

# Single-chamber cartridge injectors

Comparator: Single Dose Vial (SDV) liquid and Autodisable (AD) Needle and Syringe (N&S)

## Section 1: Summary of innovation

### 1.1 Examples of innovation types:

JUDO – a cartridge injector prototype

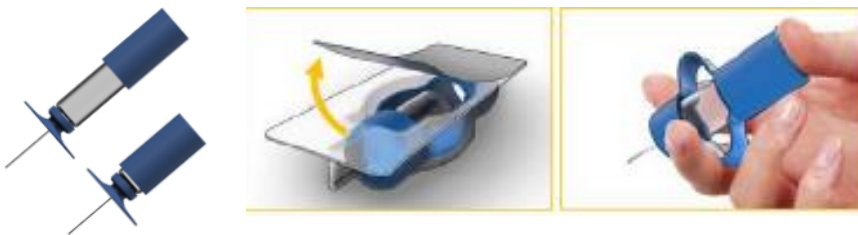


Image source: (1)

Vaccject™



Image source: <sup>a</sup>

### 1.2. Description of innovation:

- There is a large market for delivery devices that utilize prefilled cartridge technology, e.g., the pen injectors that deliver drugs for chronic conditions such as diabetes and hormone deficiencies whereby repeat injections are necessary and administered by the patient themselves or the caregiver. Prefilled cartridges are also widely used to deliver anaesthesia for dental applications.
- Prototypes of single-chamber cartridge injectors for vaccines are single-dose presentations that use pre-filled glass cartridges and are manually operated devices.
- The pre-filled cartridge is inserted into the delivery device that has a needle attached which is either exposed or not exposed based on the design of the device, this is known as the **user-assembled device which is the main focus of this technical note (TN) for the assessment.**

<sup>a</sup> [https://www.who.int/immunization/research/meetings\\_workshops/PDVAC\\_2017\\_Delivery\\_Tech\\_Update\\_Zehrung\\_PATH.pdf](https://www.who.int/immunization/research/meetings_workshops/PDVAC_2017_Delivery_Tech_Update_Zehrung_PATH.pdf)

Category: Integrated primary container and delivery technology


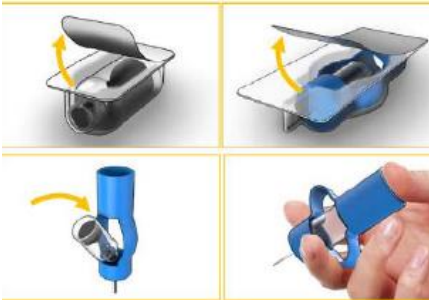
Innovation: Single-chamber cartridge injectors

Comparator: SDV liquid and AD N&S

- The cartridge devices can be equipped to administer vaccines by intramuscular (IM) and subcutaneous (SC) routes.
- Some cartridge injector devices have auto-disable mechanisms to prevent re-use and/or needle retraction mechanisms to reduce the likelihood of needle stick injury.
- Two manufacturers are developing platforms for single-chamber cartridge injector delivery systems for vaccines (Table 1):
  - Duoject – Vaccject™
  - Stevanato Group – glass cartridge delivery system

### 1.3 Examples of innovations and developers:

Table 1.

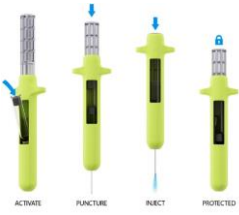
Product name; Image	Developer (place); website	Brief description, notes
<p><b>JUDO glass cartridge injector</b></p> <p><i>Pre-assembled device:</i></p>  <p>Image source: (1)</p> <p><i>User-assembled device :</i></p>  <p>Image source: (1)</p>	<p><b>Stevanato Group</b></p>	<p>The JUDO device is available in two formats (1):</p> <p>(1) <u>Pre-assembled:</u></p> <p>There is a pre-assembled cartridge device containing the prefilled cartridge packaged in a blister, which when removed needs to be attached to the needle before administration of the vaccine.</p> <p>(2) <u>Requires assembly:</u></p> <p>There are 2 separate packages containing the device and the pre-filled cartridge. For assembly, both the cartridge and device are removed from the blister packaging and the cartridge is fitted into the device, followed by the attachment of the needle in preparation for administration.</p> <p>According to the manufacturer’s information, the design of the prototypes have been completed and they are now entering the product development process (1).</p>

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Category: *Integrated primary container and delivery technology*

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Comparator: *SDV liquid and AD N&S*

Product name; Image	Developer (place); website	Brief description, notes
<p style="text-align: center;"><b>Vaccject™</b></p>  <p>Image source: <sup>b</sup></p>	<p><b>Duoject Medical Systems</b></p> <p><a href="http://duoject.com/realisations/vaccject/#">http://duoject.com/realisations/vaccject/#</a></p>	<p>The Vaccject™ device has an integrated needle attached but has no sharps exposed. Following its removal from sterile packaging, the cartridge is inserted into the device resulting in unlocking the device and piercing the septum of the cartridge. The device is placed at the target for administration and the plunger rod is compressed releasing the needle followed by the product. When the dose is fully administered, the device retracts the needle and automatically locks<sup>c</sup>.</p> <p>PnuVax, the manufacturer of a pneumococcal conjugate vaccine (PCV) candidate in development, is exploring the potential to deliver their vaccine with the Vaccject device (2).</p>

<sup>b</sup> [http://duoject.com/wp-content/uploads/2016/01/Vaccject\\_InformationCard-1.pdf](http://duoject.com/wp-content/uploads/2016/01/Vaccject_InformationCard-1.pdf)

<sup>c</sup> <http://duoject.com/realisations/vaccject/>

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## SECTION 2: Summary of assessment for prioritisation

### 2.1 Key benefits:

- Prefilled and fixed-dose vaccine-containing cartridges remove the step of withdrawing vaccine from a vial which eliminates dosing errors, makes vaccine preparation easier, and prevents vaccine contamination.
- Some of the devices are designed with SIP features to prevent sharps being exposed which can reduce needle stick injury.
- Glass cartridges are compact, and can be stored separately from the delivery device, this has the potential to reduce the cold chain storage volume compared to single dose glass vials (3).

### 2.2 Key challenges:

- There are certain challenges related to the innovation, however they do not impact the assessment of innovation in phase I. Please refer to 2.3 (below) for challenges which will be assessed in the phase II, when they are applicable.

### 2.3 Additional important information and evidence:

- Glass cartridges are widely used in the pharmaceutical industry, and fill/finish equipment can produce them at higher speed and lower cost than other presentations such as glass vials and prefilled syringes.
- Currently, the devices (Table 1) are all in the design development stage. There are no independent testing or user studies available on use of the devices in comparison to standard practice using the AD N&S, including information on ease of use, time required to prepare and deliver, or cost and storage volume of the devices.

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## SECTION 3: Evaluation criteria

### 3.1 Health impact criteria

#### Indicator: Ability of the vaccine presentation to withstand heat exposure

Legend: **Green: Better** than the comparator: The innovation includes features that may increase heat stability; **White: Neutral**, no difference with the comparator; **Red: Worse** than the comparator: The innovation includes features that may decrease heat stability, **N/A**: the indicator measured is **not applicable** for the innovation; **Grey: no data** available to measure the indicator.

Table 2.

Ability of the vaccine presentation to withstand heat exposure	Parameters to measure against a comparator	Score	Assessment
	Does the innovation have features that may improve heat stability?	Neutral	The innovation is a delivery device and does not impact the heat stability of the vaccine.

<b><u>No difference</u></b> to the comparator
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#### Indicator: Ability of the vaccine presentation to withstand freeze exposure

Legend: **Green: Better** than the comparator: The innovation includes features that may increase freeze resistance; **White: Neutral**, no difference with the comparator; **Red: Worse** than the comparator: The innovation includes features that may decrease freeze resistance, **N/A**: the indicator measured is **not applicable** for the innovation; **Grey: no data** available to measure the indicator.

Table 3.

Ability of the vaccine presentation to withstand freeze exposure	Parameters to measure against a comparator	Score	Assessment
	Does the innovation have features that may improve freeze resistance?	Neutral	The innovation is a delivery device and does not impact the freeze resistance of the vaccine.

<b><u>No difference</u></b> to the comparator
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### 3.2 Coverage and equity criteria

#### Indicator: Ease of use<sup>d</sup>

Legend: **Dark Green:** **Considerably better** than the comparator: *Better for all applicable parameters*; **Green:** **Better** than the comparator: *Better for some of the applicable parameters AND no difference for the rest of the parameters*; **White:** **Neutral**, no difference with the comparator; **Yellow:** **Mixed:** *Better than the comparator for some of the applicable parameters AND worse than the comparator for the rest of the parameters*; **Red:** **Worse** than the comparator: *Worse for some of the applicable parameters AND no difference for the rest of the parameters*; **Dark Red:** **Considerably worse** than the comparator: *Worse for all applicable parameters*, **N/A:** the indicator measured is **not applicable** for the innovation; **Grey:** **no data** available to measure the indicator.

Table 4.

Ease of use	Parameters to measure against a comparator	Score	Assessment
<ul style="list-style-type: none"> <li>Assessment of the potential for incorrect preparation based on usability data from field studies (or based on design of innovation if field studies not available)</li> <li>Assessment of the potential for incorrect administration based on usability data from field studies (or based on design of innovation if field studies not available)</li> </ul>	Does the innovation avoid reconstitution and is that an improvement?	Neutral	A single-chamber cartridge injector is not compatible with vaccines requiring reconstitution.
	Does the innovation require fewer vaccine product components?	Neutral	A single-chamber cartridge injector consists of a hand-held delivery device and a pre-filled single-dose cartridge, which is similar to the number of components required for the comparator.
	<sup>e</sup> Does the innovation require additional components or equipment (such as scanners or label readers)?	N/A	
	Does the innovation require fewer preparation steps and less complex preparation steps?	Better	A single-chamber cartridge injector does not require withdrawal of the vaccine product from the vial as it uses a pre-filled cartridge that is directly inserted into the device. Complexity of preparation must be determined based on the final device design, but it is likely to have fewer and less complex preparation steps than the comparator.

<sup>d</sup> Ease of use can prevent missed opportunities resulting from the complexity of preparation and administration procedures. It could also impact the ability for lesser trained personnel to administer the vaccine (incl. self-administration). It can be assessed based on usability data from field studies (or based on design of innovation if field studies not available).

<sup>e</sup> This parameter is only assessed for RFID/barcodes, for all other innovations it is not applicable (N/A).

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<b>Ease of use</b>	<b>Parameters to measure against a comparator</b>	<b>Score</b>	<b>Assessment</b>
<ul style="list-style-type: none"> <li>• Assessment of the potential for incorrect preparation based on usability data from field studies (or based on design of innovation if field studies not available)</li> <li>• Assessment of the potential for incorrect administration based on usability data from field studies (or based on design of innovation if field studies not available)</li> </ul>	<b>Does the innovation improve dose control?</b>	Better	A single-chamber cartridge injector uses a prefilled vaccine-containing cartridge, which is better than the step for withdrawing the vaccine from the vial.
	<b>Does the innovation improve targeting the right route of administration?</b>	Neutral	Targeting the correct depth/route of injection with a single-chamber cartridge injector is dependent on user technique, similar to an AD N&S.

	<b><u>Better</u></b> than the comparator
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**Indicator: Potential to reduce stock outs based on the number of separate components necessary to deliver the vaccine or improved ability to track vaccine commodities**

Legend: **Green:** **Better** than the comparator for one of the parameters; **White:** **Neutral**, no difference with the comparator; **Red:** **Worse** than the comparator for one of the parameters, **N/A:** the indicator measured is **not applicable** for the innovation; **Grey:** **no data** available to measure the indicator.

Table 5.

Potential to reduce stock outs based on the number of separate components necessary to deliver the vaccine or improved ability to track vaccine commodities	Parameters to measure against a comparator	Score	Assessment
<ul style="list-style-type: none"> <li>Assessment of the potential to reduce stock outs based on the innovation's features</li> </ul>	Does the innovation require fewer components?	Neutral	A single-chamber cartridge injector consists of a hand-held delivery device (one per injection) and a pre-filled single-dose cartridge (one per injection), which is similar to the number of components required for vaccine delivery with an AD N/S and SDV.
	Or does the innovation include labelling that facilitates product tracking and is it better than the comparator?	Neutral	A single-chamber cartridge injector does not impact product labelling, similar to the comparator, assuming that labelling can be developed that fits on the vaccine cartridge.

	<b><u>No difference</u></b> to the comparator
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**Indicator: Acceptability of the vaccine presentation and schedule to patients/caregivers**

Legend: **Dark Green:** **Considerably better** than the comparator: *Better for all applicable parameters*; **Green:** **Better** than the comparator: *Better for some of the applicable parameters AND no difference for the rest of the parameters*; **White:** **Neutral**, no difference with the comparator; **Yellow:** **Mixed:** *Better* than the comparator *for some* of the applicable parameters *AND worse* than the comparator *for the rest* of the parameters; **Red:** **Worse** than the comparator: *Worse for some of the applicable parameters AND no difference for the rest of the parameters*; **Dark Red:** **Considerably worse** than the comparator: *Worse for all applicable parameters*; **N/A:** the indicator measured is **not applicable** for the innovation; **Grey:** **no data** available to measure the indicator.

**Table 6.**

<b>Acceptability of the vaccine presentation to patients/caregivers</b> • Does the innovation include features that may improve acceptability of vaccinees and caregivers	<b>Parameters to measure against a comparator</b>	<b>Score</b>	<b>Assessment</b>
	<b>Painful or not painful</b>	Neutral	As the single-chamber cartridge injector is an injection system using a needle, it would be likely to have the same level of pain as the comparator.  However, there are no studies/surveys available on assessing level of pain compared to standard N&S by injection recipients. Score is based on expert opinion.
	<b>Perception of ease of administration (i.e. convenience for the vaccinees/caregivers)</b>	Neutral	It is possible that as the needle is covered with the innovation, patients may be more at ease with receiving their injections compared to a standard N&S (4). However, there are no studies/surveys available on assessing needle-phobia and speed of vaccine delivery with recipients. Score is based on expert opinion.
	<b>Any other tangible benefit to improve/impact acceptability to vaccinees/caregivers</b>		

	<b><u>No difference</u></b> to the comparator
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Category: Integrated primary container and delivery technology

Innovation: Single-chamber cartridge injectors

Comparator: SDV liquid and AD N&S

### 3.3 Safety criteria

#### Indicator: Likelihood of contamination

Legend: **Dark Green:** **Considerably better** than the comparator: *Better for all applicable parameters; AND no difference for the rest of the parameters;* **Green:** **Better** than the comparator: *Better for some of the applicable parameters AND no difference for the rest of the parameters;* **White:** **Neutral**, no difference with the comparator; **Yellow:** **Mixed:** *Better than the comparator for some of the applicable parameters AND worse than the comparator for the rest of the parameters;* **Red:** **Worse** than the comparator: *Worse for some of the applicable parameters AND no difference for the rest of the parameters;* **Dark Red:** **Considerably worse** than the comparator: *Worse for all applicable parameters;* **N/A:** the indicator measured is **not applicable** for the innovation; **Grey:** **no data** available to measure the indicator.

Table 7.

Likelihood of contamination	Parameters to measure against a comparator	Score	Assessment
<ul style="list-style-type: none"> <li>Risk assessment of potential for contamination based on design of innovation and on usability data from field studies</li> </ul>	Does the innovation reduce the risk of contamination while reconstituting the dry vaccine?	Neutral	A single-chamber cartridge injector is not compatible with vaccines that require reconstitution.
	Does the innovation reduce the risk of contamination while filling the delivery device?	Better	The single-chamber cartridge injector uses a pre-filled cartridge and does not require withdrawing the vaccine product, the risk of contamination is therefore less compared to the delivery of a vaccine by an AD N&S which involves filling of the syringe.
	Does the innovation require fewer preparation steps and less complex preparation steps?	Better	The single-chamber cartridge injector uses a pre-filled cartridge and there is no step involved in withdrawing the vaccine product, so there are likely to be fewer and less complex steps than with delivery of a vaccine by AD N&S.
	Does the innovation reduce the potential risk of reuse of delivery technology?	Neutral	The single-chamber cartridge injector will be required to have an auto-disable feature, such that after injection re-use of the device and cartridge are prevented, which is similar to the comparator.
	Does the innovation reduce the risk of use of nonsterile components?	Neutral	The single-chamber cartridge injector is packaged in sterile blisters and the cartridges are aseptically pre-filled, thus the risk of using nonsterile components is similar to the comparator.

	<b>Better</b> than the comparator
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Category: Integrated primary container and delivery technology

Innovation: Single-chamber cartridge injectors

Comparator: SDV liquid and AD N&S

### Indicator: Likelihood of needle stick injury

Legend: **Dark Green:** **Considerably better** than the comparator: Better for all applicable parameters; **Green:** **Better** than the comparator: Better for some of the applicable parameters AND no difference for the rest of the parameters; **White:** **Neutral**, no difference with the comparator; **Yellow:** **Mixed:** Better than the comparator for some of the applicable parameters AND worse than the comparator for the rest of the parameters; **Red:** **Worse** than the comparator: Worse for some of the applicable parameters AND no difference for the rest of the parameters; **Dark Red:** **Considerably worse** than the comparator: Worse for all applicable parameters; **N/A:** the indicator measured is **not applicable** for the innovation; **Grey:** **no data** available to measure the indicator.

Table 8.

Likelihood of needle stick injury	Parameters to measure against a comparator	Score	Assessment
<ul style="list-style-type: none"> <li>Risk assessment of the presence of sharps during the process of preparing and administering the vaccine</li> </ul>	Does the innovation contain fewer sharps?	Neutral	A single-chamber cartridge injector has the same number of sharps as the comparator.
	Does the innovation use sharps for preparing and/or administering the vaccine and is that better than the comparator?	Better	The single-chamber cartridge injector uses a pre-filled cartridge and there is no step involved in using a N&S to withdraw the vaccine from a vial as there is with the comparator.
	Does the innovation include an auto disable feature and is that better than the comparator?	Neutral	The single-chamber cartridge injector would be required to have an auto-disable feature preventing re-use of the device and cartridge, which is similar to the comparator (3).
	If the innovation uses sharps, does it include a sharps injury prevention feature and is that better than the comparator?	Better	The most advanced design of a single-chamber cartridge injector has a passive SIP feature whereby following injection the needle retracts back into the body of the delivery device and locks in place. Currently used AD N&S do not have an SIP feature (3).
	Does the innovation reduce the risk of injury after vaccine administration?	Better	As the most advanced device candidate has a SIP feature, there is a reduced risk of injury to the vaccine recipient, health care worker, and/or community with a used sharp after vaccine administration.

	<b><u>Better</u></b> than the comparator
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### 3.4 Economic costs criteria

#### Indicator: Total economic cost of storage and transportation of commodities per dose<sup>f</sup>

Legend: **Dark Green**: **Considerably better** than the comparator: *Reduces the volume per dose for applicable parameters*; **Green**: **Better** than the comparator: *Reduces the volume per dose for either of the applicable parameter, and there is no difference for the other*; **White**: **Neutral**, no difference with the comparator; **Yellow**: **Mixed**: *Reduces the volume for one of the parameter, and increases the volume for the other parameter compared to the comparator*; **Red**: **Worse** than the comparator: *Increases the volume per dose for either of the applicable parameters, and there is no difference for the other*; **Dark Red**: **Considerably worse** than the comparator: *Increases the volume per dose for both parameters*; **N/A**: the indicator measured is **not applicable** for the innovation; **Grey**: **no data** available to measure the indicator.

Table 9.

Total economic cost of storage and transportation of commodities per dose	Parameters to measure against a comparator	Score	Assessment
	Does the innovation reduce the volume per dose stored in the cold chain?	Better	Glass cartridges in bulk packaging have a smaller volume than SDVs. Measurements by PATH of the Vaccject cartridge estimated that the cartridge volume was 2 cm <sup>3</sup> (without packaging) compared to an SDV which can be around 10 cm <sup>3</sup> such as for Quinvaxem (5) or 14.5 cm <sup>3</sup> for Hepatitis B vaccine (6). PATH did not have prototypes of the Judo design and so could not provide similar measurements.
	Does the innovation reduce the volume per dose stored out of the cold chain?	Worse	This will be dependent on device design, but a single-dose cartridge injector has the potential to be bulkier than an AD N&S. Measurement by PATH of the Vaccject prototype estimated that the volume of the device (without packaging) was roughly 131 cm <sup>3</sup> compared to between 26 and 43 cm <sup>3</sup> for an AD N&S (7–9). PATH did not have prototypes of the Judo design and so could not provide similar measurements.

	<b>Mixed</b> for the comparator
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<sup>f</sup> The assessment of the indicator is volume-related and builds upon PATH's VTIA analysis. A directional estimation is made at this stage, and a better evaluation will be done in Phase II with more antigen-specific data.

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**Indicator: Total economic cost of the time spent by staff per dose**

Legend: **Dark Green:** **Considerably better** than the comparator: *Reduces time for all applicable parameters;* **Green:** **Better** than the comparator: *Reduces time for either, and there is no difference for the other one;* **White:** **Neutral**, no difference with the comparator; **Yellow:** **Mixed:** *Reduces the time for one of the parameters, and increases the time for the other parameter;* **Red:** **Worse** than the comparator: *Increases the time for either of the applicable parameters; and there is no difference for the other one;* **Dark Red:** **Considerably worse** than the comparator: *Increases time for all applicable parameters;* **N/A:** the indicator measured is **not applicable** for the innovation; **Grey:** **no data** available to measure the indicator.

**Table 10.**

Total economic cost of the time spent by staff per dose	Parameters to measure against a comparator	Score	Assessment
	Does the innovation have attributes that can save time for the vaccinator in preparing and administering the vaccine?	Better	Dependent on device design, a single dose cartridge injector has the potential to reduce time in preparing the vaccine because it has easier preparation steps than the comparator.
	<sup>9</sup> Does the innovation have attributes that save time for staff involved in stock management?	Neutral	A single-chamber cartridge injector does not have attributes that save time for staff involved in stock management.

	<b><i>Better</i></b> than the comparator
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<sup>9</sup> This parameter only applies to barcodes and RFID to capture the benefits for stock management processes, not based on the number of components, but the specific features of the innovation.

**VIPS TECHNICAL NOTE**



Category: *Integrated primary container and delivery technology*  
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**Indicator: Total economic cost of one-time/upfront purchases or investments required to introduce the vaccine presentation and of recurrent costs associated with the vaccine presentation (not otherwise accounted for)**

Legend:   **Neutral:** *NO* there are no one-time/upfront or recurrent costs and this is not different than the comparator; **Red:** *Worse* than the comparator: YES, there are one-time/upfront or recurrent costs.

**Table 11.**

Total economic cost of one-time/upfront purchases or investments required to introduce the vaccine presentation and of recurrent costs associated with the vaccine presentation (not otherwise accounted for)	Parameters to measure against a comparator	Score	Assessment
	Are there one-time upfront costs that will be incurred for use of this innovation or recurrent costs that will be incurred for use of this innovation?	Neutral	No. Similar to the comparator, a single-chamber cartridge injector does not entail any upfront or recurrent costs (other than training costs for vaccinators which would be required with any innovation).

	<b><u>No difference</u></b> to the comparator
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### 3.5 Secondary criteria on potential breadth of innovation use

Indicator: **Applicability of innovation to one or several types of vaccines**

Table 12.

Applicability of innovation to one or several types of vaccines	Assessment
<ul style="list-style-type: none"> <li><i>What vaccines/antigens does the innovation apply to, based on technical feasibility?</i></li> </ul>	<p>This innovation can be applied to any liquid parenteral vaccines. The innovation may be most useful with vaccines that would benefit from a compact single-dose presentation such as RSV and pentavalent vaccines.</p>

Indicator: **Ability of the technology to facilitate vaccine combination**

Table 13.

Ability of the technology to facilitate novel vaccine combination	Assessment
<ul style="list-style-type: none"> <li><i>Does the innovation facilitate novel combination vaccine products?</i></li> </ul>	<p>A single-chamber cartridge injector will not impact the ability to combine vaccines.</p>

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## SECTION 4

### 4.1 Robustness of data:

Table 14.

Category	Assessment
Type of study	Manufacturer websites and brochures. PATH technical report and expert opinion.
Inconsistency of results	Low
Indirectness of comparison <ul style="list-style-type: none"><li>Indicate the setting in which the study was conducted (low, middle or high income setting);</li><li>Comment if the data is on non-vaccine application of the innovation</li></ul>	
Overall assessment:	Low

### 4.2 List of technical experts, manufacturers and/or technology developers interviewed for input:

Table 15.

Expert/type	Organisation/contact details	Notes
N/A	N/A	No interviews conducted.



## VIPS TECHNICAL NOTE

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### 4.3 List of technical experts, manufacturers and/or technology developers that have reviewed and provided feedback/input to the technical notes:

**Table 16.**

Reviewers	Organisation/contact details	Notes
Fatema Kazi	GAVI, the Vaccine Alliance <a href="mailto:fkazi-external-consultant@Gavi.org">fkazi-external-consultant@Gavi.org</a>	Developed and reviewed TN
PATH Medical Devices and Health Technologies Team Debra Kristensen Courtney Jarrahan Mercy Mvundura Collrane Frivold	PATH Debra Kristensen <a href="mailto:dkristensen@path.org">dkristensen@path.org</a>	Reviewed TN
Julian Hickling	Working in Tandem Ltd <a href="mailto:julian@workingintandem.co.uk">julian@workingintandem.co.uk</a>	Reviewed TN
Simon Williams	President, Vaccject Simon15@me.com	

### 4.4 References:

1. Pradel G, Leader CT, Carestia S, Manager M. JUDO A new paradigm on compact and low cost vaccine delivery devices. 2017;
2. Incorporated V and pneuVax. Pneumococcal Vaccine in an innovative safe delivery system.
3. PATH. Vaccject Cartridge System Technical Review.
4. Williams S, Development B, Systems DM. VACCJECT : LOOKING TO THE FUTURE OF READY-TO-USE INJECTIONS. 2012;(November 2000):14–7.
5. World Health Organization. Quinvaxem (WHO Prequalified Vaccine). 2019.
6. World Health Organization. Euvax B (WHO Prequalified Vaccine). 2019.
7. World Health Organization. Auto-disable syringe 0.5ml BD SoloShot™Mini [product specification sheet]. E008/035. Geneva; 2009.

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8. World Health Organization. AD SoloShot™ IX 0.5ml [product specification sheet]. E008/013. Geneva; 2005.
9. World Health Organization. Haiou retractable auto disable syringe 0.05ml [product specification sheet]. E008/068. Geneva; 2017.