

# Vaccine Time, Cost and Preference Comparison Between Pre-Filled Syringe Formulations and Vaccines That Require Reconstitution: A Targeted Literature Review

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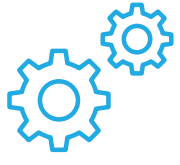
## BACKGROUND

- Vaccine formulations are available as single- or multi-dose vials, in fluid form or lyophilized powder that require reconstitution, and more conveniently as a pre-filled syringe (PFS)<sup>1</sup>
- Several factors contribute to the overall cost of vaccine preparation, including variable time requirements, labor and unit costs, management of waste, storage considerations, the potential for errors in preparation and administration, and associated costs from errors
- Healthcare professionals also have preferences that play a role in the selection of vaccine format
- To our knowledge, there is no literature summarizing the administration time, cost, and error between PFS vaccines and vaccines that require reconstitution (VRR)



## OBJECTIVES

- The objectives of the current TLR were
  - To evaluate vaccine preparation time and the labor costs of VRR and PFS vaccines
  - To assess errors in preparation and administration and costs resulting from errors of VRR and PFS vaccines
  - To summarize the evidence on healthcare practitioner preference of VRR versus PFS vaccines



## METHODS

- A targeted literature search was conducted, using Embase and MEDLINE databases
- We supplemented the list by searching the references and citations referenced by included studies
- All records identified through the initial search were screened for eligibility based on predetermined criteria, first at the abstract level, and then at the full text level
- Eligibility criteria included:
  - Studies that compared any single-dose vaccine administered from a PFS to any single-dose VRR before administration
  - Outcomes of interest i.e. time and motion (eg, assessments of time associated with vaccine preparation and administration), immunization errors, cost-effectiveness analyses (eg, calculations of costs associated with vaccine preparation and administration), preference studies (eg, important treatment attributes, treatment satisfaction, treatment preference, comprehension, and acceptability)
- Relevant data were extracted by one researcher and independently validated by another reviewer



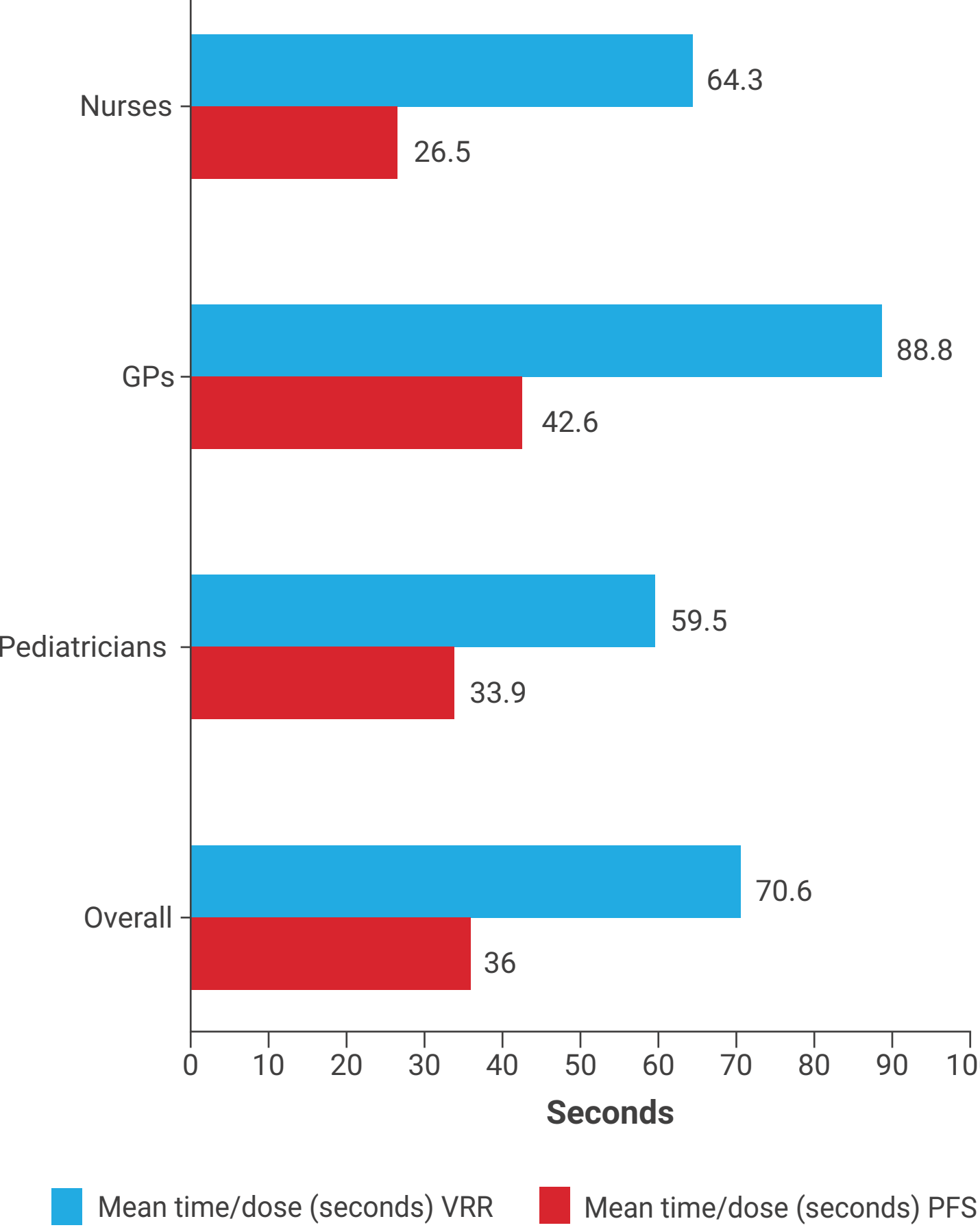
## RESULTS

- Of 957 screened records, 10 studies met the eligibility criteria,<sup>2-11</sup> including 5 surveys to evaluate preference<sup>3,5,7,10</sup> 2 cost analyses,<sup>2,11</sup> 1 budget impact analysis (BIA),<sup>8</sup> 1 cost minimization study,<sup>9</sup> and 1 cross-over randomized, open-label time and motion assessment<sup>4</sup> (**Supplemental Figure 1, accessible through the QR code**)
- 5 studies were conducted in Europe,<sup>3,5,7,8</sup> 3 studies were conducted in Asia,<sup>2,6,9</sup> and 2 studies were conducted in the United States.<sup>10,11</sup>
- Most studies (8 out of 10) presented vaccines related to the Diphtheria-Tetanus-Pertussis (DTaP)-variant vaccines;<sup>2,5,7-10</sup> 1 study assessed the COVID-19 vaccine,<sup>11</sup> and 1 study did not specify the vaccine target<sup>6</sup>

### Time and Cost

- Four studies reported time savings with PFS vaccines compared to VRR
- Time savings with PFS vaccine administration was recognized by all studies that reported time<sup>3,4,8,11</sup> (**Figure 1**)
- In the time and motion study, overall PFS saved 66 seconds; 34.5 seconds (95% CI, 28.4-40.6) for pediatricians, 46.3 seconds (95% CI, 30.9-61.7) for GPs, and 37.8 seconds (95% CI, 27.6-48.1) for nurses<sup>4</sup>
- Interviews of 201 nurses assessed self-reported time requirements to prepare and administer PFS vaccines and VRR, with an average decrease in time spent performing the vaccination process of 66 seconds (1.1 min) for PFS vaccines vs VRR<sup>3</sup>
- Survey-based assessments of preparation and administration of PFS vaccines in comparison with VRR found a time savings of 66 seconds for nurses and 33 seconds for pharmacists<sup>11</sup>
- A BIA in the United Kingdom determined that over 10 years, 172,480 hours would be saved during administration of PFS vaccines in comparison with VRR<sup>8</sup>

**Figure 1. Comparison of Time Required for Preparation and Administration of PFS Vaccines in Comparison With VRR Among Healthcare Professionals**



GP, general practitioner ; PFS, pre-filled syringe; VRR, vaccine requiring reconstitution.

- Of the 4 studies that analyzed cost-related data, all 4 cost analyses found that PFS vaccines generated cost savings in comparison with VRR (**Table 1**)<sup>2, 8, 9, 11</sup>
  - Three studies reported both direct and indirect costs associated with vaccines<sup>2, 8, 9</sup>, while Yarnoff et al. 2021 only reported indirect costs associated with vaccine preparation, storage and management<sup>11</sup>
  - Two studies presented the direct cost of PFS and VRR, with one study in Malaysia reporting a lower cost for PFS and another study from Korea reporting higher cost for PFS.<sup>2,9</sup> In the study conducted in Korea, Min et al. 2023 showed that the administration and vaccine cost for PFS is higher than VRR.<sup>9</sup> Nonetheless, after accounting for other indirect costs such as immunization error, and transportation and time cost, PFS vaccines resulted in overall cost savings compared with VRR

**Table 1. Comparison of Direct and Indirect Costs Associated With VRR vs PFS Vaccines**

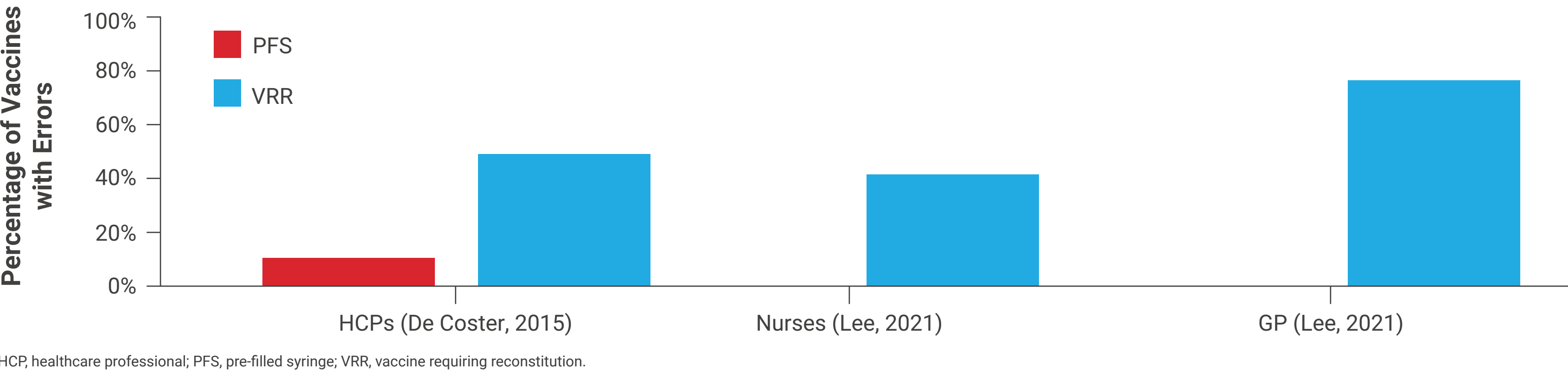
Author	Study Type	Country	Currency (Reference Year)	PFS Vaccine	VRR	Direct Cost PFS	Direct Cost VRR	Other Cost – PFS	Other Cost – VRR	Total Cost PFS	Total Cost VRR	Δ Total Cost	Summary of PFS Vaccine vs VRR
Aljunid 2022	CA	Malaysia	RM	Hexaxim	Pentaxim + Hep	\$17.10	\$31.90	Transportation: \$27.2 LoP: \$110.66	Transportation: \$54.4 LoP: \$221.33	\$155.00 per dose	\$307.63 per dose	-\$152.63	Cost saving
Mathijssen 2020	BIA (cost offset)	UK	GBP (2020)	Vaxelis®	Infanrix-Hexa®	Vaccine cost: £403,095,857 HCP vaccination cost: £7,537,800 NSI cost: £62,659	Vaccine cost: £405,897,914 HCP vaccination cost: £14,761,524 NSI cost: £134,295	LoP cost: £0	LoP cost: £0	£410,696,315 over 10 years	£420,793,732 over 10 years	£-9,079,927 over 10 years £-907,993 per year	Cost saving
Min 2023	CMA	South Korea	KRW (2020)	DTaP-IPV-Hib-HepB	DtaP-IPV/ Hib	₩259,998	₩254,501	Time cost: ₩82,320 Transportation cost: ₩25,989 Infection cost following immunization: ₩0.084	Time cost: ₩120,736 Transportation cost: ₩38,117 Infection cost following immunization: ₩8	Total cost, societal perspective: ₩368,307 per child <sup>a</sup> Healthcare perspective: ₩259,998 per child <sup>a</sup>	Total cost per infant, societal perspective: ₩415,462 per child <sup>a</sup> Healthcare perspective: ₩254,509 per child <sup>a</sup>	Total cost per infant, societal perspective: ₩47,155 Healthcare perspective: ₩5,489	Cost saving
Yarnoff 2021	CA	US	USD (2021)	mRNA-1273	BNT162b2	NR	NR	<ul style="list-style-type: none"><li>• Receiving shipment: \$0.02</li><li>• Inventory management/day: \$0.25</li><li>• Training on handling: \$0.14</li><li>• Managing thawing/day: \$0.12</li><li>• Preparation: \$0.00</li><li>• Managing wastage/day: \$0.28</li></ul>	<ul style="list-style-type: none"><li>• Receiving shipment: \$0.08</li><li>• Inventory management/day: \$0.15</li><li>• Training on handling: \$0.19</li><li>• Managing thawing/day: \$0.09</li><li>• Preparation: \$0.94</li><li>• Managing wastage/day: \$0.19</li></ul>	Indirect cost: \$0.82 per dose	Indirect cost: \$1.64 per dose	-\$0.82	Cost saving

BIA, budget impact analysis; CA, cost analysis; CMA, cost minimization analysis; DTP-HepB-Hib, Diphtheria-Tetanus-Pertussis-hepatitisB-haemophilus influenzae; GBP British pound sterling; HCP health care provider; Hep, hepatitis; KRW, Korean won; LoP, loss of productivity; NR, not reported; NSI, (non-) contaminated needle stick and sharp injuries; PFS, pre-filled syringe; RM, Malaysian ringgit; UK, United Kingdom; US, United States; USD, United States dollar; VRR, vaccines requiring reconstitution.  
\*Fully immunized.

### Errors

- Healthcare professionals reported errors during both PFS vaccines and VRR preparation; more errors were reported for preparation of VRR (**Figure 2**)
  - Two out of 3 studies that reported preparation errors stated errors involving reconstitution<sup>4, 6</sup>; 1 study reported that PFS vaccines avoided 261 needlestick and sharps injuries<sup>8</sup>

**Figure 2. Percentage of Vaccines With Errors Encountered During Preparation**

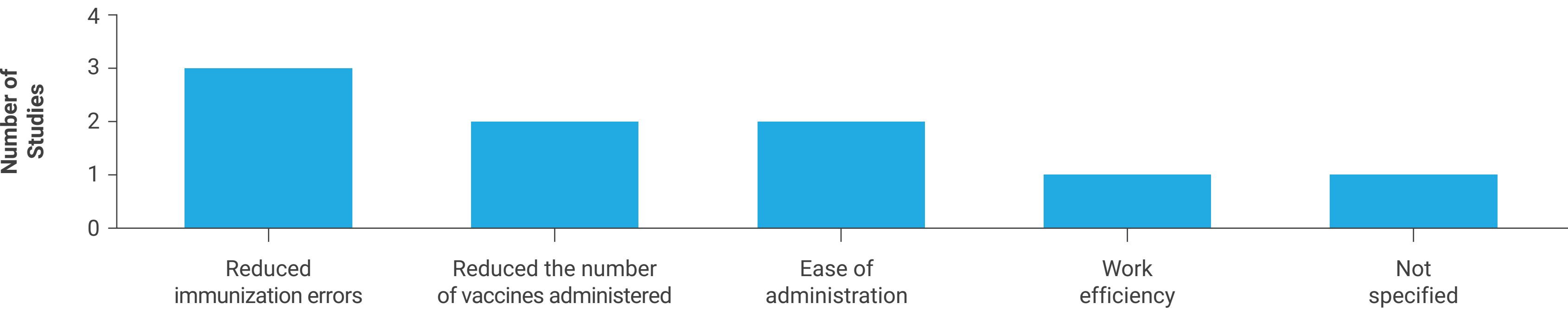


HCP, healthcare professional; PFS, pre-filled syringe; VRR, vaccine requiring reconstitution.

### Preference

- All 7 studies<sup>2,7,10</sup> that reported healthcare professional preference found that the PFS was preferred by physicians and nurses, with common reasons cited that included reduced immunization errors, errors typically occurring during reconstitution, followed by ease of administration and reducing the number of vaccines administered (**Figure 3**)

**Figure 3. Reasons HCPs Reported Favoring PFS Over VRR**



HCP, healthcare professionals; PFS, pre-filled syringe; VRR, vaccine requiring reconstitution.



## CONCLUSIONS

- Compared with VRR, PFS vaccines:
  - Require roughly half the time for preparation and administration and hence are associated with reduced labor costs
  - Were associated with reduced number of errors and avoidance of needlestick and sharps injuries
  - Were preferred by all healthcare practitioners
- Vaccine programs that select PFS vaccines over VRR may have the potential for significant cost savings

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### Acknowledgments

Medical writing and editorial assistance were provided by Meenu Minhas, PhD, of MEDISTRAVA in accordance with Good Publication Practice (GPP 2022) guidelines, funded by Moderna, Inc., and under the direction of the authors.

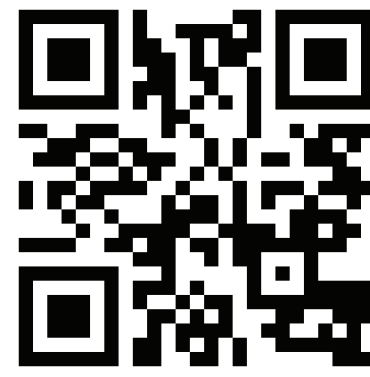
### Disclosures

DM and NVV are employees of Moderna, Inc., and hold stock/stock options in the company. SMK, AK, WWY, and KZHL are employees at ICON plc and were contracted by Moderna, Inc., to conduct this study.



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