, compared with TIV, would reduce the number of influenza infections and consequently their impact on the health care system and work absenteeism in Colombia.
- Savings resulting from reduced number of hospitalizations and medical visits, and better productivity would partially offset additional costs associated with the QIV.
- Replacement of TIV with QIV is cost-effective in Colombia considering the threshold of triple GDP per capita.

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Disclosure of COI:

1. Castro R, Rueda JA have no conflict of interest to declare
2. Drzewiecka A, Górecki M, Lemański T have no conflict of interest to declare

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