

The First BFS Enabled “Soft” Syringe

ApiJect is a new kind of ultra-low-cost drug-injection system that will help extend vaccines and medicines to everyone, which includes the last remaining 16% of the world’s children who are not currently vaccinated.⁶

The system substantially improves injection safety over the current global standard of disposable syringes and multi-dose glass vial packaging used to distribute 80% of the world’s medicines today.

At the heart of the system is the ApiJect “soft” syringe – a single-dose, lightweight device made with a medical-grade plastic drug “container” that is prefilled using sterile “Blow-Fill-Seal” manufacturing methods.

Once adopted by vaccine and medicine manufacturers, and after securing approvals from regulators and from the World Health Organization, ApiJect’s “soft” syringe format will make it possible to vaccinate and treat millions of additional patients around the world within the framework of current healthcare budgets - avoiding millions of needless deaths from unsafe injections.

Background

After a century of steadily expanding vaccination programs, the global health community has succeeded in reaching 84% coverage of the world’s newborn children, according to the UN’s World Health Organization (WHO).⁶

Efforts to reach 100% coverage are urgent and ongoing, with the potential to eradicate polio and other diseases.

There are three challenges to reaching universal coverage. First, more coverage typically imposes higher costs, but healthcare budgets in low- and middle-income countries are already limited. Second, fairness and equity: millions of the unvaccinated live in these resource-constrained countries, many in remote regions of those countries. Third, safety: according to WHO, unsafe injections of medicines and vaccines from contaminated syringes and vials result in millions of patients each year acquiring HIV, hepatitis and other life-threatening illnesses.³¹

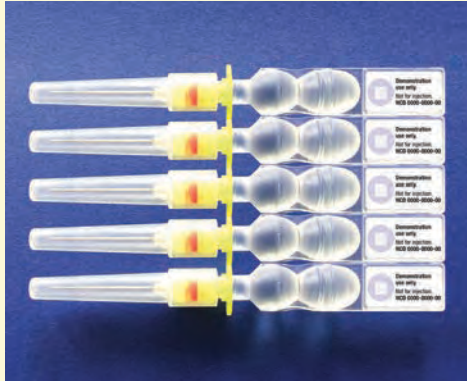
ApiJect is a new mono-dose format designed to help address the challenges of reaching 100% coverage while reducing unsafe injections.

ApiJect is an integrated system for a single-use, prefilled, “soft” syringe. It consists of three parts: a soft plastic “squeeze-bubble” type drug container (the sterile drug “packaging”); a connector mount; and a double-ended hypodermic needle in an attachable hub with a safety cap.

ApiJect’s bubble container and needle hub are manufactured separately but are shipped together, pre-attached and

ready for push-to-assemble activation. Once assembled, the needle cannot be detached or reused.

The ApiJect System replaces the 165-year-old syringe design of a rigid barrel and plunger. It also eliminates the need for the use of glass vials for drug distribution, as well their use as containers for syringe filling by medical personnel prior to final injection.



Several features of the ApiJect System are designed to address the critical issues of coverage, equity and safety.

Coverage: ApiJect contributes to more extensive coverage by enabling existing healthcare budgets to fund additional vaccinations for the same dollars (see below for details).

Equity: The ApiJect System supports improved equity and access because its low weight, ease of transport to remote areas, single-dose form factor

(no waste) and simplicity of use make it easier to vaccinate a greater number of patients, including those in geographically remote areas.

Safety: Healthcare workers and patients can trust ApiJect to be safe because prefilling means there is no chance of vial contamination. In addition, ApiJect’s containers cannot be refilled and its needle hubs cannot be disengaged and reused, so it cannot spread disease.

ApiJect is manufactured with regulator-approved medical-grade plastics.

The ApiJect System employs a well-established, sterile manufacturing process called Blow-Fill-Seal (BFS).⁵³

Regulators all over the world currently accept BFS plastic containers for the delivery of billions of doses annually of sterile medicines such as eyedrops, eardrops, nasal sprays and rotavirus oral vaccine.

The FDA has long noted that BFS-manufactured containers carry “definite advantages” for medicinal delivery, including a sterile, integrated process for manufacturing and filling.

Until now, however, no BFS products have been engineered to incorporate a needle-based injection methodology. ApiJect changes that with its efficient system that incorporates an interlocking needle hub.

ApiJect’s economic efficiency is derived from three main factors: first, its use of plastic rather than glass; second, the inexpensive BFS manufacturing process; and third, eliminating vials makes all glass unnecessary while preventing wastage of vaccine from partially-used and discarded multi-dose vials.

The ApiJect System supports a wide range of uses.

As a modular system, ApiJect can be manufactured with different sizes and shapes of containers, as well as different needle lengths, to support delivery of many different vaccines and medicines.

In addition, while rules will vary by country — and, in parts of the world, regulators may not permit it — there are likely to be countries where regulators authorize ApiJect injections by community health workers in addition to medical professionals.

Also, with the same caveats and restrictions, some health ministries may also consider approving self-injection by patients for certain vaccines or medications, particularly in circumstances where regular ongoing injections are required, or in remote areas where local medical professionals are few in number or only visit occasionally.

For example, where thus permitted by regulatory bodies, ApiJect could potentially be used to administer Oxytocin to new mothers and the birth dose of Hep-B, and could also support discreet self-injection of contraceptives, resulting in their wider use. ApiJect could also deliver the coming new HIV therapeutic, as well as regular PREP injections.

Again assuming that regulatory approval were to be granted in specific cases and/or in limited jurisdictions, ApiJect could facilitate self-injection of medicines such as Epinephrine or Narcan in urgent situations where there may not be time to wait for a medical professional to administer the needed injections.

Another logical use for ApiJect could be in quick response to medical crises and outbreaks, specifically in helping to slow or curb potential epidemics. This use case could be facilitated by the system's relatively rapid manufacturing cycle and short lead times.

Putting syringes on the Internet of Things (IoT)

A future iteration of the ApiJect System will include an embedded RFID chip that puts each syringe on the IoT, enabling each healthcare professional's mobile phone to upload data in real time such to a national or global health network (i.e., location, vaccine dose ID number, etc.). Comprehensive, accurate reports will quickly be created to assist global and national health organizations to plan, execute and track more effective inoculation programs.

ApiJect's two founders: an expert in public health and medicine with a track record of innovation, and an experienced technology entrepreneur who is one of the world's most prolific inventors.

ApiJect was designed by Marc Koska, inventor of the widely used K1 safety syringe. Mr. Koska is a longtime health activist and entrepreneur who played a significant role in developing an affordable Auto-Disable syringe, and in encouraging the WHO to expand its global policy of mandatory safety syringes beyond vaccines to all medicines. In recognition of his contributions to improving public health worldwide, Mr. Koska was

awarded the rank of Officer of the Order of the British Empire. Working with Mr. Koska is Jay Walker, Curator and Chairman of TEDMED, the independent health and medicine edition of the TED conference. Mr. Walker is a serial entrepreneur and the founder of numerous successful companies, as well as one of the world's most prolific living inventors with more than 750 patents in a wide variety of technology-related fields.

Messrs. Koska and Walker have partnered to found ApiJect Systems Corporation for the manufacture and distribution of the ApiJect System. Mr. Koska serves as the company's Director of R&D while Mr. Walker leads the company's technology efforts as well as its business and communications activities as Chairman.

Regulatory bodies have already approved BFS packaging for medicinal use for billions of doses — but none in an injection form.

Although ApiJect must obtain regulatory approval for each individual drug or vaccine in concert with the combined ApiJect System, and this must occur in each country, approval is likely for ApiJect because BFS packaging for drugs and sterile fluids is widely used without a needle component.

The ApiJect System is simply a combination application of a BFS container and an attachable needle hub. Attachable needle hubs have previously received regulatory approval for other uses such as pen-style injectors. ApiJect will work diligently to obtain these key approvals, which can be time-consuming and involve the pharma manufacturer of each drug seeking approval.

BFS has received support from the Gates Foundation. ApiJect is also working closely with established UNICEF and national suppliers.

Support for BFS containers used for injectable vaccines comes from The Bill and Melinda Gates Foundation, which has selected BFS as its preferred format for RSV vaccine, a new vaccine for deadly respiratory diseases.

ApiJect is aligned with Rommelag, the German and Swiss based inventor and leading practitioner and supplier of BFS manufacturing. ApiJect is also affiliated with syringe and needle manufacturers in 3 countries, including established UNICEF and national suppliers.

Supporting the ongoing advance toward 100% coverage and strengthening health systems.

Mr. Koska and Mr. Walker believe that the ApiJect System will enable more people per year to be covered around the world with the same healthcare budgets now in place, and that ApiJect will provide a valuable tool to help health professionals eliminate contamination and its resulting unsafe injections for patients.

These can be important steps to support the global healthcare community's ongoing progress as it seeks to save millions of children's lives by reaching 100% vaccine and medicinal coverage worldwide.

References can be found in the ApiJect brochure. For more information, contact info@apiject.com

apiject™

Introducing the first BFS-enabled "soft" syringe
**A better way to inject and track
vaccines and medications.**

158





“Today 1 in 5 people worldwide don’t get needed immunizations. WHO tells us that more than 22 million children around the world do not get the vaccines they need. We have more work to do, and technology can help. A device that costs 20-50% less per dose to deliver, compared to a 10-dose vial – and that allows almost anyone, not just professional healthcare providers, to inject vaccines and medicines – can save a million lives a year.”

MARC KOSKA
INVENTOR, APIJECT

apiject™

“Vaccines don't save lives; vaccinations do.”

– Dr. Walt Orenstein
Former Director, National Immunization Project,
US Centers for Disease Control

For 165 years the global medical establishment has relied upon the same basic technology for injections: small glass vials of medicines or vaccines are distributed from which syringes are carefully filled, calibrated for the correct dose, and then injected and discarded.

Over the decades, this process has saved countless lives – but it also costs many lives. In low- and middle-income countries, multi-dose vials are preferred for their low upfront costs. However, in some low-resource settings, syringes are “cleaned” and reused over and over. This contaminates the vial’s contents and invisibly spreads diseases such as HIV and Hepatitis.¹

The global health community, led by Gavi, WHO, Gates, PATH and others, has prioritized safety and greatly reduced cross-contamination. Yet reuse remains a significant and deadly problem. Trust and safety are compromised.

Surprisingly, multi-dose vials often work against coverage and equity, too. Since unused vaccine or medicine is discarded, some well-meaning health workers (in an effort to reduce waste) won’t open a multi-dose vial when only a few patients are present, who then go unvaccinated.²

The ironic result of all this is a technology intended to prevent the spread of disease is unsafe when cross-contaminated by reused syringes. And, a multi-dose format intended to save money and expand coverage often costs more money or reduces coverage.

These problems are exacerbated in much of the world where there is no way to precisely track how many people get injections and where they live. Consequently, for organizations such as Gavi that run global vaccination programs, there is no accurate way to measure program effectiveness and to plan for better coverage.

(continued ->)

Aligned with the World Health Organization’s goals for health systems strengthening, we’ve envisioned a new system — a single-use, prefilled syringe that we seek to have approved by late 2019. The drug is packaged in a small plastic container using a proven high-speed aseptic packaging technology called Blow-Fill-Seal (BFS). A pre-attached needle hub is positioned on the BFS container awaiting push-to-assemble activation. Together, they form a “soft” syringe: a new generation of cPAD (compact Auto Disable device) that is far less expensive.

BFS is the right technology at the right time. Its use has been FDA and CE approved for high-volume oral and ophthalmologic delivery — pioneered and perfected by an innovative German company called Rommelag.

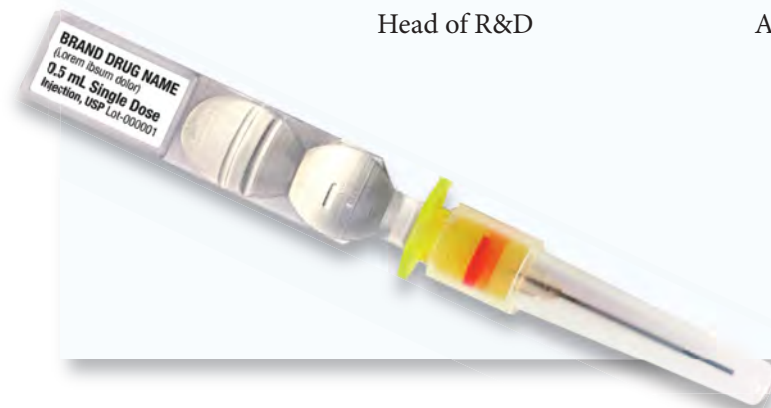
A BFS-enabled syringe will typically deliver an injection at 20-50% less cost than a 10-dose vial and syringe.³ And, starting in 2020, we are planning to introduce a built-in digital chip on each soft syringe that integrates it with the Internet of Things. Every injection will automatically generate a GPS-based usage report to the global health network via any mobile device. The chip costs just a few cents.

As the inventor of this new single-use soft syringe and the leader of its technology and business activities respectively, we’re excited to lay out our vision. We invite you to join with us as we work to deliver an important advance in global health that can benefit everyone, everywhere.



Marc Koska
Inventor
Head of R&D

Jay Walker
Chairman
ApiJect



Contents

How One Man’s Vision Helped Spark a Global Revolution for Safe Injections . . . 4

A 165-Year-Old Technology Won’t Get Us Where We Need to Go 6

The Goal is Global Health Coverage and Equity of Access 8

10-Dose Glass Vials: The Old Solution is the New Problem 9

Table 1: Estimated Infection Levels from Contaminated Vials 10

Table 2: Fear of Wastage Behavior for 10-Dose Vials 10

Table 3: 10-Dose Vials have Lower Upfront Costs than 1-Dose Vials 11

Infographic A: 10 Billion Glass Vials Every Year, Unintended Consequences . 12-13

The 30-Year Search for an Affordable 1-Dose Format 14

Why Uniject™ Will Always Be Costly to Produce 15

Ready-to-Use Prefilled Syringes: The Fastest-Growing Injection Format in the US . 16

Table 4: Comparing the Total Cost per Dose of Vaccine Delivery 18

ApiJect. A new 1-Dose Format Designed to be the Lowest Cost Option 19

Table 5: ApiJect Costs Far Less per Dose than 10-Dose Vials. 23

Infographic B: ApiJect Costs 20-50% Less per Dose than 10-Dose Vials . 24-25

BFS – An Injection Technology Breakthrough 70 Years in the Making 26

Table 6: Uniject™ vs. ApiJect – Cost Comparison 27

BFS Enjoys Broad Regulatory and Consumer Acceptance 28

Blow-Fill-Seal Manufacturing 30-31

Infographic C: ApiJect – a Wide Range of Uses and Global Impact 32-33

Established UNICEF & National Suppliers to Provide Availability at Launch . 34-35

ApiJect’s “Process Architecture” BFS Manufacturing, Filling and Finishing . . . 36

ApiJect’s Global Network of “BFS Filling, ApiJect Finishing” Plants 37

Infographic D: ApiJect’s 32 “Soft Benefits” Improve Lives in Many Ways . 38-39

The ApiJect System: Components and Regulatory Approach 40-41

ApiJect Can Impact More Than Global Health 42-43

ViaJect: “ApiJect for Animals” 44

ViaJect Can Also Help Subsistence Farmers, Livestock and Families 45

ApiJect Adds the Most Powerful Tool of the Modern World 47-53

Infographic E: With ApiJect Phase 2, Simply “Tap and Press” to Use 53

2nd Generation cPAD 54-55

To Learn More About ApiJect’s Benefits, Read Our Booklets 56-57

References and Bibliography of Sources 58-60

The Team Behind ApiJect: Marc Koska and Jay Walker 61

How One Man's Vision Helped Spark a Global Revolution for Safe Injections

Marc Koska took on a challenge that everyone believed was impossible. He helped save millions of lives...and helped transform the world of medical injections.

How does someone who is not a credentialed scientist, not a licensed medical professional, an industrialist or technology wizard play a leading role in changing the world's medical practice...helping to save millions of lives?

Marc Koska claims he did it by sheer perseverance.

Those who know him best say the secret was also passion and courage – plus a rare instinct for practical engineering.

In the mid-1980s, the world was just awakening to the threat of HIV-AIDS. Marc, a forensics evidence expert, was shocked to learn that likely half of all future HIV transmissions would come from reused, contaminated syringes, often in healthcare settings.

Equally shocking, these same syringes will kill at least 1.3 million people a year by spreading HIV and other diseases.



Marc added his voice to those of WHO, PATH, Gavi and others, whose leaders were calling for universal adoption of Auto-Disable (AD) syringes – injection devices that can only be used once. Since they cannot be reused, they cannot spread disease. Marc also designed an AD syringe himself, the K1. K1 was special because it could be manufactured on modified, existing equipment, making it the world's lowest-cost AD syringe.

In 2001 Unicef, the world's largest vaccine buyer, became the K1's first customer. Over the next decade, the K1 sold 8 billion units and helped to save an estimated 10 million lives. In recognition of his contribution, Marc was named an Officer of the Order of the British Empire.

By the early 2010s, vaccines were increasingly delivered with AD devices. Yet the majority of medicinal injections today are still given with traditional reusable syringes, filled from multi-dose glass vials that often become contaminated by one or more reused syringes.

Why is this high-risk equipment still used today in more than 100 low- and middle-income countries?

The answer is cost. Reusable syringes and glass vials are the lowest-cost option...and in many countries, cost is the overriding factor. Buying the lowest-cost injection system translates into serving the most possible patients.

Still, why do so many health workers in these countries insist on reusing syringes? Why risk contaminating the contents of the glass vials that fill those syringes?



Simply put, in low-resource settings, there is strong economic pressure to reuse any equipment that appears safe and in good working order. Health workers in these countries often believe that washing a used syringe in alcohol, or in boiling water, decontaminates it. This is not the case, but unfortunately no amount of training deters many of these well-meaning health workers from what WHO calls an “ingrained” practice.

Upon learning this, Marc – like other leaders in the field of injection safety – had a startling realization. To save lives from unsafe injections, it would not be sufficient to eliminate all traditional (non-prefilled) syringes. It would also necessary to eliminate the multi-dose glass vials from which traditional syringes are filled.

This new challenge was largely economic. Any replacement technology for injections had to cost less than traditional vials and syringes. Otherwise, it would not be adopted at scale in low-resource countries. Patients would continue dying from unsafe injections.

Marc began seeking ultra-low-cost methods and materials that could help him revolutionize all injections, not just vaccinations, by producing a prefilled, single-use device



that would replace both vials and syringes with a truly new lowest-cost option. Eventually, he found an extraordinarily fast, low-cost technology called Blow-Fill-Seal (BFS) plastics manufacturing. It's the same technology used to manufacture 50 billion sterile containers a year of eye drops, nose sprays, eardrops and the like. Putting his engineering skills to work, Marc designed a hub that attaches the same needle already used on syringes to a BFS “squeeze-bubble” container. It is a revolution for BFS.

The result is the ApiJect System, featuring a new “soft” syringe and pre-attached needle hub that can be configured with all standard needle sizes. It will be the lowest-cost delivery system available for both vaccines and medicines. It will work with local cultures, not against them; and with limited healthcare budgets, not against them.

Marc Koska believes he has developed an innovative solution that the medical world desperately needs. Based on early signs of support from important organizations in global healthcare, he may be right.



To learn more about Marc's crusade against iatrogenic infections from health care workers, please visit themarkoskastory.com.

A 165-Year-Old Technology Won't Get Us Where We Need to Go

Glass vials and syringes have let us reach 80% of the world. To reach 100%, including the poorest, we need a new approach.

The world has achieved astounding progress in global health over the past 100 years.

Billions of medical injections are given each year, saving countless lives.⁴ Of these injections, about 5% are vaccines at an estimated cost of \$50 billion per year.⁵ According to Gavi, 80% of the world's children are now immunized with one or more vaccines.⁶ For science, it's one of the great accomplishments of the last 100 years...and the global health community is working hard to finish the job. There are three critical remaining challenges.

The 3 challenges of global injections:

- **Coverage:** If one in five of the world's 1.9 billion children are not fully vaccinated, as reported by Gavi, then more than 400 million children need coverage.⁷
- **Fairness and equity:** Millions of children, mothers and patients do not have access to vaccines and medicines - especially in low-income areas.⁸
- **Safety:** A large, but unknown number of people each year, often among the poorest, are infected with diseases via contaminated injections, often from multi-dose vials.⁹

The common factor shared by all three problems is the world's reliance on traditional multi-dose glass vials and reusable hypodermic syringes.

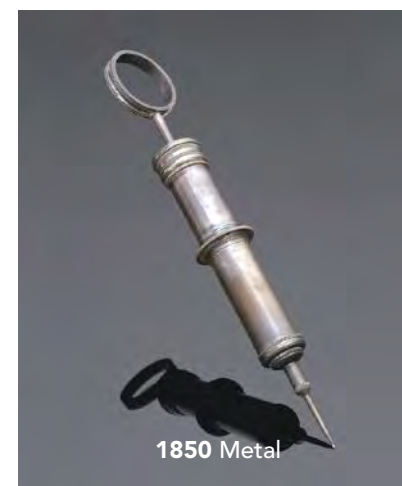
Since the introduction of hypodermic syringes in the 1850s, this technology has enabled nurses, paramedics and doctors to give trillions of injections to patients with



acceptable levels of reliability, safety and cost.¹⁰

Still, the three challenges persist, despite the world's best efforts to solve them...and despite billions invested in possible solutions. The last 20% is a hard nut to crack.

Surprisingly, the root of the problem isn't a lack of funds or a shortage of vaccines or medicines. The root of the problem is that the glass vial-and-syringe system has become antiquated. It now imposes a dozen legacy drawbacks – inefficiency, waste and counterproductive results such as danger to patients from incorrect usage. And, far too often, the need to use syringes has the unintentional effect of denying coverage and equity to hundreds of millions worldwide who require essential vaccines and medications, but who live too far from clinics, hospitals, or medical professionals.¹¹ Additional limitations



and problems include a long manufacturing lead-time for glass vials, glass flake contamination, vulnerability to breakage in transport, and improper and inappropriate reuse of syringes among others.¹²

And, because too many clinics worldwide wrongfully reuse contaminated vials & syringes, diseases are spread by healthcare providers.

This problem is officially unmeasured, but it is widely acknowledged by Gavi, WHO and other international and national health organizations. WHO statistics on this issue over the past 20 years have been sobering – and in some cases, frightening.

- Diseases spread by contaminated vials and syringes are estimated at 14% of all HIV cases worldwide.¹³
- Unsafe injections create an estimated 25% of all new Hepatitis B infections, harming 15 million patients per year.¹⁴
- For Hepatitis C, an estimated 8% of all new infections (1 million patients) result from unsafe injections.¹⁵
- An estimated 7% of all new bacterial infections result from unsafe injections (3 million cases a year).¹⁶

The problem is not confined to low-income countries. Dozens of US outbreaks of hepatitis were reported in

For non-healthcare professionals, it may be helpful to define these key terms:

- **"Universal health coverage"** means all peoples and communities can use the health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose patients to financial hardship. Thus, the 3 related objectives of coverage are access, quality and affordability.¹⁹
- **"Equity"** is the absence of avoidable or remediable differences among groups of people whether those groups are economic, social, demographic or geographic. Inequity is a failure to avoid or overcome inequalities that infringe on fairness or human rights norms.²⁰

the last decade.¹⁷ Experts believe many of these outbreaks were caused by clinical reuse of contaminated syringes.

In pandemics, contaminated vials and reused needles can be disastrous. Injections from contaminated vials, caused by employing reused syringes and improperly sterilized needles played a major role in some areas of the early Ebola outbreaks.¹⁸



To learn more about the issues with glass vials, read our booklet "Billions of Glass Vials Every Year with Unintended Consequences" or download it at bit.ly/apiject-red-booklets.

WHO's goals for health systems strengthening include safer, more cost-effective technologies.

The World Health Organization has long embraced a global agenda of “strengthening health systems” to deliver care “to those in greatest need, in a comprehensive way, and on an adequate scale.”¹³⁴

WHO's framework for action identifies six key building blocks for strengthening health systems. Among them: “A well-functioning health system ensures equitable access to essential medical products, vaccines and technologies of assured quality, safety, efficacy and cost-effectiveness, and their scientifically sound and cost-effective use.”¹³⁵ ApiJect is strongly aligned with these objectives. Its innovative design and materials enable safe, cost-effective delivery and use of vaccines and medicines. Quality is also assured because ApiJect works with Unicef suppliers and with CMO's that meet identical standards.

It's far too difficult to get fast, accurate data on population coverage of injectables.

Getting handwritten records back from the field, after healthcare workers have traveled from village to village giving injections to hundreds of remote populations, may be the best we have, but it is woefully inadequate.

As a result, global medical organizations do not have a reliable, real-time picture of how complete each injection campaign (or scheduled immunization program) has been, nor precisely where there are gaps in coverage. This lack of reliable feedback makes planning for future requirements extremely difficult to do well.

We believe it's time to replace the 165-year-old legacy technology of glass vials and syringes. A truly modern reinvention of the total system can mitigate or eliminate all of these legacy drawbacks, saving millions of lives each year, while making billions of dollars of funding go farther each year to provide global coverage and equity.



The goal is global health coverage and equity of access

In places where coverage and equity are not achieved, the costs to the world's most vulnerable populations are high:

- At least 19.5% of the world's children don't get basic vaccines every year. That includes 25% of all newborns.²¹
- More than 3 million people die from vaccine-preventable diseases each year. About 1.5 million of these deaths are in children less than 5 years old.²²
- Every day approximately 830 women die from pregnancy- or childbirth-related complications, such as not having access to a trained professional who can inject a few cents' worth of Oxytocin or an equivalent.²³
- Gavi, the global vaccine alliance, estimates that worldwide, 300+ million children a year fail to get one or more needed injections.²⁴

10-Dose Glass Vials: The Old Solution is the New Problem

80% of all vaccines are distributed in multi-dose vials due to low purchase cost. But this works against full coverage, equity, waste control and safety.²⁵

The most popular format for delivering medicines and vaccines is often used in an unsafe manner that spreads death and disease. That format is the 10-dose glass vial, accounting for between 75% to 80% of global volume of injectable vaccines (90% in some areas).²⁶

The 10-dose vial saves money for healthcare providers because it comes with a lower upfront cost than a one-dose vial, the standard format used in most Western nations.

Not only does a 10-dose vial itself cost less per dose delivered, but the costs of filling, shipping, disposal, vaccine vial monitors and cold chain storage are also lower for 10-dose vials on a per-dose basis.²⁷

Yet despite its seeming efficiency, the 10-dose vial imposes extreme “hidden” costs.

• Hidden downstream costs:

A 10-dose vial may cost less for the purchaser, but these buyers don't see – or pay – higher downstream costs from what are often high levels of waste when unused vaccine or medicine is discarded.

• Missed opportunities to vaccinate:

WHO's 1993 global review found missed opportunities to vaccinate an estimated 30% of children and women. Reasons included health workers not opening multi-dose vials for a small number of persons to avoid vaccine wastage.²⁸ They are trying their best to avoid spoilage or waste of precious vaccine. However, when workers decline to inoculate, these families are told to come

back later. But, in some countries as many as 32-46% of those turned away never receive vaccine.²⁹

• Contamination risk:

The incidence of injection-acquired diseases, as previously noted, indicates that despite the use of preservatives in the contents of multi-dose vials, reused syringes too often contaminate those contents. All patients who subsequently receive injections from that vial have a risk of infection, even if clean needles are used. These drawbacks add up to a serious, even tragic, problem with 10-dose vials. The result: a format that is intended to save money (and extend supplies), actually costs untold lives per year. Its safety cannot be trusted.



The 10-dose glass vial is the world multi-dose standard. And, that is the root of a big problem.

Buyers typically focus on low per-dose catalog prices, but wastage (sometimes running from 20% to 60%) is routinely factored into bulk purchasing schedules.³⁰ Yet, because the wastage is difficult or impossible to measure, the lower price per dose purchased dominates. A format that is chosen because it seems to promise wider coverage, actually comes with perverse incentives to reduce or deny coverage in certain instances – such as when the (small) number of immediate patients at any given injection opportunity does not match the 10 available doses that fully utilize the vial's contents.



To learn more about iatrogenic infections from health clinics, read our booklet “When Injections Spread Disease” or download it at bit.ly/apiject-red-booklets.

Contaminated multi-dose vials or syringes in clinical settings infect millions yearly.

When a health worker inserts a contaminated needle into a multi-dose vial to withdraw a vaccine or medicine, the needle contaminates all remaining doses in that vial. After that, every injection from that vial – even using clean needles or auto-disabling syringes – infects patients.

Table 1 ³¹

Disease or infection	Est. % of new cases caused by unsafe injections	Est. # of patients infected per year
Bacterial	7%	3 million
Hepatitis B	25%	15 million
Hepatitis C	8%	1 million
HIV	14%	340,000+
Top 20 Total	5-10% est.	10's of millions

Children are turned away from vaccine clinics when health workers don't want to open new 10-dose vials because of fear of wastage. Two case studies:

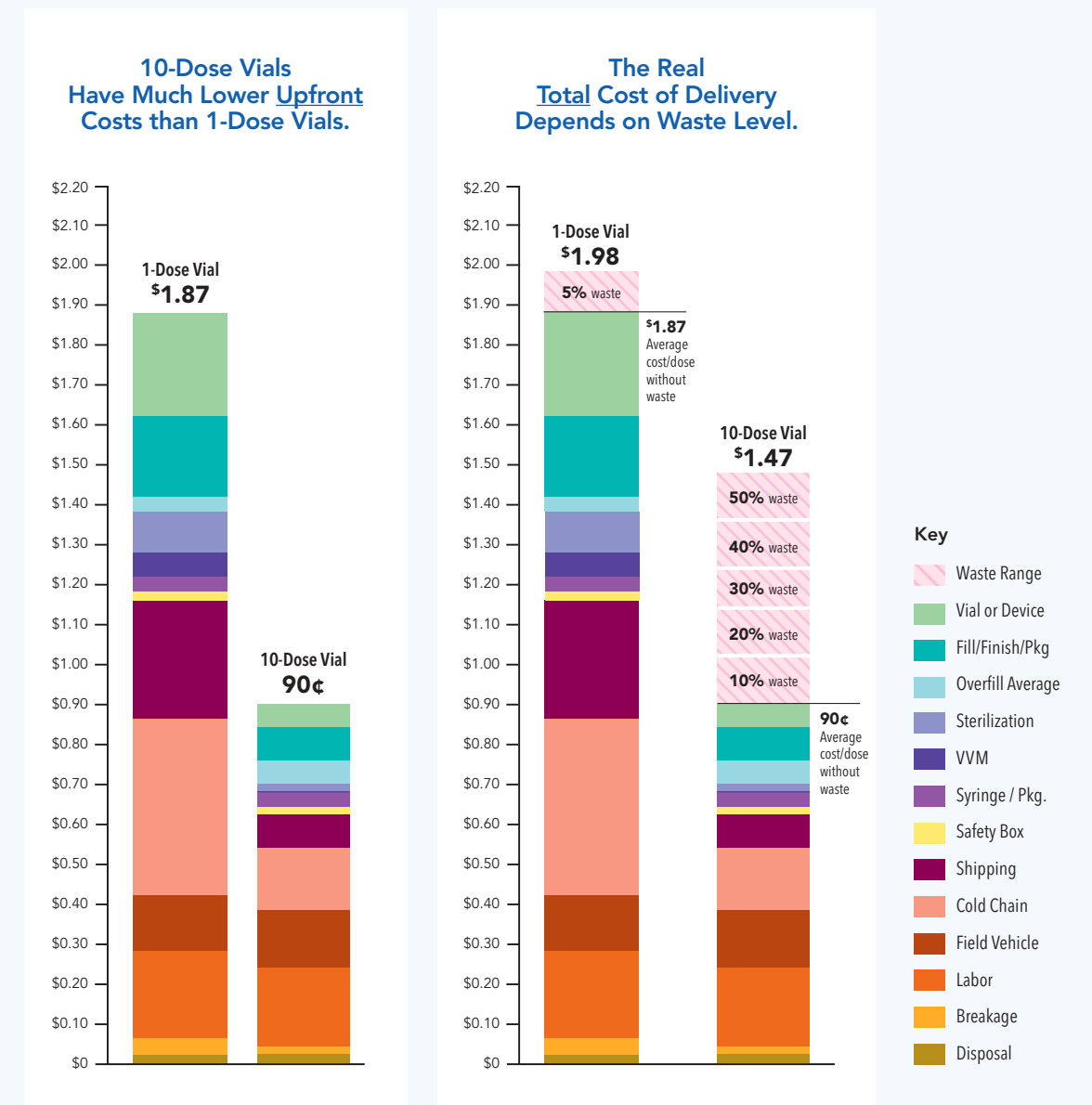
Health workers in many low-income countries wait until “enough” children are present to justify opening a vial, especially for lyophilized vaccines. (Liquid vaccines’ 28-day expiration can also result in double-digit wastage.)⁴³ Waiting to vaccinate several children at once results in many being turned away. Some patients never return and never receive vaccine, as shown in these studies from just two countries based on nationally representative samples of health facilities.³²

Table 2 ³²

	Cambodia	Nigeria
Average vaccine wastage rate in health centers (measles example)	58%	19%
Average number of children who must be present before health workers agree to open a vial	2.2	6.2
Proportion of parents saying they were turned away for vaccination	4%	30%
Proportion of those turned away who never received vaccine	12%	53%
Vaccines missed among those turned away	MCV: 63%	BCG: 33% MCV: 26%

Table 3 ³³

Comparing the Cost per Dose of 1-Dose vs 10-Dose Vials.



Figures shown do not include the cost of the injected vaccine. 25¢ per dose vaccine used to calculate overfill, waste, and breakage.

Billions of Glass Vials Every Year, Each with Unintended Consequences and Problems

A 165-year-old technology won't get us to the level of coverage, equity and safety that the world needs today



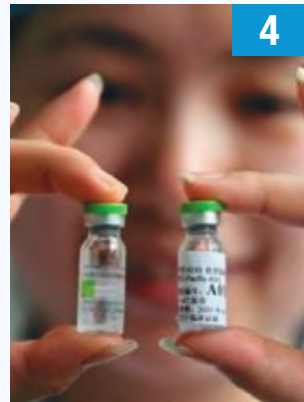
1 Expensive to make, transport and use.³⁴
TCOD (Total Cost of Delivery) for each dose of vaccine or medicine can be as high as \$2.00 per injection. Manufacturing glass vials is expensive. Weight imposes higher transport costs.



2 Only medical professionals can give injections.
Vaccines and injections must be given by trained practitioners, but in much of the world trained medical staff are unavailable. Millions of patients don't get needed vaccines or medicines.



3 Easy to counterfeit.
Anyone can make or acquire glass vials and fill them with anything. This vulnerability contributes to a \$70-200 billion global counterfeit drug market, threatening the health of millions of patients.³⁵



4 Too easy to give patients the wrong medicine.
Since glass vials look virtually identical regardless of contents, it's easy for medical staff to mistake Drug A for Drug B, therefore patients can end up getting the wrong injection.



5 Too easy to give patients the wrong dose.
Healthcare professionals must withdraw precisely the right amount of vaccine or medicine from the vial. This requires knowledge and skill. It's easy to under-dose or over-dose a patient.



6 Contaminated vials and/or reusable syringes can be deadly.
UNICEF buys vaccines in AD syringes only. Other buyers may get reusable syringes that cannot be re-sterilized, leading to mass infections (20 million+ casualties per year).



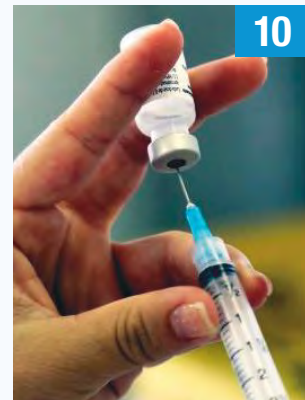
7 Internal glass flakes off and contaminates medicine.
Inside glass vials of vaccine and medicine, top layers of the glass surface can separate and flake off, usually at a scale invisible to the eye. Vials must be tested and retested.³⁶



8 Glass vials and syringes break and are subject to costly recalls.
Vials and syringes break in the factory and during transport. In a 5-year period, glass breaking and flaking led to 100+ million vials or syringes being pulled off the market.³⁷



9 Short ID needles cannot be used with glass vials.
Longer needles are needed to withdraw liquid from vials, but they require Mantoux style injections (often inaccurate for shallow intradermal injections, important for some vaccines).³⁸



10 Filling syringes uses nurses' and health providers' valuable time.
Particularly in busy clinics, time that could be spent treating more patients or spending longer with each patient, must instead be spent filling syringes.



11 Pollution from making 10 billion vials & 60 billion syringes yearly.
Manufacturing glass vials creates dust, waste and other pollution by-products. Producing a ton of glass from raw materials creates 384 pounds of mining waste.³⁹



12 High energy needs for glass are wasteful and costly.
Glass is one of the economy's most energy intensive industries. The total process uses high levels of natural gas and electricity (1% of total industrial energy use).⁴⁰



13 Manufacturing lead-time for glass creates slow crisis response.
Requirements for raw materials and glass manufacturing processes mean that vials must be ordered up to 6 months or more in advance. Too slow for rapid response during sudden outbreaks.⁴¹



14 Dangerous to discard due to needlesticks.
Disposal of used vials and syringes can be slow and even hazardous, exposing people to needlesticks, and creating possible exposure to leftover medication, etc.



15 Requires some patients to make ongoing clinical visits.
When only healthcare professionals can give injections, many patients who need recurring injections stop getting them. They may find it difficult or impossible to visit clinics as needed.

The 30-Year Search for an Affordable 1-Dose Format

The global health community agrees that a low-cost mono-dose auto-disabling device is needed. But, no affordable technology has appeared.

The global healthcare community understands that for many low- and middle-income nations, buying vaccines and medicines in 10-dose vials is a compromise – a difficult balancing act between cost, coverage, wastage and safety.

At the same time, public health officials have never given up hope that an affordable option would emerge that enabled every nation to make trustworthy mono-dose vials their standard choice of format.

In the quest for this improvement, health providers have turned to technology innovators to develop a new and safer alternative – the cPAD, or compact Prefilled Auto-Disable syringe – which they hoped could also be more affordable.

PATH develops the Uniject™ cPAD.

In the 1980s, the effort to develop a more affordable mono-dose injection format was launched by PATH, a nonprofit global health organization. With support from USAID, PATH developed an innovative, non-glass injection device called Uniject.™⁴²

Uniject™ does not have a traditional barrel syringe and plunger. It is a laminated, soft plastic container with a squeeze-bubble format. It is gamma-ray sterilized with an attached needle, then filled with medicine or vaccine in a separate step. The product is heat-sealed closed and foil packed ready for shipment.

Uniject™ offers several advantages over traditional syringes. The most important advantage is that its simple, squeeze-bubble delivery mechanism enables almost anyone, not just professionals, to administer injections easily and safely. And, it is a prefilled mono-dose device that can only be used once.



Developed at an R&D cost of more than \$50 million, Uniject™ was the first cPAD. Launched in the mid 1990s to widespread acclaim, the cost per dose was simply too high to scale.⁴⁵

Unfortunately, this did not happen for Uniject™. The cost of its multi-step, Form-Fill-Seal manufacturing process has remained high for nearly 30 years since its launch – see sidebar on facing page for details.

Uniject's cost: the key issue.

Uniject™ was a format breakthrough, because it offered greater safety at a price that was competitive with mono-dose vials. However, Uniject™ did not close the cost gap with 10-dose formats for per-dose delivery. (See Table 4 for details.)

We project that Uniject™ is more expensive per dose than one dose from a 10-dose vial, but less than the cost of a one-dose vial (see Table 4).

Sometimes, of course, a new technology is supported by the market in hope that its cost will come down as manufacturing efficiencies are found, economies of scale emerge, and rising demand enables manufacturers to earn revenues based on higher production volume.



Uniject's record in the field.

This cost differential between Uniject™ and 10-dose vials has worked against its universal adoption, even though Uniject™ has delivered 100+ million injections of contraceptive medicine and vaccines in low- and middle-income countries over the past decade or so.⁴⁶ While impressive, this represents a small percentage of the many billions of injections given worldwide each year.

PATH licensed Uniject™ to BD (Becton-Dickinson), the world's largest syringe manufacturer.⁴⁷ As part of the licensing agreement, BD supplies the Uniject system to pharmaceutical producers at preferential prices for use in low- and middle-income countries.

Gavi and WHO move to support AD syringes.

Since 1999, Gavi and WHO, along with UNICEF and UNFPA, the UN Family Planning Agency, have promoted non-reusable injection formats for ongoing programs and mass campaigns. UNICEF routinely buys vaccines in auto disable syringes (although a significant number of other buyers still purchase vaccines in reusable syringes).⁴⁸ And, Gavi's 2000-2003 injection safety program helped 50+ countries switch to AD syringes.⁴⁴

Why Uniject™ is so costly to produce.⁴⁹

The Uniject™ cPAD is manufactured from multiple layers of plastic, using an 8-step "Form-Fill-Seal" thermoset lamination process. Individual steps often take place in multiple locations or facilities over the course of several weeks or months.

An overview of the Form-Fill-Seal process:⁵⁰

1. Resin layers are bonded into 5-layer sheets.
2. Sheets are transferred to another machine.
3. Sheets are run to form final shapes.
4. Two multilayer sheets are assembled around the needle hub to create a fillable form.
5. Bombard each empty form with gamma rays to sterilize.
6. Ship empty sterilized devices to a specialized filling system.
7. Strips are then loaded into another machine for automated 3-second fill of liquid.
8. Unit is quality-checked and closed through heat-sealing.
9. The device is labeled and foil wrapped.

Ready-to-Use Prefilled Syringes: The Fastest-Growing Injection Format in the US

Designed for one-time use only, prefilled syringes are the safest choice because they can't become contaminated. They have traditionally been the most expensive format as well.

Prefilled syringes comprise an estimated \$5 billion global market, expected to reach \$7.5 billion by 2023.¹²³ This market mostly serves patients covered by insurance who self-administer medicines for chronic conditions such as HIV, diabetes or hepatitis.

More than 100 drugs and vaccines are now shipped in prefilled syringes; and the number is steadily growing.¹²⁴ Suppliers include leading pharmaceutical manufacturers such as AbbVie; Bristol-Myers Squibb; Becton Dickinson; Eli Lilly; Amgen; Baxter; Bayer; Pfizer; F. Hoffman-La Roche; and Novartis.¹²⁵



Prefilled syringes are the preferred format in high-income countries for many reasons.

Less prep time: Correctly filling standard syringes from a glass vial can be time-consuming. For non-professional administrators, the process can seem demanding and complicated. These are dangerous drawbacks during emergencies such as allergic reactions, drug overdoses or injuries. Prefilled syringes save time; and when seconds

count, they can also save lives.¹²⁶

Accuracy: It's too easy to overfill or underfill a standard syringe, often reducing injection effectiveness.¹²⁷ With prefilled syringes, administrators cannot overfill or underfill, so patients receive correct dosages.

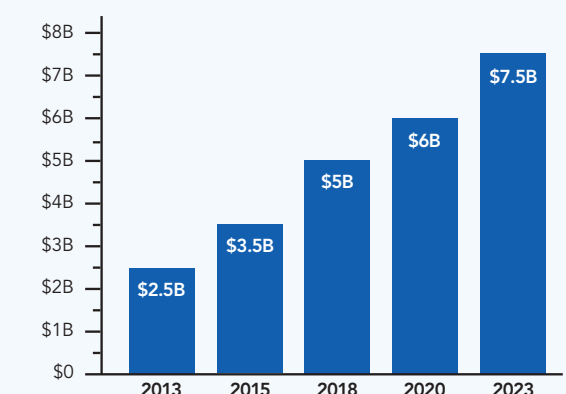
Shelf life: Most drugs and vaccines contain preservatives, but microbial contamination can still compromise sterility just hours after they are unsealed from a multi-dose glass vial (in those areas of the world where multi-dose vials are used). By comparison, biologicals can remain sterile and effective for up to three years in properly stored prefilled syringes, including both glass and plastic versions.¹²⁸

Less waste: Glass vials and syringes are overfilled by 20-30% to compensate for waste (including difficulty retrieving the vaccine or medicine). Prefilled syringes require less than 2% overfills, enabling the same amount of vaccine or medication to provide 18-23% more doses.¹²⁹

More safety: Prefilled syringes are single-use devices. They cannot transfer diseased blood from the first patient to the second patient. There is no glass vial to become contaminated, either. Result: patients can trust that the prefilled format is safe.

Reduced barriers to administration: Taken together, these advantages make prefilled syringes more suitable for community health workers to give injections, and for patients to self-administer. If regulators permit, expanding the base of health workers who can give injections could greatly increase coverage and adherence.

Global Prefilled Syringes Market Growth
Dollar Volume in \$ Billions



Prefilled syringes also have numerous drawbacks and challenges.

Cost has been the most significant drawback of prefilled syringes. Compared to a traditional 1-dose glass vial and syringe that costs about \$1.00, a prefilled syringe may cost \$5.00 to \$10.00 per unit for some applications (such as common self-administered medicines) or even \$20.00 to \$30.00 per unit for advanced applications such as surgical anesthetics.¹³⁰

A second problem with prefilled syringes is the complex manufacturing processes that are required. Older production techniques sometimes allowed air bubbles to get into the syringe chamber during the filling phase. New methods for in-line vacuum filling and inserting rubber stoppers, eliminate bubbles but cost more.

Another manufacturing challenge for prefilled syringes is sterilization. This critical step must be performed either by gamma radiation or by autoclaving, which is a high-temperature pressure chamber process that creates a pH shift in glass syringes. (Glass is still used for more than half of all prefilled syringes.¹³¹) The need for separate steps to sterilize all components of a prefilled syringe prior to filling, and then the follow-up procedures for filling and

handling to preserve sterility, add complexity and cost.

Traditional prefilled syringes pose a number of additional problems as well:

- Glass prefilled syringes are subject to flaking and breakage over time.
- Plastic syringes can be subject to leaching (plastic molecules detaching from inside the syringe to mix with the medicine or vaccine contents).
- Visible precipitates are possible due to longer storage time in the syringe; this often leads to discarding of prefilled syringes.
- Blemishes or irregularities in a syringe barrel may interfere with plunger operation or create a suspicious appearance, also leading to discarded units.
- Regulatory requirements and client needs vary by country, resulting in different requirements for calibration of automated inspection equipment.¹³²
- There is a lack of data on prefilled syringe content sensitivity to air, light, temperature changes, etc.¹³³

The ideal solution would be a low-cost prefilled syringe that could be manufactured and sterilized with simpler technology.

If prefilled syringes cost the same as traditional syringes and glass vials, they would become the world's preferred injection format because of their many advantages.

To strengthen health systems worldwide, and to better serve the world's seven billion patients, a low-cost prefilled syringe is needed that can be produced at scale with fast, simple and reliable manufacturing technology, to provide a trustworthy alternative.



To learn more about the benefits of a low-cost single-dose injection, read our booklet "How a Low-Cost Mono-Dose Syringe Can Increase Safety" or download it at bit.ly/apiject-red-booklets.

Table 4 ⁵¹

Comparing the Total Cost per Dose of Vaccine Delivery

Costs shown do not include cost of vaccine injected

Scenario: **25% waste** and **25¢ per dose** (used for calculating overfill, breakage, waste)

Purchase Cost (Upfront)	ApiJect	10-Dose Vial per dose	Uniject™	1-Dose Vial
1 Vial (or cPAD)	\$0.04	\$0.065	\$0.25	\$0.25
2 Fill/Finish/Pkg/Overhead	\$0.01	\$0.09	\$0.30	\$0.20
3 Overfill	\$0.01	\$0.05	\$0.01	\$0.05
4 Sterilization	\$0.01	\$0.02	\$0.05	\$0.10
5 VVM*	\$0.05	\$0.005	\$0.05	\$0.05
6 UNICEF vaccine purchase price	\$0.12 diff. +/-	\$0.23 +91%	\$0.66 +464%	\$0.65 +453%
7 Syringe/Needle Hub (ex. shipping)	\$0.20	\$0.04	\$0.00	\$0.04
8 Safety Box	\$0.01	\$0.02	\$0.01	\$0.02
9 Shipping (Air/Truck)	\$0.04	\$0.08	\$0.04	\$0.30
10 Purchase Cost per Dose	\$0.37 diff. +/-	\$0.37 0%	\$0.71 +94%	\$1.01 +175%
Field Costs (In Country)				
11 Cold Chain + All Storage	\$0.20	\$0.16	\$0.57	\$0.45
12 Field Vehicle + Transit Labor	\$0.14	\$0.14	\$0.14	\$0.14
13 HCW Labor	\$0.10	\$0.20	\$0.10	\$0.22
14 Breakage	\$0.00	\$0.01	\$0.00	\$0.03
15 Disposal	\$0.01	\$0.02	\$0.01	\$0.02
16 Field Cost per Dose	\$0.45 diff. +/-	\$0.53 +18%	\$0.82 +82%	\$0.86 +91%
17 Total Cost/Dose Pre-Waste	\$0.82 diff. +/-	\$0.90 +10%	\$1.53 +87%	\$1.87 +129%
Invisible Waste Cost				
18 Waste %	5%	25%	5%	5%
19 Waste Value @ 25¢ dose	\$0.05	\$0.29	\$0.09	\$0.11
20 Total Cost of Delivery (excludes cost of vaccine)	\$0.87 diff. +/-	\$1.18 +36%	\$1.62 +86%	\$1.98 +127%



To learn more about ApiJect's costs, read our booklet "Comparative Analysis of Total Injection Cost" or download it at bit.ly/apiject-red-booklets.

ApiJect. A New 1-Dose Format (BFS + Hub) Designed to be the Lowest Cost, Safest Option

Prefilled single-use "soft" syringes made with proven BFS technology can help the world achieve 100% coverage, access and safety.

A low-cost, integrated injection solution can strengthen health systems worldwide.

A new type of single-use prefilled syringe is about to become available beginning in 2020. Called ApiJect, it is a simple yet sophisticated mono-dose system that costs *less per dose upfront* and also costs *up to 50% less per dose delivered depending on wastage costs*.⁵²

ApiJect's cost advantage enables any country to stretch its health budget farther and move closer to full coverage and equity while eliminating contamination.

In Phase 2, this same prefilled single-use syringe will, just by touching a mobile phone, provide built-in, real time, mobile-connected healthcare data communication that enables healthcare providers to track coverage rates and GPS locations, then use this information to better target their budgets, personnel and planning strategies.

The first next-generation cPAD.

The ApiJect device is comprised of three components. First, a squeezable plastic bubble that contains a precise prefilled dosage of a vaccine or medicine. Second, a connector mount; and third, a pre-attached sterile hub that disables the device after one use and includes a double-ended needle of the correct length with a safety cap.

ApiJect essentially replaces the traditional glass vial with the squeezable plastic bubble, while also replacing the disposable syringe with an appropriate-sized attached needle and its safety cap. As a result, there is no need to use the syringe's needle to withdraw a precise quantity

- Single-Use
- Small
- Lightweight
- Unbreakable
- Prefilled
- Precise Dose
- Color/Shape Coded
- Inexpensive
- Includes VVM
- 3 Needle Sizes
- Hard to Counterfeit
- Short training period
- Pre-assembled



ApiJect shown at actual size
3.125 inches
(78mm)

of vaccine or medication from a small glass vial to load the syringe – and no risk of vial contamination.

Instead, the correct dose is prefilled so no dosing or calibration is required from whoever gives the injection; and the right length needle size is pre-attached for each injection. This duplicates the benefits of today's far more expensive prefilled syringes or even BD's Uniject™.

As with Uniject™, to activate an ApiJect the user simply pushes down the needle hub into the "liquid container." ApiJect delivers the correct dose when the administrator (nurse, CHW, medic, etc.) squeezes the top bubble, with very little force required. As with a cPAD, the entire ApiJect process is easy, intuitive and non-threatening.



The Technology: Blow-Fill-Seal (BFS).

Each part of the ApiJect System is manufactured at very high speeds in a sterile form using a well-established manufacturing technology called Blow-Fill-Seal (BFS).⁵³ Both the container (the plastic bubble) and its content (i.e., vaccines) are automatically machine-integrated during a high-speed sterile manufacturing process.

BFS is a trusted, well established technology for packing pharmaceutical grade liquids, delivering 50 billion doses of sterile eyedrops and eardrops annually, along with a smaller number of parenteral applications. It has been most recently used for a new oral vaccine from GSK.

ApiJect utilizes reliable BFS technology with a machine attached needle hub to bring BFS' natural advantages of cost, speed and ease of use to the world of injections. BFS is the ideal choice to meet the modern world's high-volume demand with the ability to produce up to 34,000 finished devices per hour, per machine, with no extra steps.⁵⁴ BFS' end-to-end manufacturing process allows for the highest possible speed and scale.

Strengthening health systems in critical ways.

ApiJect brings more than a dozen valuable advantages to everyone who uses healthcare today and to more than a billion people who are not being well served by the current injection system of glass vials and traditional syringes. Six of the most important benefits include:

1. At last, a prefilled, single-dose delivery system that is lower in upfront cost and lower in total cost than a 10-dose vial.

ApiJect reduces TCOD (Total Cost of Delivery) of each dose of vaccine or medicine to a patient by an average 20-50% from the lowest cost alternative, often more.

With ApiJect, a single dose of a vaccine or medication can be delivered for 87¢ per injection.⁵⁵ By comparison, 10-dose injections cost, on average, about \$1.07 to \$1.47 per dose delivered when waste costs are added to raw materials, manufacturing, packing, shipping, cold chain, administration and disposal.⁵⁶ See table 5.

2. One-time sterile injection prevents the spread of infection.

Like auto-disabled or safety syringes, ApiJect prevents reuse and contamination, bringing all buyers into UNICEF standards.

The medicine is filled aseptically in the BFS container and the needle hub is sterilized in production and a thin piece of paper is attached to the bottom to keep it sterile until punctured during activation. In addition, ApiJect cannot be reused or refilled, ensuring no danger of vial or needle contamination.

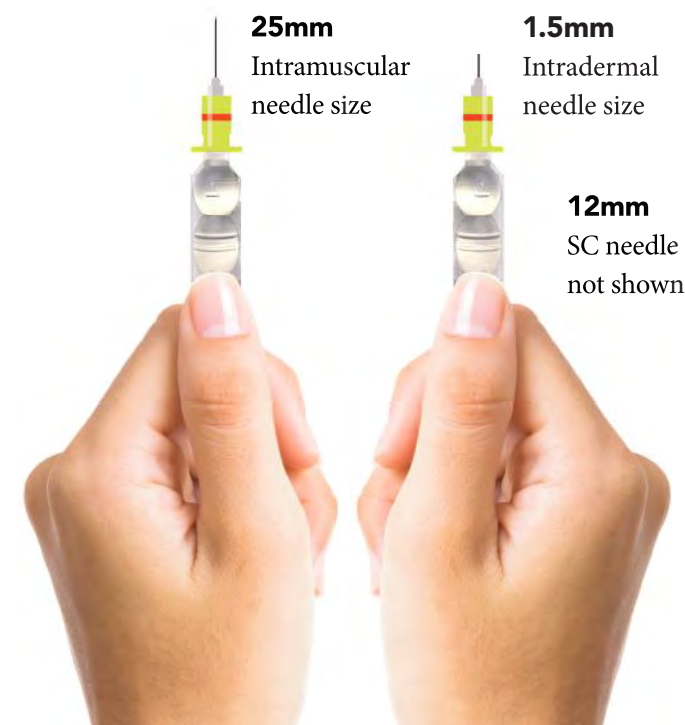
3. When permitted by authorities, many more community health workers will be able to give injections with minimal training.

ApiJect means that health ministries and agencies will have the option, at their discretion, of permitting injections

of all kinds to be given by up to 2 million or more community health workers (CHWs) worldwide – including midwives who are not licensed practitioners.⁵⁷

If health agencies decided to permit all CHWs to give injections, this would have a significant impact on global health. Currently one in five children worldwide (400 million people) are “untouched by vaccines,” said WHO’s vaccine director.⁵⁸ In the developing world, millions of mothers give birth unattended by medical staff; and thus they and their newborns cannot get timely injections of vaccines such as those for tetanus or Hepatitis B.⁵⁹

According to Dr. Henry Perry, senior scientist at the Johns Hopkins Bloomberg School of Public Health, “If CHWs are used to deliver the interventions they are capable of delivering and if 100% coverage could be attained, then the lives of 3.6 million children would be saved every year.”⁶⁰



4. Shallow injections of vaccines (intradermal) no longer require special injection skill.

Many vaccines and medicines require an intradermal (ID) injection, which uses a significantly smaller needle than a standard intramuscular (IM) injection. But since the longer IM needle is needed to pierce the rubber stopper and withdraw the medicine from the vial, the healthcare worker is forced to do a far more difficult shallow injection, using the Mantoux-style.

ApiJect can be affixed with an ID needle, allowing for a standard injection procedure that is significantly easier and far less painful than the Mantoux-style.

5. When appropriate and approved, family members or patients can self-inject.

ApiJect reaches the places and people that can't be reached by glass vials today. In low- and middle-income nations, especially in places lacking medical staff, the option of safe, easy self-injection is a world-changer. For example, women or family members can self-administer contraceptives on a quarterly schedule. And, for patients with chronic conditions that require injections over time such as HIV PREP, self-injection using ApiJect can meet this need long after healthcare workers have left an area. In the West, the option of self-administered one-time injection can increase the number of patients who will remain current on longer-term courses of treatment.

6. A two-second test eliminates counterfeits.

Pharmaceuticals are the world's biggest counterfeit market (\$200 billion for pills, syrups and injectables).⁶⁴ Phony drugs endanger millions of patients. ApiJect is extremely difficult to counterfeit. It embeds highly visible official logos within the walls of the plastic bubble (not touching the drug). These embedded logos cannot be scratched off genuine products. Users of ApiJect can instantly verify legitimacy, eliminating the danger of using counterfeits.

ApiJect Offers Many Additional Benefits:

• **Right drug, right dose – made simple.**

Chances of injecting incorrect drugs are reduced because ApiJect containers not only come in different colors, but also different shapes – economically – unlike glass vials. And, since every dose is prefilled, the device eliminates dosing errors.

• **50-80% faster emergency response time.**⁶⁵

Raw materials requirements and manufacturing processes mean that glass vials must be ordered up to 6 months or more in advance – which can be far too slow for rapid response during many kinds of outbreaks.⁶⁶ ApiJect can be manufactured with as little as six weeks’ notice, making it more suitable for rapid campaign response in case of sudden outbreaks or emergencies.

• **Almost any adult or teen can use.**

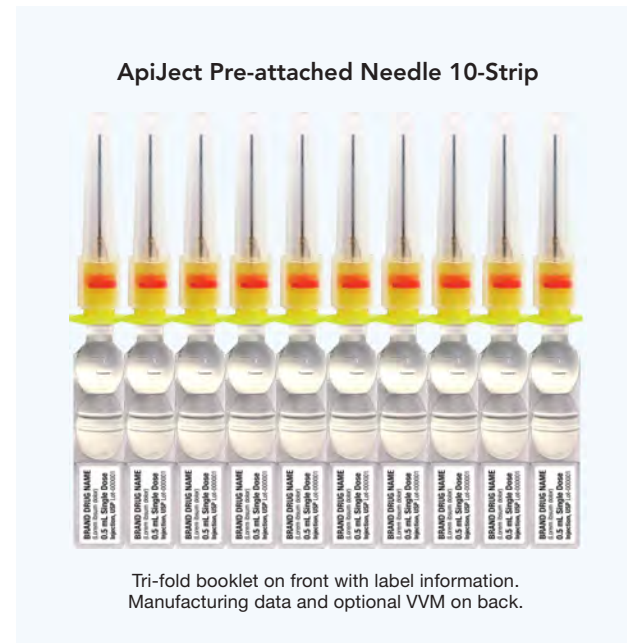
Traditional glass vials and syringes can require 10-12 steps to prepare and administer each injection (the most critical and time-consuming of which is accurately filling the syringe from the vial).⁶⁷

ApiJect requires just five steps to use: uncap the double-ended needle; clean the injection site; press the needle toward the container to activate; give the injection; dispose of the device. Nearly any adult or teen can become competent with it almost immediately.

• **More patients will get ongoing injections.**

When only professionals can give injections, many patients who need recurring injections often stop getting them. They may find it difficult to visit clinics, or they may dislike repeat visits and the associated costs or disruptions.

With the option of self-injection at home (when deemed appropriate), ApiJect makes it much more convenient



and appealing for patients to continue with long-term treatment regimens. Family administration or self injection are potential game-changers for MDR-TB, HIV PREP and other long-term chronic disease therapies.

• **Safer to discard.**

Disposal of used vials and syringes can be hazardous due to needlesticks, cuts from broken glass vials, exposure to leftover medication, etc. ApiJect’s lack of glass, plus its needle safety cap and smaller size (easier to manipulate) reduce these hazards, making disposal safer.

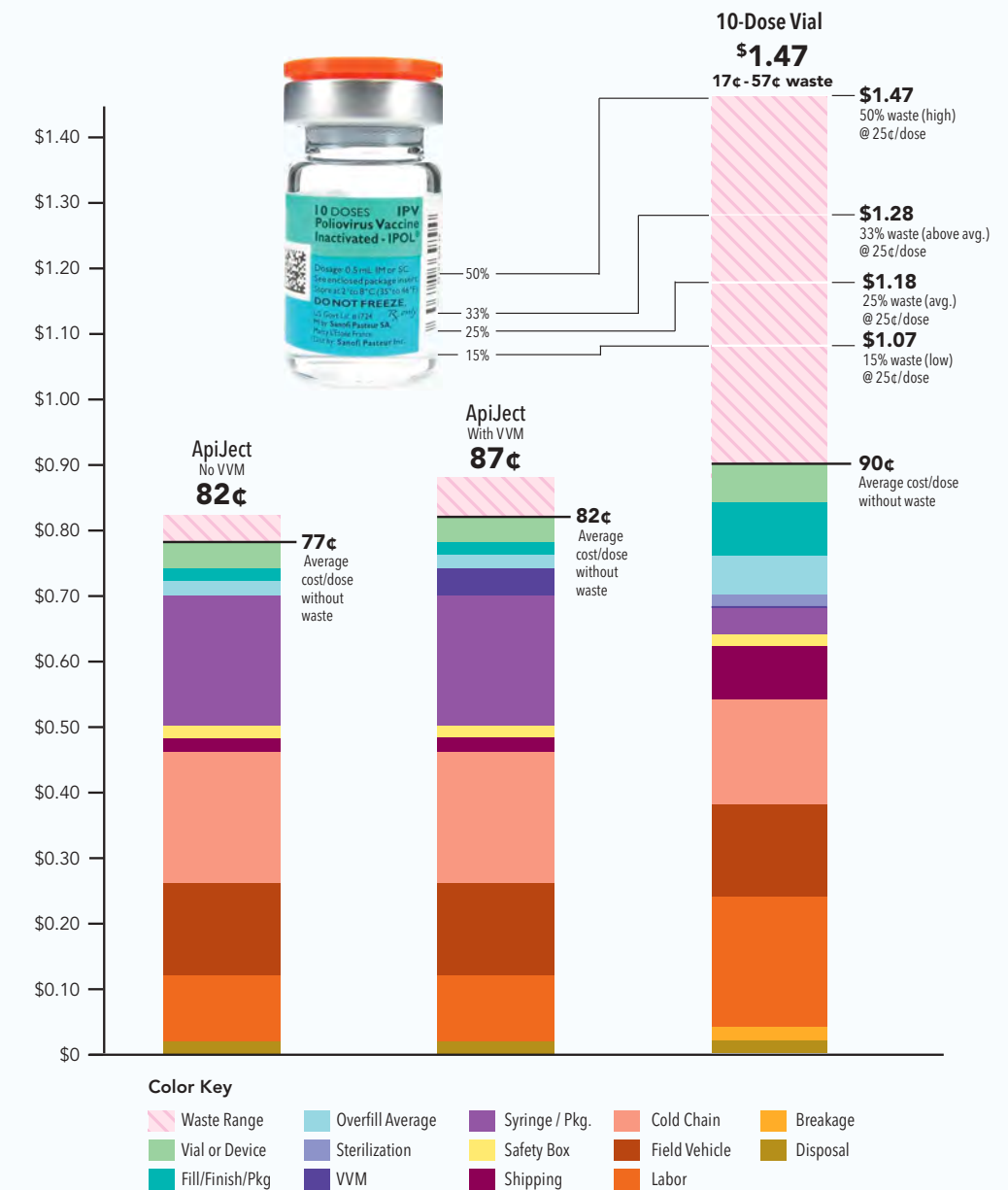
• **Significantly less adverse environmental impact for both energy and waste.**

Compared to energy-intensive glass manufacturing, ApiJect’s small-footprint plastics manufacturing process uses 80% less raw materials and thereby consumes 75% less energy, generating 80% less pollution and 15% less waste product.⁶⁸ Less material usage requirements leads to less pollution, regardless of disposal method.

Table 5⁶⁹

ApiJect Costs Far Less per Dose than 10-Dose Vials. The Higher the Actual Waste, the More the Savings.

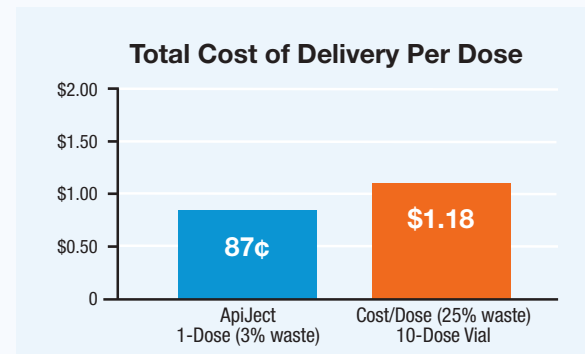
20-50% savings per dose is typical. 60% or more is achievable.



Figures shown do not include the cost of the injected vaccine. 25c per dose vaccine used to calculate overfill, waste, and breakage.

The ApiJect™ System Costs 20-50% Less per Dose than 10-Dose Vials

And, it delivers critical global health benefits such as coverage, equity and safety at no additional cost



1 Typical cost savings 20% - 50% less than a 10-dose vial.⁷⁰

Reduces TCOD (Total Cost of Delivery) of each dose of vaccine or medicine to a patient by 20% to 50%. Using glass vials and syringes to deliver a 25¢ vaccine costs an average of \$1.07 - \$1.47 per injection in 10-dose form not incl. the cost of the injected vaccine. ApiJect costs an average of 87¢ per dose delivered.



2 Millions of community health workers can now give injections.

Where permitted, vaccines and injections can now be safely given by additional unlicensed practitioners, including midwives, where medical staff are unavailable. This new option can bring vaccines and medicines to the 20% of people worldwide who don't regularly get them now.⁷¹ Supports Gavi and WHO goals for global coverage and equity.



3 Health agencies can permit patients to self-inject safely.

In some nations, remote areas often lack medical staff. If authorities approve, a birth attendant can inject a mother with Oxytocin after childbirth; others can self-inject various vaccines or medicines. In the West, self-injection will likely increase patient adherence to long-term treatment regimens.



4 Shallow injections (intradermal) no longer require special skill.

Longer needles are needed to withdraw liquid from vials, but they require Mantoux-style injections (often inaccurate for shallow intradermal injections, important for some vaccines.⁷² ApiJect is prefilled, designed and configured so it can utilize the very short needles required. The result? ID injections are easy and more effective.



5 Virtually eliminates counterfeit drug injections.

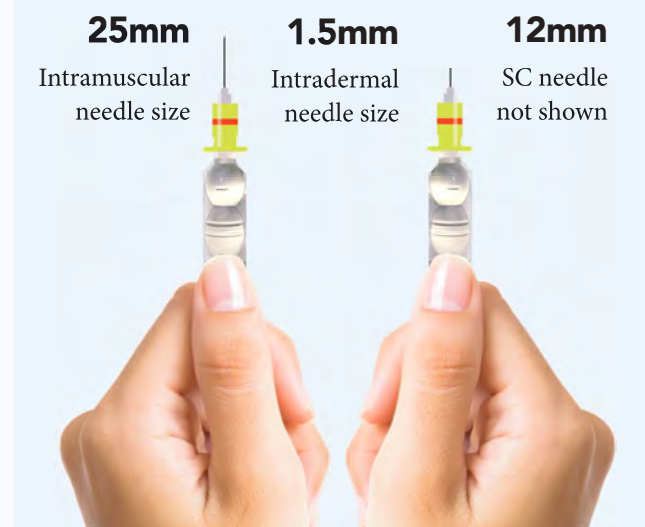
ApiJect embosses official logos into the plastic container that can't be scratched off or tampered with. Users can instantly verify genuine products, virtually eliminating injectables from the staggering \$200 billion a year in counterfeit drug sales that plague much of the world.⁷³



6 Right drug, right dose, right needle – made simple.

There's no chance of mistaking Drug A for Drug B because ApiJect can come in different-colored and shaped containers. Prefilled volumes eliminate dosing errors. And, only the right size needle for each of 3 classes of injectables are pre-attached to the bubble.

- 7 Single use only.**
No reuse prevents spread of disease.
- 8 50-80% faster to market.⁷⁴**
Quicker response to crises.
- 9 One-minute training.**
Virtually any adult or teen can use.
- 10 85% less energy used.⁷⁵**
Manufacture, transport & storage savings.
- 11 75% less waste from mfg.⁷⁶**
No by-products, no glass landfill, etc.
- 12 Safer to discard.**
No broken glass.
- 13 Saves nurses & doctors time.**
No need to carefully fill syringes.



BFS – A Proven Packaging Technology With 50+ Years of Experience and Reliability

Blow-Fill-Seal manufacturing has been used billions of times for sterile respiratory and ophthalmic products since the 1960s. Now it is ready for injectables.

It may seem surprising that after decades of searching for a technology for an affordable mono-dose injection format, a solution has finally emerged. Perhaps even more surprising is that this technology has been used by segments of the global health market for decades.

The technology used by ApiJect to achieve a cost/quality breakthrough for injection devices has been in continual use since the 1960s. It's called Blow-Fill-Seal manufacturing (often referred to as "BFS") and is in use worldwide.⁷⁷

BFS is a high-efficiency, low-heat, low-cost manufacturing method used to produce a wide range of liquid-filled containers. A single machine forms, fills and seals the container. First, plastic resin is melted by an extruder at high temperature and pressure, forming a molten plastic tube. The tube is filled with liquid medication and sealed. The entire process takes 3 to 15 seconds.



Many billions of eyedrop doses each year are made on BFS machines worldwide. See video: <https://bit.ly/2KKtaAa>

BFS today is well established as a highly affordable and reliable choice for medical-grade delivery of over the counter treatments and prescription drugs. These include respiratory and ophthalmic products, certain medicines taken by mouth and some parenterals (IV solutions).

Billions of doses of medicine have been safely delivered to patients worldwide using BFS containers starting in the 1960s. The pioneering inventor of BFS is Rommelag, a family-owned company based in Sulzbach-Laufen, Germany that remains the worldwide industry leader.⁷⁸ In a visionary insight, Rommelag realized some years ago that prefilled mono-dose "blisters" created using BFS technology could be combined in-line with the proper hypodermic needle to allow for the easy injection of the fluid within the blister. A key advantage would be a much lower cost than existing injection formats for both vaccines and medicines – specifically glass vials and standard syringes.

Rommelag experimented with a variety of methods to accomplish this while steadily investing in improved engineering for their machines, which the company sells worldwide to a wide range of industries. Despite considerable efforts, company engineers did not develop a solution that they deemed ready for market.

A critical insight required to bring Rommelag's vision to reality was provided by Marc Koska, inventor of the K-1 Auto-Disable Syringe. Mr. Koska had been seeking a new way to create an affordable, prefilled mono-dose AD syringe format. He was inspired in part by Uniject™, the first cPAD, a high-cost Form-Fill-Seal AD mini-syringe with an integrated needle element. He knew that a more

affordable process was necessary – and he realized BFS could be the answer. But how would the needle work?

Mr. Koska's key insight: rather than attaching a needle as part of the initial BFS manufacturing process, there could be a separate, pre-assembled hub that housed a double-ended needle. This hub would then be plugged into a connector mount on the BFS container as a post-filling finishing step at the time of manufacturing.

He proceeded to design ApiJect, a BFS cPAD device that used BFS containers and an attachable needle housing hub. ApiJect promises to unlock the power and benefits of BFS as a competitor to the current standard of 10-dose vials with syringes that withdraw and then inject vaccines.

Mr. Koska knew that BFS manufacturing offers a large cost advantage over glass manufacturing of vials and plastic manufacturing of traditional barrel-and-plunger type syringes. It is also much more affordable than the multi-step laminate process used for Uniject™.

Beyond cost, Mr. Koska discovered that there are a number of additional factors that make BFS a truly superior alternative to traditional multi-dose vials. Among them:

1. **Rapid, high-volume manufacturing.**
2. **BFS temperature compatible for filling.**
3. **No separate sterilization needed.**
4. **Versatility in design.**
5. **Allows for multi-layer plastics.**
6. **Reliability.**
7. **Small footprint for BFS machine.**
8. **Adaptability & customization.**

Rommelag's BFS is the right technology at the right time, and ApiJect is the right invention to bring affordable mono-dose vaccines and medicines to the world.

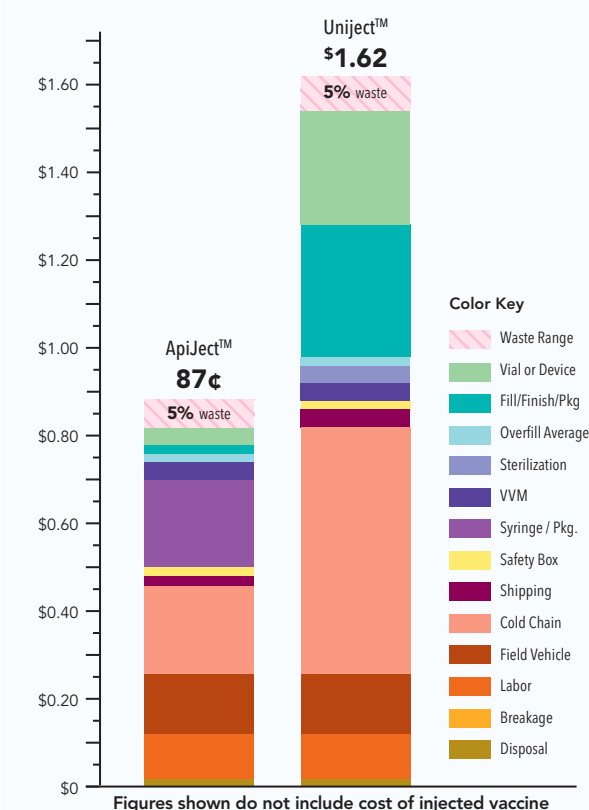
To learn more about how ApiJect's manufacturing, read our booklet "How We Manufacture a Prefilled Syringe" or download it at bit.ly/apiject-red-booklets.



Rommelag state-of-the-art contract BFS production facility in Zell, Switzerland supports Bio-safety Level 2 processes.

Table 6⁷⁹

BFS Delivers Dramatic Cost Savings



BFS Enjoys Broad Regulatory and Consumer Acceptance

The FDA and CE have long recognized BFS as an effective aseptic technology. Each year, BFS containers supply more than 50 billion doses worldwide.

The advantages of Blow-Fill-Seal (BFS) technology for pharmaceuticals and medicines have been hiding in plain sight for decades – especially in the US. As recently as 2010, few US based pharmaceutical manufacturing executives had personally seen a BFS manufacturing installation.¹⁰⁵ This might be considered somewhat surprising, given the fact that by then BFS containers had been used for decades to deliver high volumes of sterile products both in the US and in Europe.

According to the FDA, most US medicinal applications of BFS have been, and remain, ophthalmics and respiratory care products.¹⁰⁶ The situation is different in Europe, where certain classes of injectables are widely supplied in BFS containers as well.¹⁰⁷ For example, Europe's largest IV facility employs BFS technology.¹⁰⁸



PATH, the world's leading technology NGO, collaborated with Rommelag, the pioneering BFS inventor and manufacturer, to produce this MMD (multi mono-dose) BFS ora form factor.

Acknowledged by the FDA

The FDA has acknowledged since 2004 that BFS confers definite advantages for medicinal delivery. The FDA's 2004 publication, "Guidance for Industry – Sterile Drug Products Produced by Aseptic Processing," remains its current statement on BFS standards. That document notes:

"[BFS] is an automated process by which reservoirs are formed, filled, and sealed in a continuous operation. This manufacturing technology includes economies in reservoir closure processing and [also in] reduced human intervention... Advantages of BFS processing are known to include rapid reservoir closure processing and minimized aseptic interventions."¹⁰⁹

Superior sterility

Driven by growing regulatory acceptance, and based on improving manufacturing processes and products, BFS systems for pharmaceutical liquids have grown steadily during the past 20 years. Manufacturers have engineered a series of enhancements that increase product integrity and help guarantee patient safety.¹¹⁰ One example: New methods have been developed to keep air from the surrounding environment out of the containers during filling, using positive airflow technology.¹¹¹ Any particles created from cutting and sealing the plastic container are pushed outward; there is no inflow from the surrounding environment. Environmental monitoring verifies the lack of non-viable particles in the final product.¹¹²

Manufacturers have also developed advanced ultrasonic techniques for sterile finishing while machines slice the top of a formed Blow-Fill-Seal container.¹¹³ As a result,

BFS has demonstrated that it can achieve what has been termed a "drastic reduction" in foreign particulates compared to the reported industry average.¹¹⁴

Challenge studies on aseptic BFS systems started in 1990 through 2011 and beyond. They demonstrated the ability for BFS manufacturing processes to produce vials "free" of viable microorganisms, with endotoxin levels in the acceptable range, while producing high sterility assurance levels (10⁻⁶ SAL) throughout the manufacturing process.¹¹⁵

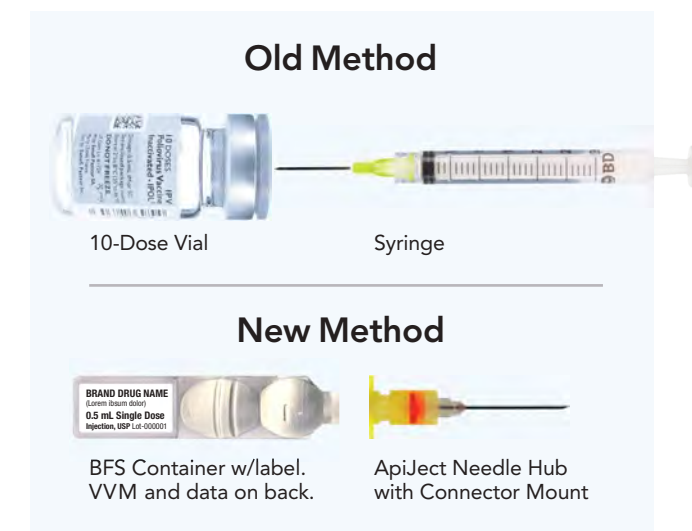
Innovations for temperature control

A critical issue for vaccines, biologics, proteins, and other complex solutions is their vulnerability to degradation in quality and effectiveness due to any long-term exposure to elevated temperatures. For many vaccines, conventional sterilization cannot be employed.¹¹⁶

BFS avoids this problem. Heat sensitivities of contents do not lead to degradation of quality for medicines and vaccines when they are handled with the most recent BFS technology. BFS engineers have developed methods to keep containers cooler during the manufacturing, filling and sealing process, which takes just 15 seconds from start to finish.¹¹⁷ The rapidity of the process also serves to minimize or eliminate any temperature effects on vaccines.



BFS offers almost unlimited flexibility in container shape and size – but has never had an attached needle for injections.



Little chance of drug-container interaction

One key consideration for BFS technologies is the question of whether any of the plastics used to manufacture the containers could interact in a negative way with the vaccines or medicines that fill them. For example, no "leaching" must occur (plastic molecules dissolving into medicine).

BFS manufacturing predominantly employs two resins: polyethylene and polypropylene. The FDA generally views these substances as inert. They contain no additives. Their permeability by water vapor is minimal. In addition, containers made of these plastics may be handled safely and easily in critical care sites, including clinics and hospitals. International regulators have broadly classified BFS resins as acceptable for pharmaceutical liquids.¹¹⁸

Pharmaceutical manufacturers, regulatory bodies, global health organizations and other key players increasingly recognize that BFS offers a viable solution to many challenges that stand between them and global healthcare coverage and equity.

To learn more about the potential impact of a single-dose format like ApiJect, read our booklet "How Low-Cost Mono-Dose Syringes Enable Many Use Cases" or download it at bit.ly/apiject-red-booklets.

A single unit of the latest Blow-Fill-Seal manufacturing machine can produce more than 200 million sterile, prefilled ApiJect devices per year.

OVERVIEW

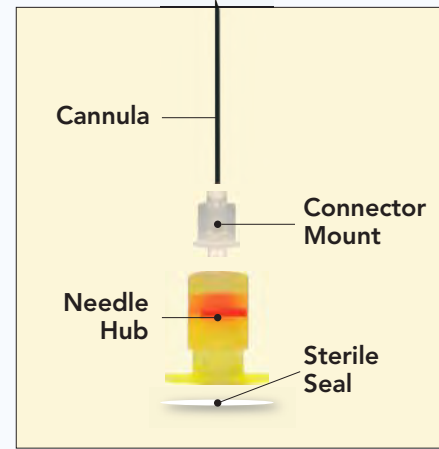
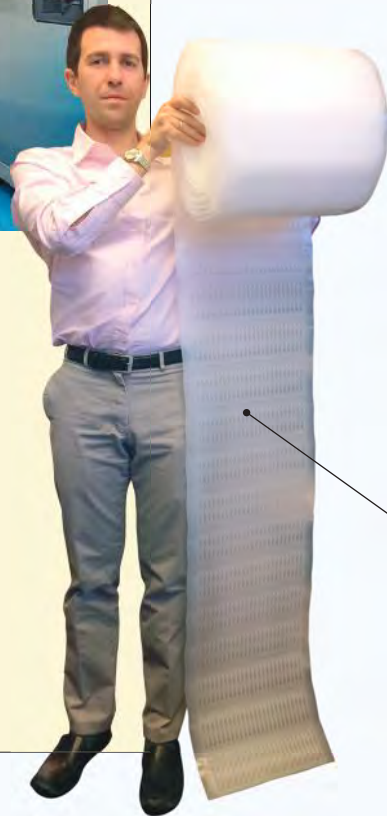
A BFS machine forms 20-25 drug containers, fills them with medicine and then cools, seals and inspect each one.

A 2nd machine trims and cuts; a 3rd machine affixes connector mounts and ApiJect needle hubs.

The entire process takes 10-15 seconds, start to finish.

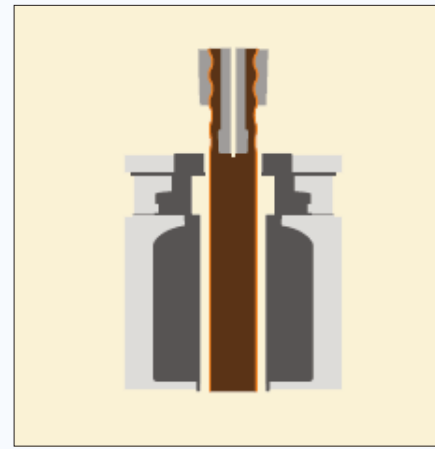


In just 5 minutes, prefilled ApiJect System syringes containing 2,000 individual doses are manufactured in a continuous belt that is auto-fed into a cutter. End result: single syringes or strips of 5, 6 or 10.



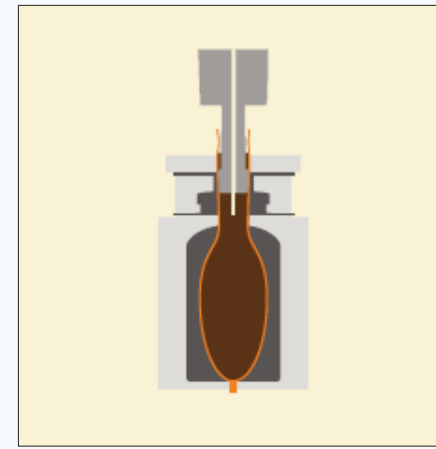
1 Prefabrication and Sterilizing

At a separate location, connector mounts and needle hubs are prefabricated and sealed, then sterilized with Ethylene Oxide (gas under vacuum).



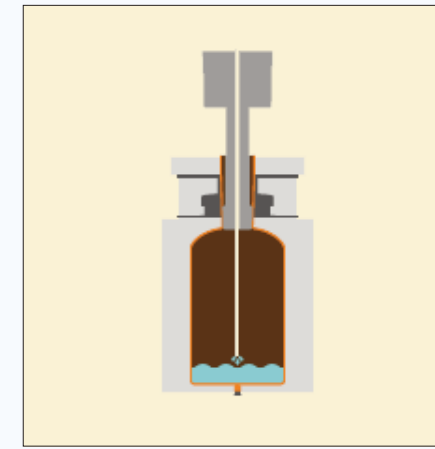
2 Extruding

At a BFS site, soft, heated polymer is extruded (pushed out) of manufacturing machine as "parison" (open tubes) into machine's Class A clean space (no sterilization needed).



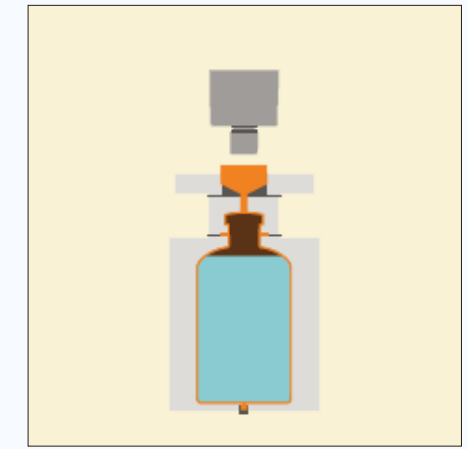
3 Blowing

Positive air pressure creates open space inside parisons. The mold closes (welding shut the parison base) and instantly chills each container to "lock in" its double-bubble syringe shape.



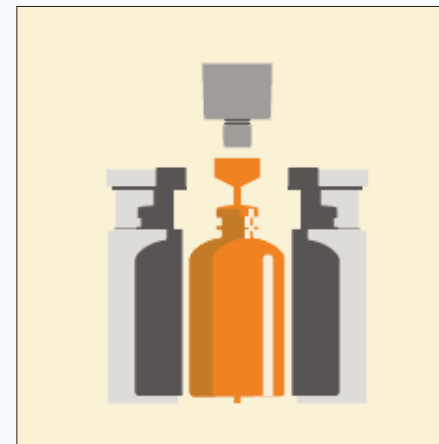
4 Filling

A mandrel (hollow, needle-like rod) extends into each container. Liquid vaccine or medicine rapidly flows through the mandrel to fill the container with required precise dosage.



5 Sealing

Mandrel is removed; head mold closes to seal the top of the double-bubble syringe-shaped container.



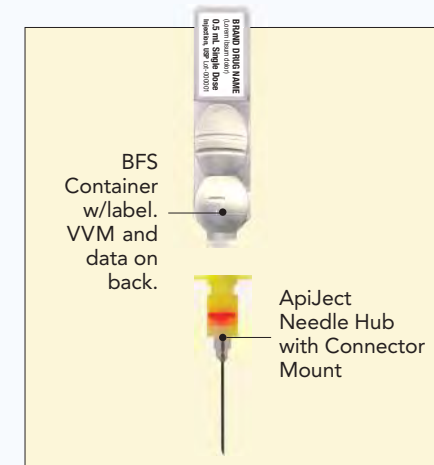
6 Trimming and Cutting

A continuous belt of prefilled containers scrolls out of main machine into the adjacent machine where excess plastic is trimmed off ("deflashed").



7 Inspecting

ApiJect containers are laser-inspected for stability and leaks. Required labels and VVMs if needed are then applied.



8 Pre-assembly

Syringes move into a separate machine onsite for pre-assembly with connector mounts and needle hubs (previously manufactured offsite).



9 Wrapping and Packaging

Finished, prefilled syringes are wrapped & packaged for shipment, using standard automated systems for blister pack or ribbon pack containers.

The ApiJect System's "Soft" Syringe – a Wide Range of Uses and Global Impact

20-50% lower Total Cost of Delivery than a 10-Dose glass vial with better coverage, equity, speed and safety at no additional cost



1 Access for 400+ Million People
 In many countries, vaccines and medications are wasted because there aren't enough medical staff to deliver them. Where permitted, ApiJect let millions of health workers administer vaccines and medicines to millions of children, new mothers and adults.⁸⁰



2 Oxytocin and Hep-B at Childbirth
 In the developing world, millions of women give birth with no medical professional present. As a result, every day approximately 830 women die from preventable causes related to pregnancy and childbirth.⁸¹ ApiJect could be used to administer low-cost Oxytocin to save lives.



3 Wider Use of Contraceptives
 Many societies discourage contraception for social or religious reasons. Taking pills at home is highly "visible," so many women don't do it. With discreet quarterly self-injection, more women will be able to control their reproductive choices.



4 Faster Action in Medical Crises
 Epidemics require rapid response. Making glass vials requires a lead time of up to 6 months or more.⁸² ApiJect's 1-2 month speed to market means much faster delivery of vaccines or medicines at scale.



5 Fast Help for First Responders
 Soldiers, police and firefighters don't always have a medic, doctor or clinic nearby when injury occurs. ApiJect enables them to carry medicine for injection, enabling immediate treatment.



6 New Polio Vaccines
 WHO has called for a global changeover from oral to injectable polio vaccines. When that transition occurs, ApiJect can support smaller doses where a formulation exists for ID injection.⁸³



7 Future: More HIV Treatment
 New injectable HIV therapeutics are now in development that will require injections every month or two. The option for self-injection or injection by community health workers dramatically expands access.



8 More Flu Vaccinations
 Each year on average about 60% of adults don't get flu vaccine injections in the West; coverage rates are even lower in other regions.⁸⁴ ApiJect's low-cost, potentially universal coverage and option for self-administration can greatly increase vaccination rates.



9 Better Adherence Opportunities
 For drugs requiring self-injection, ApiJect makes adherence more likely. Crucial for regimens such as TB and potentially other diseases in countries or populations where cost is a critical factor.



10 Allergies and Anti-Opioid Applications
 Epinephrine and Narcan are very expensive in today's formats. IM injections using ApiJect requires smaller doses and offers a far less expensive alternative format.

ANIMAL HEALTH



11 Animal Health on Small Farms
 Worldwide 70 billion farm animals are raised for food.⁸⁵ In low-and middle-income countries, far fewer farm animals receive medicinal injections than in the West. ApiJect can help small subsistence farmers and disadvantaged families treat animals showing signs of illness.



12 Veterinarians and Pet Owners
 Veterinarians spend much time dosing injections for the world's 500+ million pets.⁸⁶ ApiJect eliminates that step, saving time. And, when veterinarians have the option to prescribe injections for pets that are given by owners at home, more pets will get treated.

Established UNICEF & National Suppliers to Provide Global ApiJect Availability at Launch

ApiJect has affiliated with 2 of the largest UNICEF-approved syringe manufacturers, as well as BFS leader Rommelag, to provide high-volume, high-quality, low-cost supply

To build out a global network of manufacturer suppliers, ApiJect is entering into affiliation agreements with several well-established syringe manufacturers, including UNICEF's largest supplier of disposable medical devices, HMD Healthcare, and one of the world's most advanced needle manufacturers, Tae-Chang Industrial. They are joined by OneJect, Indonesia's leading distributor for government vaccine and family planning programs.

The leaders of these organizations have market-based experience in initiating new technologies and products that have become standards industrywide. Each understands the importance of keeping costs sufficiently low to support Gavi's goals of global coverage and equity, as well as the importance of conforming to PQS, ISO, CE and FDA standards. These initial ApiJect suppliers have an established track record of serving markets at both national and global scale.

These three founding affiliates will be joined by Rommelag, headed by industry visionary Bernd Hansen, the world's leader in BFS. Rommelag's new \$50 million Swiss facility provides a state-of-the-art contract-fill solution.

In addition, FMW Group, led by partner Tobias Wilke, will provide world-class injection molds to ensure ApiJect's quality is upheld to the highest standards

Recognizing the importance of region-specific custom design, this manufacturing and distribution base enables ApiJect to reliably supply buyers in more than 80 nations in a timely manner while incurring minimal shipping costs.



ApiJect founding affiliates are ideally located to serve 85% of the population of low- and middle-income country markets.



ROMMELAG
Bernd Hansen
CEO

Switzerland: Rommelag, while not currently a UNICEF supplier, meets identical quality standards. Its 1,800+ employees serve customers in more than 80 countries around the world. It currently delivers vaccines and medicine in BFS packaging.

Rommelag is committed to provide contract BFS fill support and BFS machine sales to manufacturers. The company's contract manufacturing subsidiary has invested \$50 million to build a new BSL-2 filling plant in Zell, Switzerland. The Zell facility is in full operation currently and will support ApiJect.

Bernd Hansen's father Gerhard Hansen was the inventor of the Blow-Fill-Seal technology and founder of Rommelag in 1964. After studying electrical engineering, Bernd joined Rommelag in 1981 and became its CEO in 1985.



HMD HEALTHCARE
Rajiv Nath
Joint Managing Director

India: ApiJect will design its products specifically for the Indian, South Asian and Southeast Asian markets in cooperation with HMD Healthcare (Hindustan Medical Devices), one of the world's five largest syringe suppliers.

HMD has been manufacturing and supplying medical disposables for more than 60 years. Some 3,500 HMD employees at seven plants across South Asia supply more than 60% of India's disposable syringes, while producing more than 3.5 billion needles.

The Joint Managing Director of HMD's Hindustan Syringes & Medical Devices Ltd. is Rajiv Nath, who also serves as President of the All India Syringes & Needles Mfg. Assn.; and is the Founder and Forum Coordinator for the Assn. of Indian Medical Device Industry (AiMeD).



TAE-CHANG INDUSTRIAL
Hanjin In
Chairman

South Korea: Tae-Chang Industrial Co., Ltd. of South Korea is a global manufacturer of needle products, all of which are GMP, ISO & CE certified. Established more than 25 years ago, T-C Industrial exports to more than 50 nations, including the US and Japan. The company's product development team and facilities supply global clients while serving as an OEM supplier to all major medical suppliers in the region.

T-C Industrial's next plant – its sixth – will be a 150,000 sq. ft. facility dedicated to ApiJect production, equipped with BFS machines for manufacturing and filling of BFS vials, through to final assembly with ApiJect hubs and sterilization.



ONEJECT
Jahja Tear Tjahjana
Chairman

Indonesia: OneJect Indonesia employs more than 300 employees in its 53,800 sq. ft. facility, housing manufacturing, engineering and R&D for medical devices. Established in 2004, OneJect is Indonesia's exclusive licensee for Marc Koska's K1 Auto-Disable syringe. Though not currently a UNICEF supplier, OneJect is Indonesia's largest distributor for government vaccine and family planning programs and is supported by Gavi.

Chairman Jahja Tear Tjahjana founded OneJect's original parent company, a general services contractor, in 1990. By 1994 he had expanded the company into large-scale infrastructure construction (public housing, airport facilities, etc.). OneJect is among a dozen companies that Mr. Tjahjana has launched or acquired since 1990.



FMW GROUP
Tobias Wilke
Partner

Germany: FMW is a developer of fine plastic products and a creator of the highest standard molds, which includes prototype, pre-production and serial production molds. They serve customers across the globe and in a variety of industries, including Medical Devices, Automotive, Packaging and Baby Products.

The FMW Group's three partners (Bernd Mohr, Stephan Fischer, Tobias Wilke) have each spent more than 20 years as senior executives or owners of larger globally active companies in the plastics (injection molding) and the toolmaking industries.

FMW is the inventor of various "safety caps" for standard syringes, including the "F Series." These are distributed by a partner worldwide under license.



ApiJect's "Process Architecture" Supports Pharmaceutical Companies in BFS Manufacturing, Filling and Finishing

Architecture enables pharma companies to smoothly change from traditional syringes and glass vials to BFS methods and materials

In addition to inventing a new "soft" syringe that represents the next-generation cPAD, ApiJect Systems has also invented a "process architecture" to support pharmaceutical companies that want to package their medicines and vaccines in ApiJect syringes.

This "process architecture" will provide a gradual, economical and logistically comfortable path that enables pharma companies to smoothly change over from traditional syringes and glass vials to BFS manufacturing.

The name of our process architecture is "BFS Fill and ApiJect Finishing," or BFAF. When a customer such as a national health ministry wants a certain drug delivered to them in the ApiJect form factor, the pharma company that manufactures that drug will decide among three options:

1. Buy the BFS equipment to manufacture, fill and finish the package themselves.
2. Rely on a 3rd-party contract manufacturing organization (CMO) for both fill and finish operations.
3. Hybrid model: a pharma company could purchase a BFS machine to manufacture and fill their BFS containers but hire a CMO to run that equipment under contract in the CMO's outside facility. This allows equipment to be moved at a future time.

CMO finishing operations will include testing the filled BFS containers; pre-attaching mounts and needle hubs with the proper sized, double-ended needle for each



drug or vaccine; laser-checking the combined unit to ensure stability and lack of any leakage; then wrapping, boxing and shipping.

BFS manufacturing equipment costs about \$10 million in capex for a single packaging line that can produce 200+ million BFS containers per year. Because today's pharmaceutical companies typically use proprietary glass filling plants, they do not currently own BFS machines and the required finishing equipment.

Accordingly, until demand for ApiJect is strong enough for pharmaceuticals manufacturers to justify investing in their own BFS equipment, they are likely to send their drugs and vaccines to our CMO partners.

ApiJect Will Build a Dedicated Global Network of "BFS Filling, ApiJect Finishing" Plants

Starting in 2019, new facilities will be constructed to serve as "BFAF" Contract Manufacturing Organizations in Asia and Europe

ApiJect and its South Korean partner Tae-Chang Industrial Co., Ltd. are building the first fully integrated, end-to-end, vaccine-ready BFS Filling & ApiJect Finishing line for vaccines.

Designated "Facility Zero," it is the first in a planned global network of dedicated facilities that will manufacture BFS containers, ApiJect needle hubs and connector mounts – and will provide filling and finishing services, all within the cold chain whenever needed.

ApiJect's "BFAF" network will support pharmaceutical companies worldwide on a CMO (Contract Manufacturing Organization) basis.

Breaking ground in the summer of 2019, Facility Zero will begin with a single BFS line that is capable of manufacturing 200+ million BFS syringes per year.

Space, power and other logistical factors in Facility Zero will support a total of six BFS production lines, bringing the plant's annual production capacity to 1.2 billion or more ApiJect units per year as demand increases. Facility Zero will be certified by the South Korean Ministry of Food & Drug Safety.

Several additional ApiJect suppliers have agreed to be part of our BFAF CMO network. Rommelag will build BFAF Facility One in Germany or Switzerland.

T-C Industrial, Rommelag and other ApiJect suppliers are already well-established in their respective markets

and are capable of efficiently serving their global regions.

T-C's blueprints for Facility Zero will enable other ApiJect supplier partners to replicate the plant, increasing speed and efficiency of the construction phase for Facility One, Facility Two, and beyond.

Each drug or vaccine will receive the required, separate regulatory approvals to be manufactured in BFS syringe format; filled in a given facility; and finished in the same or another facility.



ApiJect's 32 "Soft Benefits" are Difficult to Measure, but Improve Lives in Many Ways

The benefits of a BFS "soft" syringe cannot be assigned a specific dollar value – but they still provide meaningful real-world quality-of-life improvements



1. Much better coverage and equity
Improves delivery of injectable medicines and vaccines to 400+ million patients in remote places, far from medical staff and clinics.

5. Injection speed
Health workers can inject more patients in less time, especially in mass inoculation settings. This is especially important when time is limited in crisis situations.

6. Dosage accuracy
Precision-prefilled mini-syringes at no extra cost increases confidence and efficacy of delivering correct results.

7. Intradermal/subcutaneous needle optionality
Prefilling does not require fluid withdrawal from a glass vial using long needles. ApiJect is prefilled and supports even the shortest ID needle.



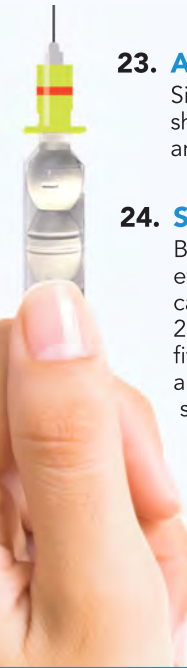
11. No reuse possibility
Single-use feature prevents re-use, reducing spread of disease.

12. No risk of glass flaking contamination
All medical-grade plastic device eliminates contamination of medicine from glass flaking and thus no glass-based recalls.

16. Less training
Takes 1 minute training for almost anyone to use. Ideal for optional self-administration, especially in contraceptive use.

17. Less fear
Smaller device and ID needle options creates less patient anxiety. More adoption & adherence.

18. Less overfill
Precise prefilling requires less overfill of antigen per dose than the normal 10% per vial.

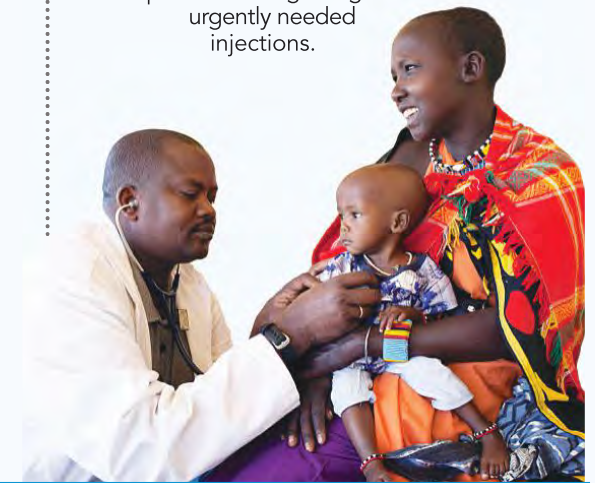


23. Anti-counterfeiting
Simple 2-second scratch-test shows product is genuine and can be trusted.

24. Small mfg. footprint
BFS technology is small and efficient. A \$5M machine capable of delivering 25 million doses a year fits in a shipping container and can be set up in any suitable location.

25. Pocket portable
Device is sufficiently small, light and sturdy – able to be carried in a pocket without breaking.

29. Less pain
Patients prefer shorter needles. Fear of pain and needles prevents many patients and parents from getting urgently needed injections.



2. CHW empowerment
Millions of community health workers and midwives – with governmental approval – can now give injections because of the ease of the process.

3. Self-injection option
Patients can self-inject with success and confidence, where appropriate and approved (e.g., contraceptives).

4. Labor utilization
No time is spent filling syringes from vials – allows more time helping patients.



8. Easier drug accuracy
Color-coded needle hubs and vials show user which drug is being administered.



9. Fractional dose option conserves vaccine supply
In situations where certain vaccines are in short supply, administration of fractional ID doses increases coverage and the number of lives saved.

10. Lower needlestick risk
Smaller format means less chance of accidental needlestick of both the patient and the person administering the injection.

13. Eliminates drug waste
Single-dose, prefilled container avoids "extra" medicine being thrown away unused or expired. Especially valuable in countries with high volumes of 10-dose glass vials.

14. Drone delivery optionality
Doses can be safely airdropped without special packaging or breakage.



15. Less total weight and volume
Glass is heavy and more difficult to carry and transport. Plastic is light and far more doses can be carried by a person, especially a medic or CHW on foot or in small vehicle.

19. Pandemic response time
Speed to market is much faster than glass vials and can get large quantities of an antidote from factory to the public in days or weeks.

20. Adherence
Because the format is easier to use with less fear, patients are more likely to stay with longer term treatment regimens such as TB, allergy injections, HIV, etc.



21. Pandemic coverage
Allows faster, wider inoculations of more people, by more people.

22. Ease of tracking
The smaller, lighter, high-density format is more compact and thus easier to track for local field operators.

26. Animal use option
Device can be used for critical small animal needs, especially in areas with low veterinary coverage.

27. Environmental impact: energy and materials
Uses less energy and raw materials in manufacturing.

28. Environmental impact: less disposal waste
Creates less waste after device is used.



30. Environmental impact: far less pollution
BFS manufacturing creates far less pollution and far less waste byproducts compared to glass.

31. No glass breakage waste
Zero glass breakage in manufacturing or transit. Less cost. More coverage.

32. Real data, real time
Mobile chip-enabled version generates powerful real-time reporting, giving a snapshot of coverage times and locations.



The ApiJect System: Components and Regulatory Approach

ApiJect's system combines a wide range of different containers, needle hubs and VVM options. This drives a component-based registration process.

Modularity is the traditional approach for injectables technology. For more than a century, needles of many lengths and sizes have worked interchangeably with a wide range of vials and syringes to bring vaccines and medicines to the world.

The ApiJect System is a family of new products that updates this modular approach with a variety of new designs and proven materials, while preserving the same underlying philosophy of standardized, interchangeable parts.

The ApiJect System includes multiple needle hubs with typical needle lengths. These hubs use a standardized interface to marry individual needles to BFS containers – the “packaging” for injectable vaccines and medicines.

All ApiJect System products are shipped in sealed foil packages. The needle hubs are pre-attached to sealed BFS containers but not pre-activated. That is, the double-ended needle does not pierce the container until the end user deliberately presses the components together, immediately prior to injecting a vaccine or medicine into a patient.

Modular design greatly increases design flexibility

ApiJect's modular design offers enhanced flexibility at lower cost.¹¹⁹ For traditional injectables technology, i.e., glass vials and traditional syringes, the mix-and-match utility creates a limited degree of flexibility in use and applications.¹²⁰ This is due to the economics and manufacturing limits of working with glass. Once certain

sizes, shapes and components have become standard (i.e., one-dose vials, 10-dose vials; etc.), large sunk costs and long lead times make it prohibitively expensive to reconfigure the manufacturing process for new designs.

In practical terms, these limits on glass manufacturing flexibility also limit the opportunities and incentives for innovation, customization, and variability. Economic reality and practical necessity force suppliers and users to simply make do with the status quo decade after decade.

The ApiJect System overcomes these limitations

The ApiJect System enables us to greatly amplify design and manufacturing customization, innovation and variability. With BFS, creating a new module for the ApiJect System – such as a new BFS container – merely requires refitting an existing manufacturing machine with a new mold.¹²¹ Consequently, innovation becomes fast and affordable. In fact, innovations can even trigger cost reductions.¹²²

A new world of opportunities

The ApiJect System makes full use of the mix-and-match capabilities of modular design. Pharmaceutical companies can pair any of three needle sizes with our dual chamber BFS container to deliver their vaccine or medicine. In just a few years, we expect that the ApiJect System will include a variety of needle hubs and dozens of different BFS containers that are ready to be approved by regulatory authorities when used with a specific drug. Pharmaceutical companies will then be able to pair any needle hub with a BFS container in a shape of their choosing to create a combination that best meets their needs. Options are also available to add Vaccine Vial Monitors to the BFS container and, coming soon, an RFID chip for injection tracking.

A new way of thinking about injectables technology

The ApiJect System represents more than simply a new product or even a new manufacturing technology. It is a new way of thinking about delivery systems for injectable vaccines and medicines, limited only by our imaginations.

An approval path for ApiJect's components

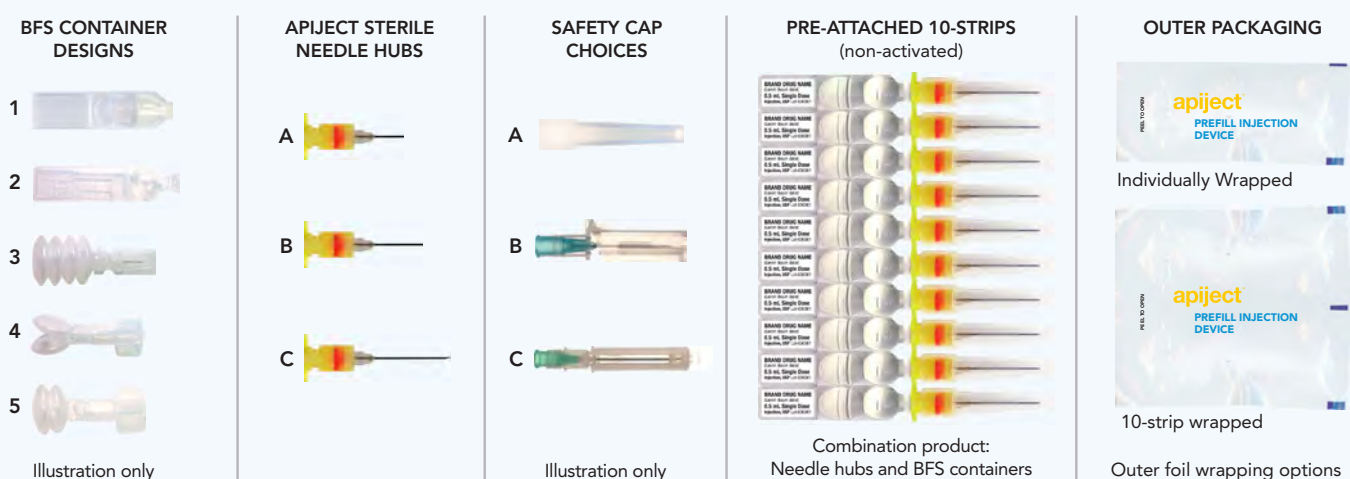
ApiJect is pursuing a 3-step process to seek approval for its injection technology system from appropriate regulators worldwide.

Needle hub + BFS container = Combination

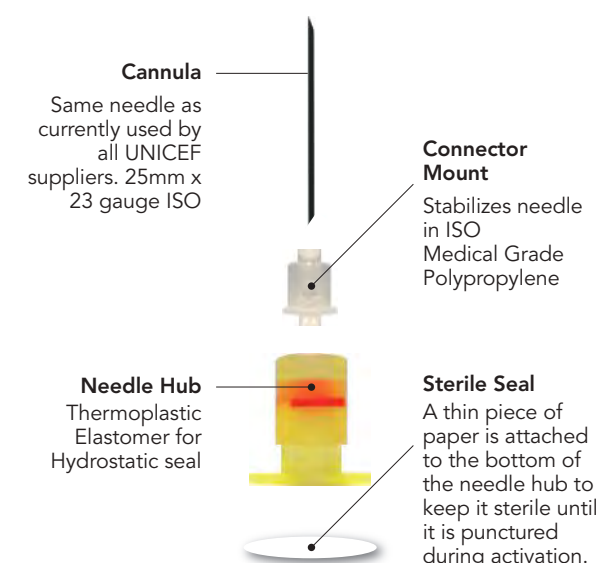
1. Obtain registration for ApiJect's Needle Hub in 3 sizes. The hub uses the same cannulas used by all UNICEF suppliers.
2. Obtain registration for BFS containers for an initial set of specific vaccines and drugs. Pharmaceutical companies will lead this process, supported by Rommelag & ApiJect.
3. Obtain combination registration for the approved hubs and BFS containers to be pre-attached without piercing the plastic top. Shipped together, they work as a system.

Note: The ApiJect System is a combination device for regulatory purposes, but functionally it will be viewed by the market as a cPAD.

The ApiJect System: An ever-expanding set of safe, low-cost injection options



The ApiJect Needle Hub



Global Health in its Many Forms

ApiJect represents an entire platform change for injectable medicines. The following are some of the areas where ApiJect can make a real difference.

Pandemic Defense

The next pandemic is not a question of “if,” but “when.” The challenges facing the people and organizations preparing for the next national and global outbreak are daunting, and the risks are incredibly high. They need to be able to respond as fast as possible to contain the problem and stop the spread of death and injury.

ApiJect can help. At 25 million doses produced per manufacturing machine, per month, ApiJect can scale rapidly to help get vaccines and medicines to first responders in a timely fashion. And, if manufacturing facilities have been previously established to be ready to respond rapidly to such emergencies, ApiJect devices can start being manufactured within just days of the drug being delivered to a CMO facility in bulk format.



Injectable Contraceptives

According to the U.N., 758 million women ages 15 to 49 who are either married or in a relationship practice some form of family planning. Injectable contraceptives represent the third most popular form of non-permanent contraception for women, and the fastest growing of the major methods. However, another estimated 143 million women are unable to practice any pharmaceutically-based form of contraception. ApiJect can help them. ApiJect’s low cost and high-volume manufacturing capacity are essential for NGOs and governments seeking to provide injectable contraceptives to their at-risk populations.

A single injection remains effective for 2-3 months, making it a convenient option for most women. And, with its compact size, ApiJect can be stored discreetly at home and used as needed by many women who do not have easy access to a health clinic for regular injections.

Oxytocin and Epinephrine

Last year, an estimated 700,000 mothers died from blood loss during childbirth. Their lives could have been saved if they were given a standard injection of Oxytocin during the birthing process.

This inexpensive hormone is a staple in nearly all modern hospital births in high-income countries. Unfortunately, many of the 90 million mothers who give birth annually in low- and middle-income countries do not receive Oxytocin and are consequently at risk. Likewise, Epinephrine is a hormone that saves people who are suffering from a life-threatening allergic reaction. Examples include anaphylactic shock resulting from a bee sting, or a severe asthmatic reaction to food, triggered by an allergy. However, the market cost of Epinephrine makes it prohibitively expensive for millions of people who need to have it readily available. ApiJect’s low cost and ease of rapid-scale manufacturing can make it affordable and practical for millions of people to receive emergency injections of these and other hormones. ApiJect’s compact size and ease of use also make it ideal to keep on hand for at-risk populations.



Tuberculosis Test

In 2018, there were 10 million new cases of Tuberculosis (TB) – and the number is growing. When there is a TB outbreak, governments and NGOs try to act quickly to contain the disease. Unfortunately, the cost of treatment is high. Ideally, to save money and limit the number of patients, members of at-risk populations should be given a screening test that helps health professionals assess the likelihood that a specific individual is developing TB. The difficulty is that the TB test requires an intradermal (ID) injection, and since most ID injections are given with longer intramuscular needles, only a trained professional can administer them. (Shallow injections made with long needles require the administrator to use the Mantoux method, which requires skill and practice.) ApiJect helps alleviate this problem. An ApiJect can be equipped with an ID needle hub, allowing for a standard – and much simpler – injection technique, not the Mantoux method. This makes it possible and practical for a larger population of healthcare professionals to administer the needed test. Furthermore, ApiJect’s low cost means that governments can procure more TB tests on the same budgets.



To learn more about the potential impact of a single-dose format like ApiJect, read our booklet “Injectable Contraceptives Not Only Improve the Health and Lives of Women, but Transform Communities” or download it at bit.ly/apiject-red-booklets.

Introducing ViaJect: “ApiJect for Animals” A prefilled Mono-Dose for Pets and Animal Companions

Worldwide, pets receive an estimated 500 million injections per year; ApiJect means faster, safer, more convenient and lower-cost care.



Both veterinarians and pet owners will benefit from an easier, simpler, lower-cost option for injections.

An estimated 400 million dogs serve as animal companions to humans worldwide. In the US alone, the pet population includes more than 70 million dogs; the number of cats is higher. As nations grow their GDP, pet healthcare and pet spending grows along with it. In the US, pet owners spent an estimated \$69 billion on acquiring, feeding and caring for their pets in 2017.¹³⁶

The animal health market in the US commands its own \$26 billion economy; total US pet industry expenditures were expected to reach more than \$72 billion by 2018.¹³⁷ We estimate there are half a billion injections per year that serve the world’s population of companion animals, and the number is growing rapidly. But many pet owners are unable to vaccinate their furry friends because the costs

are too high. ApiJect can help increase pet vaccination coverage with our low-cost format, provided to the pet and animal companion market with a specialty version of the ApiJect product called ViaJect.

Our prefilled presentation will be welcomed by veterinarians because it saves them time and reduces error rates. Furthermore, in markets where regulators choose to allow it, owners can inject their pets at home thanks to ApiJect’s simple and compact format. This will increase the convenience of providing more consistent healthcare to pets and animal companions and also lower the cost. The result is that more pets are more likely to consistently receive the ongoing medical attention they need in an affordable, practical way.

ViaJect Can Also Help Subsistence Farmers Worldwide Keep Livestock Healthy – and Keep Families Alive

Most animals on small farms go unvaccinated, putting livestock and farm families at risk.

Hundreds of millions of small family farms around the world keep livestock, from dairy cows and goats to sheep and poultry. For billions of people in many low- and middle-income nations, these animals generate critically needed income from valuable products such as wool, hair, silk, hides, skins, furs, wax, feathers, bones, horns and more. Domestication of small animals is global.

At the same time, these “living renewable resources” often provide the chief means of physical survival for many families on small farms, serving as their primary source of food since animals and bees produce meat, milk, eggs, and additional edibles. If farm animals in these sectors get sick or die, the humans who own them can be at risk, too – not just for adverse health impacts, but for the family’s physical survival. Unfortunately, in much of the world – particularly in LMICs – most of these

animals go unvaccinated. For example, the UN estimates that only 38% of livestock in Tanzania and 21% in Uganda receive vaccines, and a similar number receive treatment for parasites and other infections. Not surprisingly, low rates of basic animal healthcare often result from limited availability of injectable medicine and vaccines; and, unsustainable high costs.

Through its ViaJect product line, ApiJect’s low-cost, high-volume, versatile and easy-to-use technology could have a significant impact on this enormous, often overlooked, segment of global health. By making it both convenient and cost-effective for hundreds of millions of subsistence farmers and small farmers worldwide to treat their livestock, ViaJect enables small farm animals to safely generate more income and more sustenance, ultimately improving the family’s well-being.



ApiJect can be fitted with small needles for small animals with soft skins, or with the larger needles to pierce thicker hides.



“ Mobile phones and wireless networks have transformed the world. Globally, there are more mobile devices than people. ApiJect’s unique digital platform

integrates each syringe with the Internet of Things, enabling health organizations to track billions of injections in a new way that will accelerate health systems strengthening. As mobile continues to improve the everyday lives of ordinary people, data-driven planning and decision making becomes the critical frontier in global health.”

JAY WALKER
CHAIRMAN, APIJECT

ApiJect Adds the Most Powerful Tool of the Modern World to “Change the Equation”

Mobile phones and data networks are the defining tool of our time. Putting injections on the Internet of Things will help provide 100% injection coverage, equity and safety.

The Problem:

With billions of injections given per year, the world’s medical organizations, communications technologies and reporting protocols cannot be expected to accurately track who gets what injection of medicine or vaccine.⁸⁷ Add the variables of when, where, who delivered it and the batch number of each particular dose and the problem of gathering timely data is even harder. When it comes to tracking and measuring vaccine coverage, the global health community is “flying blind.”

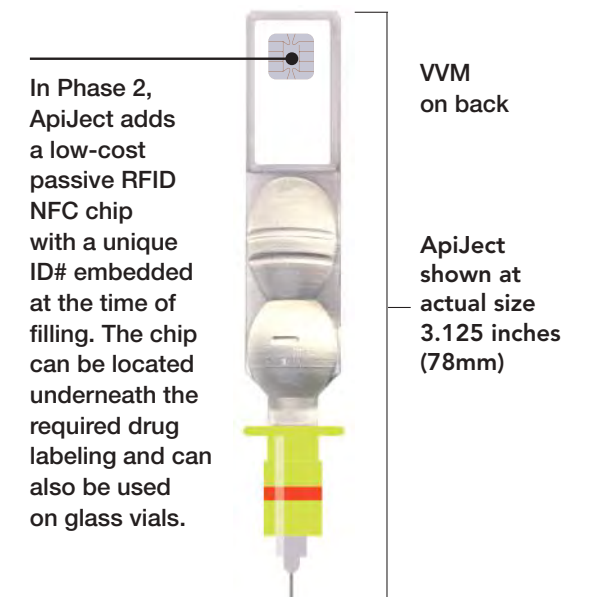
That means even the most ambitious and well-funded campaigns to bring vaccines and medicines to the world, find it difficult to measure their success rates and target under-performing areas for improvement.

Planning suffers when there is a lack of fast, accurate, actionable data. Short of spending billions of dollars on new technology, how can we build a simple (yet also

modern) data ecosystem that can instantly track all injections of vaccines and medicines anywhere in the world...one dose at a time or millions of doses in weeks?

The Innovation:

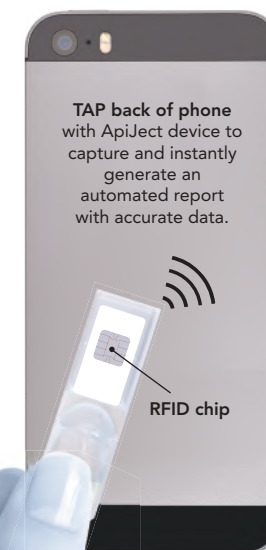
ApiJect offers an affordable, effective solution. Starting in 2021, ApiJect will add a new health data communications option – a platform that is



physically integrated, in part, into the syringe itself. This platform will weave together current mobile technology; the Internet of Things; the GPS network; widely established radio-frequency ID technology (RFID) and the existing global mobile/computer network. It will enable ApiJect to capture and instantly generate an automated report with accurate data about every injection given in the field by organizations such as Gavi. The resulting data can then be distributed to all stakeholders.

The Technologies: RFID and NFC

Each Phase 2 ApiJect device will be manufactured with a Near-Field Communications (NFC) computer chip embedded in the plastic hand grip of the syringe. It is the same type of RFID chip found in billions of credit cards, debit cards and high-end smartphones all over the world.



Unlike a QR code, each self-contained chip actively and continually broadcasts data, and can be remotely queried (even inside a closed box). It costs just a few cents per unit based on data size requirements.⁸⁸

NFC chips are what engineers call “passive devices,” which means they do not need or contain an internal power supply. Instead, the chip is activated when it comes within a few inches of an outside power source, such as the antenna embedded in a mobile phone.⁸⁹

Each NFC chip will store a unique serial number. When that number is uploaded to the cloud, it is instantly associated with a data set of 8 essential identifiers.

The Process:

To activate ApiJect Phase 2’s automated reporting data feature, a health professional or community health worker (CHW) performs 3 simple steps:

1. Launch the ApiJect app on their mobile phone.
2. Tap the back of the phone to the ApiJect device so that the magnetic field activates the chip and captures the unique serial number. In a second, the number is captured and the phone screen confirms “Data Received.”
3. The medic inserts the needle in the patient and squeezes the ApiJect device’s plastic bubble. This injects the vaccine or medication.

Data is automatically uploaded from the phone’s app to the Internet of Things (in real time or batch delayed), where it is associated with a specific data set. This data is combined with data from other ApiJect devices in the field to generate useful reports for anyone who needs them.

The Data:

When the central data system receives the serial number

from the ApiJect chip, it also captures associated time and geo-location data (GPS) from the phone.

The serial number and time/place data are then stored in a cloud-based system. The system knows:

1. The **specific drug** being administered (from the serial #).
2. The **actual dose** being administered (from the serial #).
3. **Location** where injection is given (from GPS).
4. **Time** when injection is given (from the phone’s operating system).
5. **Medic** who gave the injection (from app & phone identifier).
6. **Clinic** where injection was given, if any (from GPS data interpreted from clinic mapping).

7. Manufacturing data and **history** of the drug, including batch number, manufacturing date, shipment history and destination, order number, customer number, delivery place and date (from serial #).

8. Ambient outdoor **temperature and weather** at the time and location of injection (from correlation of weather data with GPS location and time of chip activation).

Key Benefits:

Starting in 2021, ApiJect will be able to provide national and global health organizations such as Gavi and WHO with detailed, accurate, real-time snapshots of injection coverage and effectiveness. Data from millions of ApiJect devices, using an open API, can be compiled and assembled into useful reports on the rate and locations of vaccination or drug coverage. All data can be accessed and incorporated into the WHO EVMA 2.0 Framework⁹⁰ at no cost.

India’s software design industry will be a major contributor to ApiJect Phase 2 – adding the capability for mobile-based tracking for every injection

Every injection made with ApiJect Phase 2 will be able to easily transfer critical health data in real time to the global health community using advanced technology that will be designed in India.

ApiJect will rely upon Indian-based software engineering to co-design the hardware design and write the needed code base to drive ApiJect Phase 2. ApiJect has both an in-house software facility in Delhi and will work with one or more of India’s leading technology suppliers.

India is a logical choice for two reasons. First, India is the world’s largest market for medical injections, providing its citizens with an estimated 3 billion vaccine injections each year. In addition, India delivers an estimated 8 billion therapeutic injections annually.



ApiJect will use the proven capabilities of 100+ developers who currently perform advanced code-writing in the Delhi based facility owned by the Walker family of companies.

The second reason ApiJect has selected India’s software industry to develop ApiJect Phase 2 technology is the nation’s leadership in software development. Generating US\$120 billion per year and employing 13 million people

directly and indirectly, IT is India’s fifth largest industry.⁹¹ The sector’s reputation as a world leader in software development is unsurpassed. India’s IT services for export are growing 9% per year while the domestic market is expanding 10-12% annually and India’s digital services are growing twice as fast.⁹²

As of 2019, India’s medical device industry is valued at US\$5.2 Billion and is growing at 15.8% CAGR; various sources project that by 2025, the market will reach US\$50 billion.⁹³

The nation’s mHealth services are projected to grow just as rapidly, expanding from US\$435 million to US\$945 million by 2020.⁹⁴ In addition, the Indian healthcare IT market is currently valued at \$1 billion and is likely to grow about 1.5 times by 2020.⁹⁵

ApiJect is dedicating a software development facility in Delhi, managed by Walker Digital Tracking Systems, to execute the engineering of its Phase 2 technology.



India’s Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan, with Mr. YS Chowdary, Minister of State for Science & Technology and Earth Sciences and other dignitaries at a 2017 Biotechnology Industry Research Assistance Council event.

ApiJect will also forge several high-level partnerships with India-based producers of health related data. These companies will assist with aggregating and correlating data uploaded from ApiJect Phase 2 devices in the field, and translating that data into a wide range of actionable

Millions of hotel rooms currently use RFID chip cards for “keyless” room entry

Who would have thought 20 years ago that the 6,000-year-old key would first be replaced by a mag stripe and door reader and then again by 10c worth of disposable, reprogrammable computer chip? That’s exactly what happened.



RFID-enabled card keys have replaced the old metal keys in nearly every new hotel over the past decade. Together, with mag-stripe keys, digital keys are now the standard for most of the world’s 15+ million hotel rooms.⁹⁶

Today’s “tap and go” card keys provide multiple layers of room access privileges (guest, housekeeping, security, fire, etc).

Billions of credit cards join the trend

RFID-based inexpensive NFC chip technology has expanded to credit cards and card reader systems from Visa, MasterCard, American Express, Apple and Samsung.⁹⁷



RFID and related chips are now everywhere worldwide, from the local Starbucks to the

millions of retail locations that now accept contactless payment options. It was just a matter of time before these same technologies became incorporated into health systems.

Medical organizations will receive detailed reports that answer questions such as:

- How many health workers and which ones, in which clinics of Region 9, participated in our Hep-B vaccination campaign this month? How many patients did each worker inoculate overall? Per day? Per week?
- Are routine weekly birth doses of Hep-B inoculations increasing or decreasing in Districts 27, 36 and 44?
- How quickly does Clinic #47 use up its polio vaccine after each new shipment? Should the volume and frequency of shipments be increased? By how much?
- How do inoculation rates with the new RSV vaccine in Clinic #214 vary with weather?

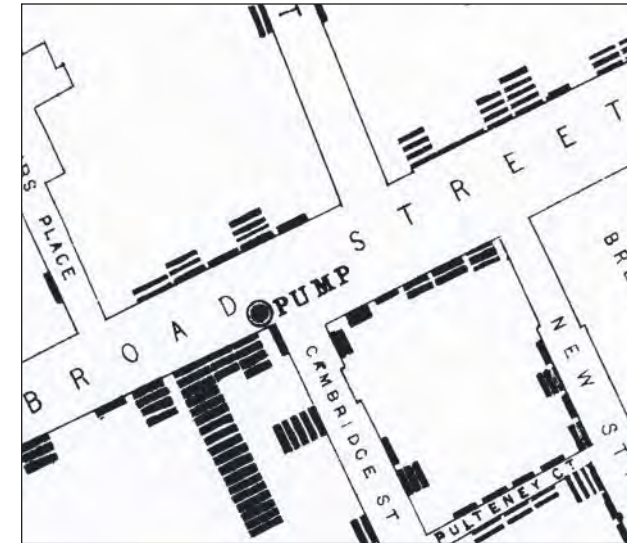
Users will be able to generate reports that answer these questions and thousands more. Health organizations will know where they are succeeding and where more effort and resources are required. They will be able to pinpoint high-level success zones as well as problem areas, and able to assess the reasons for each.

mHealth and the IoT: important new tools for strengthening health systems around the world

WHO has stated that mobile and wireless technology “has the potential to transform the face of health service delivery across the globe” and to effectively support widely shared goals of achieving greater global coverage and equity.⁹⁸

The mobile-connected technology of ApiJect Phase 2 falls within the broad field of “mHealth.” WHO defines mHealth as a “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and wireless devices.”⁹⁹

Today there is a high level of global enthusiasm about the potential of mHealth. Billions of dollars are being invested at all levels and across all sectors of the ecosystem. These levels and sectors include national health ministries; numerous regional organizations around the world; various



This 1854 London map was used by Dr. John Snow to track cholera cases and identify their source: a contaminated well.

research and treatment efforts targeting specific diseases; hospital systems; pharma companies; medical device makers; and more.

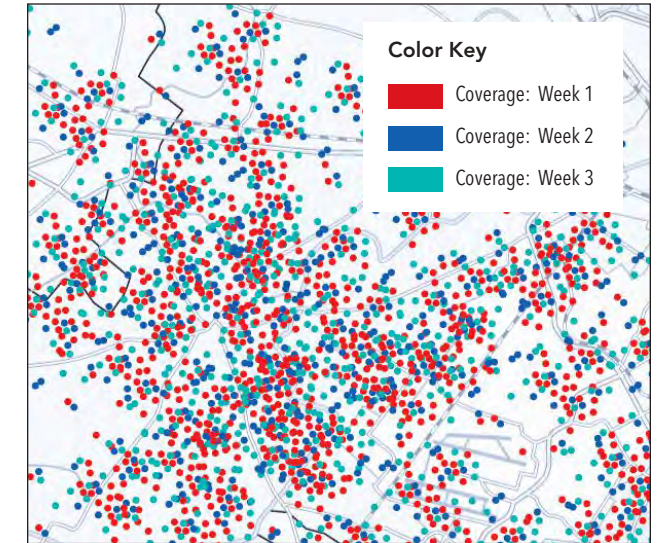
As mHealth solutions demonstrate an ability to expand coverage and deliver more impact for each dollar spent, a growing appetite is expected for such solutions among health ministries in low- and middle-income countries, and payers and regional and global health organizations. These entities could benefit from IoT-connected support of their ongoing efforts to monitor and track vaccine and drug administration in the field.¹⁰⁰

ApiJect believes its Phase 2 technology will provide useful support to the coming explosion of mHealth use. Phase 2 is designed to address these critical needs through its functionality, which enables better monitoring and tracking of inoculation and treatment campaigns in remote areas, and through its and simplified operations.

ApiJect Phase 2 features open APIs, enabling all stakeholders to participate

Consistent with ApiJect’s mission of global coverage, Phase 2 technology will feature an Open API – a publicly available application programming interface.

Developers from any qualified stakeholder, at any level of



ApiJect with digital network connectivity will enable health agencies to track injection rates and improve planning.

the healthcare infrastructure, get full and free access to ApiJect’s data.

ApiJect will furnish stakeholders with the ability to design their own national or international systems for compatibility and communication with Phase 2. They will also have the ability to modify and control their unique use of Phase 2 reporting and data transmission functions. And, they will have the ability to control access to data for their country or their specific target populations. All data acquired by ApiJect Phase 2 will belong to the country, payer or organization that manages or funds a particular program. ApiJect has no data ownership.

ApiJect Phase 2 will be useful to stakeholders at all levels in the health ecosystem

While ApiJect Phase 2 serves the healthcare system from the top down, it also serves participants from the field-level up. Clinic managers will benefit because Phase 2 will make it effortless to obtain comprehensive data on their clinic’s performance right on their phone, with no paperwork, including comparisons to performance during previous periods, trend lines for coverage, and more. And, depending on the country, there is a broad range of logistics integration and support that will benefit from near-real-time, injection specific field data available on the IoT.

Global support infrastructure for mHealth is already widely available

WHO, anticipating the rapidly growing importance of healthcare organization-driven mHealth, directed its mHealth Technical Evidence Review Group to develop an mHealth evidence reporting and assessment (mERA) checklist that provides preliminary standards and guidelines.¹⁰¹

Global support infrastructure for mHealth is already widely available. WHO has tracked mobile subscription rates since the early part of this decade. Today there are more than seven billion mobile network subscriptions worldwide.¹⁰² As of 2011, WHO reported that over 70% of mobile subscribers resided in low- and middle-income countries.¹⁰³ The 2018 rate is likely to be much higher.

Supporting this broad global base of mobile devices, a number of the world's leading technology companies have invested resources in developing and providing solutions for capturing and storing large volumes of health data, as well as analytics to and for stakeholders in the healthcare ecosystem, including pharma, payers, patients and more. Numerous high-tech corporations have established sufficient global penetration to enable them to provide scalable service, with programs, capabilities and appropriate privacy protections that can be customized for each country as it establishes its unique regulatory requirements.

ApiJect will seek design input for Phase 2 from Gavi, PATH, ministries and field-based CHWs

ApiJect seeks to work closely with Gavi, PATH, WHO and care providers and NGOs “on the ground” to ensure that Phase 2 supports both medical professionals and non-professional healthcare workers in the field. That starts with Phase 2's simple mHealth technology: an RFID/NFC chip in each syringe that communicates with an app installed on any health worker's phone.

Equally simple will be the worker's role in activating

Phase 2's reporting. Just tapping the back of the phone to the syringe is the sole requirement. Data transmission, as well as subsequent report generation, are automatic. Technology experts have acknowledged that for patients, any and all connected devices and software should be positioned as a valuable tool designed to help them – not as a monitoring tool designed to spy on them.

Not surprisingly, the same recommendation applies to healthcare workers. ApiJect Phase 2 may provide incentives to healthcare workers and clinics for achievements in

The global casino industry uses RFID technology to process trillions of dollars of casino chips each year

Low-power RFID chips, planned for integration with ApiJect in 2021, are already a widely used instant-tracking consumer-facing technology.

One of the most high-profile examples is the casino (gaming) industry, where 30+ million casino gaming chips worldwide are embedded with invisible RFID tags, each with a unique number that identifies the chip and its value. RFID tags made or licensed by Walker Tracking Systems process trillions of dollars in chip movements, typically in real time.¹⁰⁴ After ten years of 99.999% accuracy, RFID has revolutionized data collection and management for the gaming industry worldwide.

Walker Digital Tracking Systems will also develop a new, curved RFID tag that will be affixed to glass vials of medicine or vaccine, positioned under the label. This RFID tag will enable geo-location tracking of each vial, plus tracking of individual injections at the point of use. For the first time, pharmaceutical companies, national health ministries and global vaccination bodies will have a total tracking system for shipping and administration of glass vials and their contents.



providing care, such as recognition within the system, and free phone minutes for each injection delivered.

Summary:

When the mobile-connected, prefilled mini-syringe and its data communication system are deployed at scale, nearly everyone in the world will be able to see where we have coverage and where we need to do better.

The time is growing near when every injection will be

documented and tracked, globally, to provide the vital intelligence that enables course corrections in the field, and continual adjustments for better planning. Put simply, the Internet of Things is coming to the world of safe injections and the benefits are numerous.

We believe that ApiJect's affordable and practical new device and technology offers a leapfrog solution over the many challenges and costs associated with old-style glass vials and syringes and their administration.

Infographic E

With ApiJect Phase 2, simply “tap and press” to use. Data is automatically captured, then uploaded and reported.

TAP

The health worker **TAPS** the **back** of their phone to the ApiJect device.

One tap uploads the ApiJect serial number to the cloud with time and geo-location (GPS) of activation.



TAP back of phone with ApiJect device

RFID chip

The serial number is associated with the drug name & dose; batch # and history; medic ID#; and other factors.

PRESS

The health worker **PRESSES** the bubble to inject the vaccine.



REPORT

Data is used to automatically generate useful **REPORTS** for anyone who needs them.



Polio vaccinations in Kenya by date

Region 7 vaccine injections by clinic this week

Hep-B inoculations by city/town, daily/weekly/monthly

Injections by health worker in a specific clinic/time frame

2nd Generation cPAD

ApiJect: The First BFS cPAD - The “Soft” Syringe

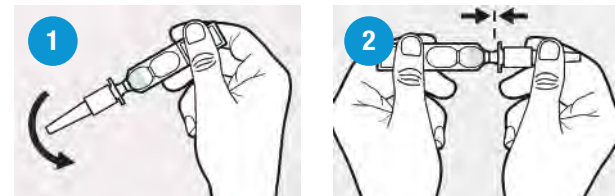
PRODUCT SUMMARY

ApiJect devices can expand global coverage and equity of vaccine distribution while enhancing safety for patients and healthcare workers (1) below the current per-dose delivery cost of a multi-dose vial; (2) manufacturable by any pharmaceutical company; and (3) in a single dose, non-refillable presentation. ApiJect is a single dose compact prefilled auto-disable device (cPAD) that uses well-established Blow-Fill-Seal (BFS) technologies to achieve new benchmarks in cost and safety.

THE APIJECT DEVICE

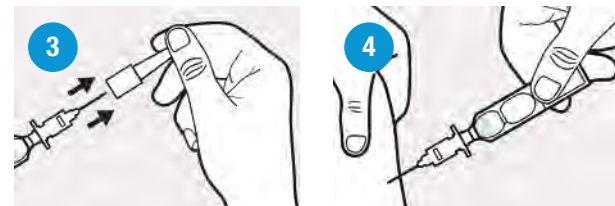
The ApiJect device is a cPAD created using BFS plastic technology (BFS cPAD). It is manufactured, filled, and sealed in a single aseptic process, contributing to a lower cost per dose delivered than a 10-dose vial presentation.¹ ApiJect devices are packaged singly or in strips of 5 or more contained in a blister pack with the biological, container, and needle hub preassembled. ApiJect can be manufactured from 0.1 to 2.0 mL doses with ID, SC, or IM needle lengths.

INSTRUCTIONS FOR USE



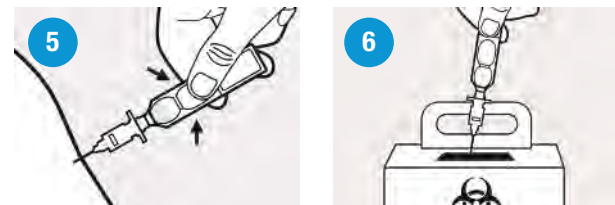
SHAKE DOWNWARD: Flick device to move liquid medicine into the bubble.

CLICK: Activate by holding 2 ends and push together. Makes a “click” sound.



UN-CAP: Remove the needle cap.

INSERT: Insert needle.



PRESS: Press top bubble to inject.

DISPOSE: Discard properly.



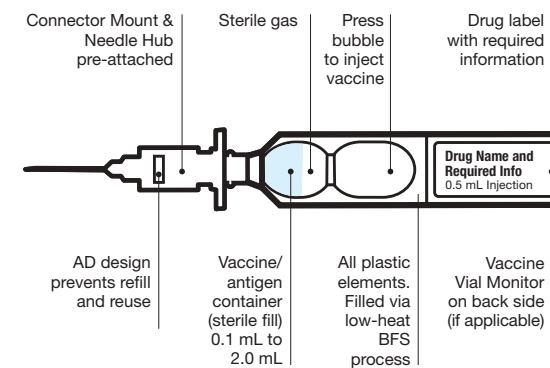
BLOW-FILL-SEAL (BFS)

BFS is an established manufacturing process in the healthcare field. More than 50 billion packaging units are produced for sterile medical contents every year.² A BFS machine creates the medical-grade LDPE polyethylene container, fills it with the biological, and seals it in a seamless aseptic process. Current BFS machines produce 34,000 injectable sterile doses per hour, enabling monthly BFS production of 25 million doses per month per machine.³ For example, BFS ampoule packaging is currently approved for use with GSK’s Rotavirus

RATIONALE

- Single dose:** Significantly reduces wastage, guarantees accuracy, facilitates outreach.
- Prefilled:** Ensures correct dosage, and simplifies the injection process.
- Non-refillable/single-use:** Eliminates patient-to-patient transmission of bloodborne pathogens.
- Affordability:** Delivers total cost at or below price per dose of a 10-dose vial and syringes.
- Simplicity:** Any healthcare worker can quickly vaccinate a patient with minimal training. Allows for patient self-injection when appropriate and regulator-approved.
- Compact:** Enables easy transport to remote areas and efficiently utilizes the cold chain.
- Lightweight:** Significantly less weight compared to single or multi-dose glass vials and plastic syringes.⁴
- Flexible Design:** Meets specific needs for different markets and contents by enabling custom tailoring of the container.
- Environmental:** Significant reduction in energy and raw materials to manufacture. Easier to recycle and dispose of.⁵
- Manufacturing Speed:** Shorter lead time to initiate high-volume production.

NEEDLE HUB + BFS CONTAINER



MANUFACTURING PARTNERSHIPS & ADVISORS

ApiJect is supported by a team of internationally-approved manufacturing partners:

- Rommelag (Switzerland) – The inventor of and world leader in BFS technology.
- Tae-Chang Industrial (South Korea) – A leading cannula and syringe manufacturer.
- HMD Healthcare (India) – One of the world’s five largest medical device suppliers.

ApiJect receives support and advice from established innovation-support organizations, including: The Bill and Melinda Gates Foundation and PATH.

Production

With assistance from ApiJect’s partners, several facilities around the world will be ready to produce ApiJect units in Q4/19 - Q1/20 pending regulatory approval. Each will have fully automated, high-volume production lines capable of producing 25 million doses per month per BFS machine. Pharmaceutical companies that choose to offer their product in ApiJect have the option of purchasing BFS machines and installing ApiJect production finishing lines in their facilities.

Regulatory

ApiJect’s needle hub and BFS container will undergo separate regulatory submissions followed by an application for a combination registration in the EU and the US.

Optional Configurations

The purchaser may order ApiJect in a variety of configurations based on preference:

- Single-item or 5 or more dose strip packaging
- ID, SC, or IM needle sizes
- Custom BFS container shapes and colors

Uses

ApiJect can be used for any type of injection, including vaccines, pharmacologicals, contraceptives, hormones, and emergency

field campaigns. Improved epidemic response and disaster preparedness are also possible as each BFS machine can mass-produce 25 million doses a month with lead times of a few weeks. Glass vial lead times are eliminated.

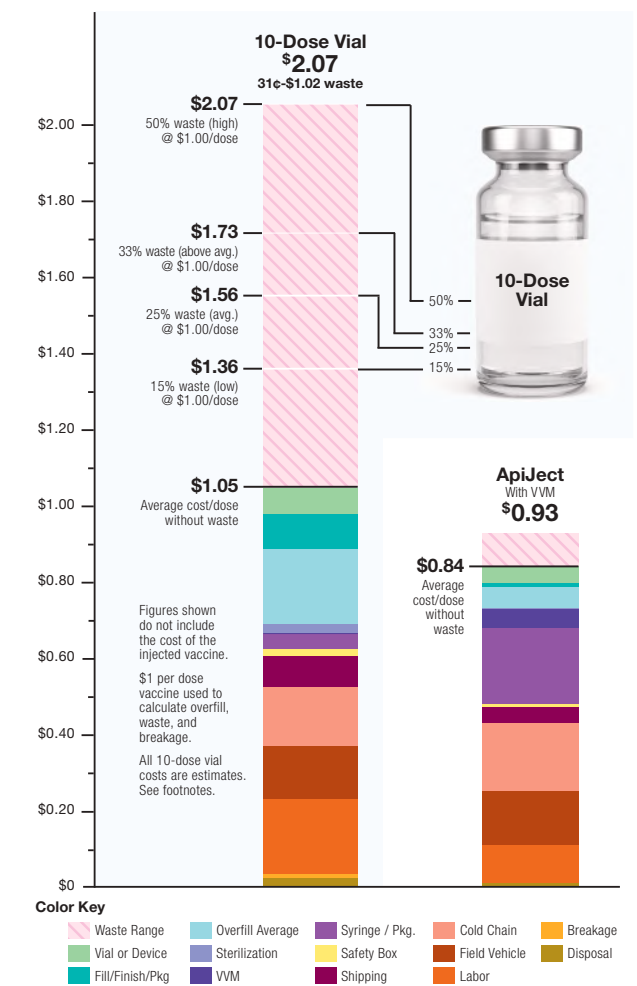
Cost

The ApiJect device can be manufactured and delivered at a lower cost per dose than multi-dose vials. ApiJect has committed to a Global Access price below the total cost of the same contents delivered in a 10-dose vial format.

History of the ApiJect Device

Supported by the Bill & Melinda Gates Foundation in association with PATH, Marc Koska, the inventor of the K1 Auto-Disable Syringe, has designed a needle hub that can be affixed to a BFS container to create a prefilled “soft” syringe. The ApiJect team has worked closely with Rommelag, HMD, and T-C Industrial to create a market-ready product and global manufacturing system pending regulatory approval.

COMPARING APIJECT TO 10-DOSE VIAL COST⁶



1) Can a Compact Pre-Filled Auto-Disable Injection System (cPAD) Save Costs for DTP-HepB-Hib Vaccine as Compared with Single-Dose (SDV) and Multi-Dose Vials (MDV)? Evidence from Cambodia, Ghana, and Peru, Cyril Nogier, Patrick Hanlon, Karin Wiedenmayer, Nicolas Maire. January 29 2015. / Cost of goods sold and total cost of delivery for oral and parenteral vaccine packaging formats, Jeff Sedita, Stefanie Perrelli, Matt Morio, Michael Berbari, Jui-Shan Hsu, Eugene Saxon, Courtney Jarrahan, Annie Rein-Weston, and Darin Zehrung, Vaccine, 2018 Mar 14; 36(12): 1700-1709. / PATH, Pentavalent Vaccine in the Uniject™ Injection System: Health Care Waste Management Considerations. September 31 2014. / Delivery cost analysis of a reactive mass cholera vaccination campaign: a case study of Shanchol™ vaccine use in Lake Chilwa, Malawi. Patrick G. Ilboudo and Jean-Bernard Le Gargasson, BMC Infect Dis. 2017; 17: 779. December 19 2017. / DTWP-HepB-Hib vaccine available in a compact, pre-filled auto-disable injection technology, UNICEF, Information Bulletin. March 2015. 2) Rommelag Engineering <https://www.rommelag.com/en/engineering/>. 3) Rommelag Engineering <https://www.rommelag-engineering.com/en/bfs/>. 4) Blow-Fill-Seal: An Advanced Aseptic Packaging Technology, Andrew W. Goll, https://www.healthcarepackaging.com/sites/default/files/whitepaper/WeilerEbook_V5.pdf. 5) Ibid / US Energy Information Administration, Glass manufacturing is an energy-intensive industry, mainly fueled by natural gas, August 21, 2013 <https://www.eia.gov/todayinenergy/detail.php?id=12631>. 6) See footnote 1. For inquiries or information, please e-mail us at info@apiject.com

To Learn More About ApiJect's Benefits, Download our White Papers

Downloads are available at bit.ly/apiject-red-booklets



How a Low-Cost Mono-Dose Syringe Can Increase Safety and Coverage



Billions of Glass Vials Every Year With Unintended Consequences



Low-Cost Mono-Dose Syringes Enable Many Use Cases for Global Impact



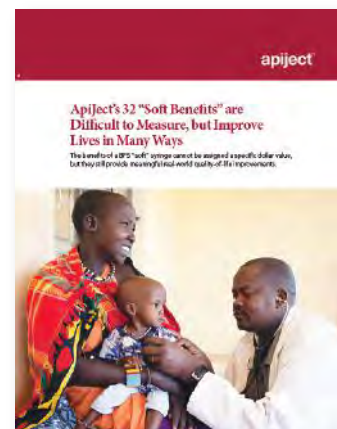
Vaccine Technology: Its Past Evolution and Future Landscape



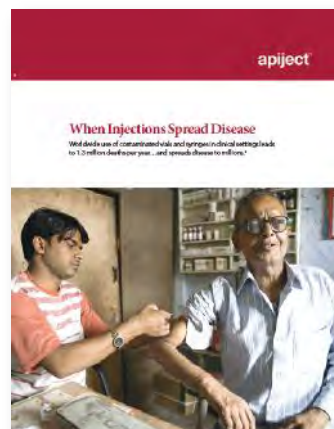
Injectable Contraceptives Not Only Improve the Health and Lives of Women, but Transform Communities



Pandemics



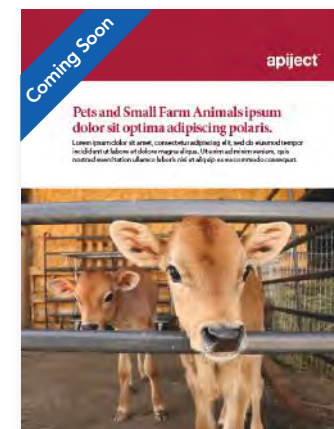
ApiJect's 32 "Soft Benefits" are Difficult to Measure, but Improve Lives in Many Ways



When Injections Spread Disease



How We Manufacture a Prefilled Syringe with the World's Lowest Cost Per Dose Delivered



Pets/Small Farm Animals



The Marc Koska Story

References and Citations

1. <http://www.who.int/mediacentre/news/releases/2015/injection-safety/en/>. Accessed 12/3/18.
2. http://www.who.int/immunization/rfp_review_missed_opportunities_vaccination/en/, accessed 12/3/18.
3. Can a Compact Pre-Filled Auto-Disable Injection System (cPAD) Save Costs for DTP-HepB-Hib Vaccine as Compared with Single-Dose (SDV) and Multi-Dose Vials (MDV)? Evidence from Cambodia, Ghana, and Peru. Cyril Nogier, Patrick Hanlon, Karin Wiedenmayer, Nicolas Maire. January 29 2015. Cost of goods sold and total cost of delivery for oral and parenteral vaccine packaging formats. Jeff Sedita, Stefanie Perrell, Matt Morio, Michael Berbari, Jui-Shan Hsu, Eugene Saxton, Courtney Jarrahan, Annie Rein-Weston, and Darin Zehrung. Vaccine. 2018 Mar 14; 36(12): 1700–1709. PATH, Pentavalent Vaccine in the Uniject™ Injection System: Health Care Waste Management Considerations. September 31 2014. Delivery cost analysis of a reactive mass cholera vaccination campaign: a case study of Shanchol™ vaccine use in Lake Chilwa, Malawi. Patrick G. Ilboudo and Jean-Bernard Le Gargasson. BMC Infect Dis. 2017; 17: 779. December 19 2017. DTWP-HepB-Hib vaccine available in a compact, pre-filled auto-disable injection technology. UNICEF, Information Bulletin. March 2015
4. <http://www.who.int/mediacentre/news/releases/2015/injection-safety/en/>. Accessed 08/24/18.
5. Ibid.
6. www.gavi.org/library/publications/gavi/gavi-2016-2020-mid-term-review-report/ Accessed 12/03/18.
7. Ibid.
8. PATH, Increasing access to lifesaving vaccines, Dec. 2013 PATH, A History of Vaccines, April 2015.
9. The Journal of the American Osteopathic Association, May 2018, Vol. 118, 311–320. doi:10.7556/jaoa.2018.062, Iatrogenic Hepatitis C Virus Transmission and Safe Injection Practices. AIDS Committee of North Bay & Area, Theresa Boyle, Experts Warn Against Use of Multi-Dose Vials <http://aidsnorthbay.com/experts-warn-against-use-of-multi-dose-vials/>.
10. Royal College of Physicians of Edinburgh <https://www.rcpe.ac.uk/heritage/college-history/alexander-wood> British Journal of Hospital Medicine 2017 Nov 2;78(11):647, Ellis, Harold, Alexander Wood: Inventor of the Hypodermic Syringe and Needle <https://www.magonlineibrary.com/doi/10.12968/hmed.2017.78.11.647>.
11. It's a long, long walk: accessibility to hospitals, maternity and integrated health centers in Niger, Int J Health Geogr. 2012; 11: 24, 2012 Jun 27. doi: 10.1186/1476-072X-11-24, Justine I Blanford, Supriya Kumar, Wei Luo, and Alan M MacEachren. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3515413/>.
12. International Pharmaceutical Quality, Sharp Uptick in Recalls for Glass Lamellae Problems Under Scrutiny, Aug 3rd, 2011.
13. Path Challenges and Innovations in Vaccine Delivery, 10th Annual African Vaccinology Course (AAVC): Developing Vaccinology Expertise for Africa, 10–14 November 2014 Cape Town, South Africa, by Darin Zehrung, Senior Technical Officer and Portfolio Leader, Delivery Technologies, Vaccine and Pharmaceutical Technologies Group, 13 November 2014.
14. Ibid. Pharmacy & Therapeutics, 2013 Nov; 38(11): 649, 666, Grissinger, Matthew, Perilous Infection-Control Practices With Needles, Syringes, and Vials. Bull World Health Organ. 1999; 77(10):789–800, Simonsen L., Kane A., Lloyd J., Zaffran M., Kane M., Unsafe Injections in the Developing World and Transmission of Bloodborne Pathogens: a Review.
15. Ibid.
16. Ibid.
17. Center for Disease Control and Prevention Healthcare-Associated Hepatitis B and C Outbreaks (≥ 2 cases) Reported to the Centers for Disease Control and Prevention (CDC) 2008–2017 <https://www.cdc.gov/hepatitis/outbreaks/healthcarehpeoutbreaktable.htm>.
18. Footage From 1976 Documents Discovery of Ebola Virus <https://www.wsj.com/articles/footage-from-1976-documents-discovery-of-ebola-virus-1413470954> Dipti Kapadia And Gautam Naik, Oct. 16, 2014.
19. WHO, Universal health coverage and health financing http://www.who.int/health_financing/universal_coverage_definition/en/.
20. WHO, Health systems/equity, <http://www.who.int/healthsystems/topics/equity/en/>.
21. World Health Organization, Immunization Coverage Fact Sheet, 11 April 2018 <http://www.who.int/en/news-room/fact-sheets/detail/immunization-coverage>.
22. Children's Hospital of Philadelphia, Global Immunization: Worldwide Disease Incidence <http://www.chop.edu/centers-programs/vaccine-education-center/global-immunization/diseases-and-vaccines-world-view>.
23. World Health Organization, Maternal Mortality Fact Sheet, 16 February 2018 <http://www.who.int/en/news-room/fact-sheets/detail/maternal-mortality>.
24. www.gavi.org/progress-report/. Accessed 12-03-18.
25. Bulletin of the World Health Organization 2003, 81 (10), Paul K. Drain, Carib M. Nelson, & John S. Lloyd, Single-dose versus multi-dose vaccine vials for immunization programmes in developing countries.
26. Ibid.
27. Ibid.
28. http://www.who.int/immunization/rfp_review_missed_opportunities_vaccination/en/, accessed 08/24/18.
29. Missed opportunities and barriers for vaccination: A descriptive analysis of private and public health facilities in four African countries, Comfort Zuyehi Olorunsaye, Margaret Shaw Langhamer, Aaron Stuart Wallace, Margaret Lyons Watkins, Global Immunization Division, Centers for Disease Control and Prevention; Emory University.
30. Human Vaccines Journal, 01 Mar 2010, Volume 6, 2010 – Issue 3, Pages 270–278, Impact of Wastage on Single and Multi-dose Vaccine Vials: Implications for Introducing Pneumococcal Vaccines in Developing Countries. Divya Parmar, Elaine M. Baruwa, Patrick Zuber & Souleymane Kone. Vaccine Wastage Assessment, UNICEF, April 2010, Field assessment and observations from National stores and five selected states of India.
31. Path Challenges and Innovations in Vaccine Delivery, 10th Annual African Vaccinology Course (AAVC): Developing Vaccinology Expertise for Africa, 10–14 November 2014 Cape Town, South Africa, by Darin Zehrung, Senior Technical Officer and Portfolio Leader, Delivery Technologies, Vaccine and Pharmaceutical Technologies Group, 13 November 2014.
32. Ibid. And: Tiwari, Ranjana & Dwivedi, Shatkratu & Swami, Piyush & Mahore, Rakesh & Tiwari, Sakshi. (2017). A study to assess vaccine wastage in an immunization clinic of tertiary care centre, Gwalior, Madhya Pradesh, India. International Journal of Research in Medical Sciences. 5. 2472. 10.18203/2320-6012.ijrms20172431. https://www.researchgate.net/publication/317197954_A_study_to_assess_vaccine_wastage_in_an_immunization_clinic_of_tertiary_care_centre_Gwalior_Madhya_Pradesh_India, accessed 08/24/18. And: Vaccine. 2017 Dec 4;35(48 Pt B):6751–6758. doi: 10.1016/j.vaccine.2017.09.082. Epub 2017 Oct 21. <https://www.ncbi.nlm.nih.gov/pubmed/29066189>. Accessed 08/24/18.
33. See footnote 3.
34. See footnote 3.
35. The Lancet, 03 October 2015, Fiona Clark, Rise in Online Pharmacies Sees Counterfeit Drugs Go Global [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(15\)00394-3/fulltext?code=lancet-site](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)00394-3/fulltext?code=lancet-site).
36. International Pharmaceutical Quality, Sharp Uptick in Recalls for Glass Lamellae Problems Under Scrutiny, Aug. 3rd, 2011.
37. Ibid.
38. Immunization Action Coalition, Administering Vaccines, immunize.org/catg.d/p3085.pdf. Australian Diabetes Educators Association (ADEA), Clinical Guiding Principles for Subcutaneous Injection Technique, October 2015. www.adea.com.au/wp-content/uploads/2015/11/Injection-Technique-Final-digital-version2.pdf.
39. Information Packet #11: Recycling Is Business, by The Research Library for RCRA, US EPA-New England, Spring 1995: p. 89V-2 (p. 6 of PDF). EPA Publication # 901R95005.
40. US Energy Information Administration, Glass manufacturing is an energy-intensive industry mainly fueled by natural gas, August 21, 2013 <https://www.eia.gov/todayinenergy/detail.php?id=12631>.
41. Life Science Leader, Dan Schell, What You Should Know About Blow-Fill-Seal Technology, July 19, 2010 <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>.
42. PATH, Reflections on Innovations in Global Health, The Radically Simple Uniject Device.
43. Tiwari, Ranjana & Dwivedi, Shatkratu & Swami, Piyush & Mahore, Rakesh & Tiwari, Sakshi. (2017). A study to assess vaccine wastage in an immunization clinic of tertiary care centre, Gwalior, Madhya Pradesh, India. International Journal of Research in Medical Sciences. 5. 2472. 10.18203/2320-6012.ijrms20172431. Accessed 08/24/18. Vaccine. 2017 Dec 4;35(48 Pt B):6751–6758. doi: 10.1016/j.vaccine.2017.09.082. Epub 2017 Oct 21. <https://www.ncbi.nlm.nih.gov/pubmed/29066189> Accessed 08/24/18.
44. <https://www.gavi.org/library/news/roi/2010/gavi-catalyses-new-injection-safety-standards/>
45. Insider industry knowledge.
46. Insider industry knowledge.
47. PATH, Reflections on Innovations in Global Health, The Radically Simple Uniject Device.
48. https://www.unicef.org/immunization/23245_safety.html
49. Insider industry knowledge.
50. BD Medical – Pharmaceutical Systems, BD Uniject™ Prefillable Injection System Technical Manual, Edition 4, June 2009.
51. See footnote 3.
52. See footnote 3.
53. Rommelag Engineering <https://www.rommelag-engineering.com/en/info/aseptic-filling/>.
54. Rommelag Engineering <https://www.rommelag-engineering.com/en/bfs/>.
55. See footnote 3.
56. See footnote 3.
57. Estimate updated from World Health Organization, 2011. World Health Statistics 2011 - Table 6: Health workforce, infrastructure and essential medicines. <https://www.independent.co.uk/life-style/health-and-families/health-news/worldwide-20-per-cent-of-children-go-unvaccinated-8581495.html> – Accessed 08/20/18.
58. WHO global database on maternal health indicators, 2017 update: http://www.who.int/gho/maternal_health/en/ World Health Statistics 2017 report, page 29.
59. Dr. Henry Perry, senior scientist, Johns Hopkins Bloomberg School of Public Health, quoted p. 20 of One Million Community Health Workers Campaigns Annual Report 2014: Building Healthy Communities by Bringing CHWs to Scale (Published on Mar 12, 2015). <https://issuu.com/1millionhealthworkers/docs/annualreport2014>.
60. Immunization Action Coalition, Administering Vaccines, immunize.org/catg.d/p3085.pdf. Australian Diabetes Educators Association (ADEA), Clinical Guiding Principles for Subcutaneous Injection Technique, October 2015. www.adea.com.au/wp-content/uploads/2015/11/Injection-Technique-Final-digital-version2.pdf.
61. WHO, Bulletin of the World Health Organization 2011;89:221–226. doi: 10.2471/BLT.10.079426, 05 Jan. 2011, Intradermal delivery of vaccines: potential benefits and current challenges, JK Hickling, KR Jones, M Friede, D Zehrung, D Chen, D Kristensen, <http://www.who.int/bulletin/volumes/89/3/10-079426/en/>.
62. The Lancet, 03 October 2015, Fiona Clark, Rise in Online Pharmacies Sees Counterfeit Drugs Go Global, Fighting counterfeit pharmaceuticals: New defenses for an underestimated - and growing - menace, Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, June 29, 2017. <https://www.strategyand.pwc.com/reports/counterfeit-pharmaceuticals> InSight Crime, Counterfeit Drugs Kill 1 Mn People Annually: Interpol, Natalie Southwick, Oct. 24, 2013 <https://www.insightcrime.org/news/brief/counterfeit-drugs-kill-1-million-annually-interpol/>.
63. Life Science Leader, Dan Schell, What You Should Know About Blow-Fill-Seal Technology, July 19, 2010.
64. Interview.
65. World Health Organization, WHO Best Practices for Injections and Related Procedures Toolkit, March 2010.
66. US Energy Information Administration, Glass manufacturing is an energy-intensive industry mainly fueled by natural gas, August 21, 2013.
67. See footnote 3.
68. See footnote 3.
69. World Health Organization, Immunization Coverage Fact Sheet, 11 April 2018 <http://www.who.int/en/news-room/fact-sheets/detail/immunization-coverage>.
70. Immunization Action Coalition, Administering Vaccines, immunize.org/catg.d/p3085.pdf. Australian Diabetes Educators Association (ADEA), Clinical Guiding Principles for Subcutaneous Injection Technique, October 2015 <https://www.adea.com.au/wp-content/uploads/2015/11/Injection-Technique-Final-digital-version2.pdf>.
71. The Lancet, 03 October 2015, Fiona Clark, Rise in Online Pharmacies Sees Counterfeit Drugs Go Global. PwC, Fighting counterfeit pharmaceuticals: New defenses for an underestimated - and growing - menace, Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, June 29, 2017. <https://www.forbesindia.com/article/leaderboard/indian-it-services-sector-time-for-a-reboot/49671/1>.
72. https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/The_Indian_Medical_Device_Industry.pdf.
73. <https://www.statista.com/statistics/628210/mhealth-services-and-devices-market-size-in-india/>.
74. https://economics.timesofindia.com/articleshow/52048195.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
75. Open Key, The Evolution of Hotel Keys <https://www.openkey.co/blog/the-evolution-of-hotel-keys>. Hospitality Technology, Smart Guestroom Locks Becoming Standard, Dorothy Creamer, Managing Editor, 09/06/2013 <https://hospitalitytech.com/smart-guestroom-locks-becoming-standard>.
76. TechRadar, What is NFC? Everything you need to know, Cameron Faulkner May 09, 2017. <https://www.techradar.com/news/what-is-nfc>.
77. WHO, Effective Vaccine Management (EVM) Initiative. http://www.who.int/immunization/programmes_systems/supply_chain/evm/en/. WHO, UNICEF, Achieving immunization targets with the comprehensive effective vaccine management (EVM) framework, March 2016. http://www.who.int/immunization/programmes_systems/supply_chain/EVM-JS_final.pdf.
78. <https://www.statista.com/topics/2256/it-industry-india/>.
79. <http://www.forbesindia.com/article/leaderboard/indian-it-services-sector-time-for-a-reboot/49671/1>.
80. https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/The_Indian_Medical_Device_Industry.pdf.
81. <https://www.statista.com/statistics/628210/mhealth-services-and-devices-market-size-in-india/>.
82. https://economics.timesofindia.com/articleshow/52048195.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
83. Open Key, The Evolution of Hotel Keys <https://www.openkey.co/blog/the-evolution-of-hotel-keys>. Hospitality Technology, Smart Guestroom Locks Becoming Standard, Dorothy Creamer, Managing Editor, 09/06/2013 <https://hospitalitytech.com/smart-guestroom-locks-becoming-standard>.
84. TechRadar, What is NFC? Everything you need to know, Cameron Faulkner May 09, 2017. http://www.who.int/goe/publications/goe_mhealth_web.pdf.
85. WHO – mHealth: new horizons for health through – mobile technologies. Geneva, Switzerland: 2011. <https://www.bmj.com/content/352/bmj.i1174>.
86. Ibid.
87. <https://thehonestanalytics.com/the-mhealth-mobile-healthcare-ecosystem-opportunities-growing-trends-and-demands-analysis-forecast-2018-to-2025/>.
88. http://www.who.int/goe/publications/goe_mhealth_web.pdf.
89. Walker Table Systems <http://www.wdtablesystems.com/pjm-technology/>
90. <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>
91. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
92. <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>
93. <https://www.fda.gov/downloads/Drugs/Guidances/ucm070342.pdf>
94. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
95. <https://www.fda.gov/downloads/Drugs/Guidances/ucm070342.pdf>
96. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
97. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
98. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
99. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
100. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
101. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
102. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
103. https://www.huffingtonpost.com/gil-laroya/modular-design-for-techno_b_5008239.html
104. https://www.weileringeering.com/images/downloads/WhitePapers/Weiler-Catalent%20paper_FINAL.pdf
105. <https://www.petsecure.com.au/pet-care/a-guide-to-worldwide-pet-ownership/>.
106. Insider industry knowledge.
107. Internal calculation.
108. TechRadar, What is NFC? Everything you need to know, Cameron Faulkner May 09, 2017. <https://www.techradar.com/news/what-is-nfc>.
109. WHO, Effective Vaccine Management (EVM) Initiative. http://www.who.int/immunization/programmes_systems/supply_chain/evm/en/. WHO, UNICEF, Achieving immunization targets with the comprehensive effective vaccine management (EVM) framework, March 2016. http://www.who.int/immunization/programmes_systems/supply_chain/EVM-JS_final.pdf.
110. <https://www.statista.com/topics/2256/it-industry-india/>.
111. <http://www.forbesindia.com/article/leaderboard/indian-it-services-sector-time-for-a-reboot/49671/1>.
112. https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/The_Indian_Medical_Device_Industry.pdf.
113. <https://www.statista.com/statistics/628210/mhealth-services-and-devices-market-size-in-india/>.
114. https://economics.timesofindia.com/articleshow/52048195.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
115. Open Key, The Evolution of Hotel Keys <https://www.openkey.co/blog/the-evolution-of-hotel-keys>. Hospitality Technology, Smart Guestroom Locks Becoming Standard, Dorothy Creamer, Managing Editor, 09/06/2013 <https://hospitalitytech.com/smart-guestroom-locks-becoming-standard>.
116. TechRadar, What is NFC? Everything you need to know, Cameron Faulkner May 09, 2017. http://www.who.int/goe/publications/goe_mhealth_web.pdf.
117. WHO – mHealth: new horizons for health through – mobile technologies. Geneva, Switzerland: 2011. <https://www.bmj.com/content/352/bmj.i1174>.
118. Ibid.
119. <https://thehonestanalytics.com/the-mhealth-mobile-healthcare-ecosystem-opportunities-growing-trends-and-demands-analysis-forecast-2018-to-2025/>.
120. http://www.who.int/goe/publications/goe_mhealth_web.pdf.
121. Walker Table Systems <http://www.wdtablesystems.com/pjm-technology/>
122. <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>
123. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
124. <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>
125. <https://www.fda.gov/downloads/Drugs/Guidances/ucm070342.pdf>
126. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
127. <https://www.fda.gov/downloads/Drugs/Guidances/ucm070342.pdf>
128. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
129. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
130. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
131. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
132. https://www.huffingtonpost.com/gil-laroya/modular-design-for-techno_b_5008239.html
133. https://www.weileringeering.com/images/downloads/WhitePapers/Weiler-Catalent%20paper_FINAL.pdf
134. Global PwC, Fighting counterfeit pharmaceuticals: New defenses for an underestimated - and growing - menace, Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, June 29, 2017. <https://www.strategyand.pwc.com/reports/counterfeit-pharmaceuticals> InSight Crime, Counterfeit Drugs Kill 1 Mn People Annually: Interpol, Natalie Southwick, Oct. 24, 2013 <https://www.insightcrime.org/news/brief/counterfeit-drugs-kill-1-million-annually-interpol/>.
135. Life Science Leader, Dan Schell, What You Should Know About Blow-Fill-Seal Technology, July 19, 2010.
136. Interview.
137. World Health Organization, WHO Best Practices for Injections and Related Procedures Toolkit, March 2010.
138. US Energy Information Administration, Glass manufacturing is an energy-intensive industry mainly fueled by natural gas, August 21, 2013.
139. See footnote 3.
140. See footnote 3.
141. World Health Organization, Immunization Coverage Fact Sheet, 11 April 2018 <http://www.who.int/en/news-room/fact-sheets/detail/immunization-coverage>.
142. Immunization Action Coalition, Administering Vaccines, immunize.org/catg.d/p3085.pdf. Australian Diabetes Educators Association (ADEA), Clinical Guiding Principles for Subcutaneous Injection Technique, October 2015 <https://www.adea.com.au/wp-content/uploads/2015/11/Injection-Technique-Final-digital-version2.pdf>.
143. The Lancet, 03 October 2015, Fiona Clark, Rise in Online Pharmacies Sees Counterfeit Drugs Go Global. PwC, Fighting counterfeit pharmaceuticals: New defenses for an underestimated - and growing - menace, Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, June 29, 2017. <https://www.forbesindia.com/article/leaderboard/indian-it-services-sector-time-for-a-reboot/49671/1>.
144. https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/The_Indian_Medical_Device_Industry.pdf.
145. <https://www.statista.com/statistics/628210/mhealth-services-and-devices-market-size-in-india/>.
146. https://economics.timesofindia.com/articleshow/52048195.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
147. Open Key, The Evolution of Hotel Keys <https://www.openkey.co/blog/the-evolution-of-hotel-keys>. Hospitality Technology, Smart Guestroom Locks Becoming Standard, Dorothy Creamer, Managing Editor, 09/06/2013 <https://hospitalitytech.com/smart-guestroom-locks-becoming-standard>.
148. TechRadar, What is NFC? Everything you need to know, Cameron Faulkner May 09, 2017. http://www.who.int/goe/publications/goe_mhealth_web.pdf.
149. WHO – mHealth: new horizons for health through – mobile technologies. Geneva, Switzerland: 2011. <https://www.bmj.com/content/352/bmj.i1174>.
150. Ibid.
151. <https://thehonestanalytics.com/the-mhealth-mobile-healthcare-ecosystem-opportunities-growing-trends-and-demands-analysis-forecast-2018-to-2025/>.
152. http://www.who.int/goe/publications/goe_mhealth_web.pdf.
153. Walker Table Systems <http://www.wdtablesystems.com/pjm-technology/>
154. <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>
155. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
156. <https://www.pharmaceuticalonline.com/doc/what-you-should-know-about-blow-fill-seal-0001>
157. <https://www.fda.gov/downloads/Drugs/Guidances/ucm070342.pdf>
158. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
159. <https://www.fda.gov/downloads/Drugs/Guidances/ucm070342.pdf>
160. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
161. <http://www.worldpharmatoday.com/Articles/bfs-technology-for-parenteral-packaging>
162. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
163. <http://www.todaysmedicaldevelopments.com/article/tmd-0511-blow-fill-seal/>
164. https://www.huffingtonpost.com/gil-laroya/modular-design-for-techno_b_5008239.html
165. https://www.weileringeering.com/images/downloads/WhitePapers/Weiler-Catalent%20paper_FINAL.pdf
166. Global PwC, Fighting counterfeit pharmaceuticals: New defenses for an underestimated - and growing - menace, Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, June 29, 2017. <https://www.strategyand.pwc.com/reports/counterfeit-pharmaceuticals> InSight Crime, Counterfeit Drugs Kill 1 Mn People Annually: Interpol, Natalie Southwick, Oct. 24, 2013 <https://www.insightcrime.org/news/brief/counterfeit-drugs-kill-1-million-annually-interpol/>.
167. Life Science Leader, Dan Schell, What You Should Know About Blow-Fill-Seal Technology, July 19, 2010.
168. Interview.
169. World Health Organization, WHO Best Practices for Injections and Related Procedures Toolkit, March 2010.
170. US Energy Information Administration, Glass manufacturing is an energy-intensive industry mainly fueled by natural gas, August 21, 2013.
171. See footnote 3.
172. See footnote 3.
173. World Health Organization, Immunization Coverage Fact Sheet, 11 April

ally representative samples of health facilities.

Human Vaccines Journal, 01 March 2010, Volume 6, 2010 - Issue 3, Pages 270-278, Impact of Wastage on Single and Multi-dose Vaccine Vials: Implications for Introducing Pneumococcal Vaccines in Developing Countries, Divya Parmar, Elaine M. Baruwa, Patrick Zuber & Souleymane Kone.

Cost of goods sold and total cost of delivery for oral and parenteral vaccine packaging formats. Jeff Sedita, Stefanie Perrell, Matt Morio, Michael Berbari, Jui-Shan Hsu, Eugene Saxon, Courtney Jarrahan, Annie Rein-Weston, and Darin Zehrung. Vaccine. 2018 Mar 14; 36(12): 1700–1709.

The Lancet, 03 October 2015, Fiona Clark, Rise in Online Pharmacies Sees Counterfeit Drugs Go Global.

International Pharmaceutical Quality, Breakage and Particle Problems in Glass Vials and Syringes Spurring Industry Interest in Plastics, Aug 7, 2011.

International Pharmaceutical Quality, Sharp Uptick in Recalls for Glass Lamellae Problems Under Scrutiny, August 3rd, 2011.

Quartz, How this smart contraceptive design could liberate women in Africa, Tim Fernholz, July 25, 2014.

Information Packet #11: Recycling Is Business, by The Research Library for RCRA, US EPA-New England, Spring 1995: p. 89V-2 (p. 6 of PDF). EPA Publication # 901R95005.

US Energy Information Administration, Glass manufacturing is an energy-intensive industry mainly fueled by natural gas, August 21, 2013.

United States Department of Labor, Safety and Health Information Bulletins, Disposal of Contaminated Needles and Blood Tube Holders Used for Phlebotomy, 03-10-15.

PATH, The radically simple Uniject™ injection system <http://www.path.org/projects/uniject.php>

Drugs Real World Outcomes, 2015 Mar; 2(1): 43–52, January 29, 2015, Can a Compact Pre-Filled Auto-Disable Injection System (cPAD) Save Costs for DTP-HepB-Hib Vaccine as Compared with Single-Dose (SDV) and Multi-Dose Vials (MDV)? Evidence from Cambodia, Ghana, and Peru, Cyril Nogier, Patrick Hanlon, Karin Wiedenmayer, and Nicolas Maire.

Estimate updated from World Health Organization, 2011. World Health Statistics 2011 - Table 6: Health workforce, infrastructure and essential medicines.

WHO global database on maternal health indicators, 2017 update.

World Health Statistics 2017 report, page 29.

Dr. Henry Perry, senior scientist, Johns Hopkins Bloomberg School of Public Health, quoted p. 20 of One Million Community Health Workers Campaign's Annual Report 2014: Building Healthy Communities by Bringing CHWs to Scale (Published on Mar 12, 2015).

PwC, Fighting counterfeit pharmaceuticals: New defenses for an underestimated - and growing - menace, Peter Behner, Dr. Marie-Lyn Hecht, Dr. Fabian Wahl, June 29, 2017.

InSight Crime, Counterfeit Drugs Kill 1 Mn People Annually: Interpol, Natalie Southwick, Oct. 24, 2013.

US Energy Information Administration, Glass manufacturing is an energy-intensive industry mainly fueled by natural gas, August 21, 2013.

Business Wire, Collaboration Helps Broaden Access to Pfizer's Contraceptive, Sayana® Press (medroxyprogesterone acetate), for Women in Some of the World's Poorest Countries, May 8, 2017.

Pharmaceutical Online, Blow/Fill/Seal Technology Automates Aseptic Vaccine Packaging, Andy Goll, Weiler Engineering, October 3, 2016.

UN News, New UN report finds bulk of world's rural populations excluded from healthcare access, 27 April 2015

International Labor Organization, Global Evidence On Inequities in Rural Health Protection. New Data on Rural Deficits in Health Coverage for 174 Countries, Scheil-Adlung, X, 2015.

UNFPA, Family Planning [https://www.unfpa.org/family-](https://www.unfpa.org/family-planning)

planning.

Gavi, Inactivated Polio Vaccine Support, 22/03/2018.

Centers for Disease Control and Prevention, National Early-Season Flu Vaccination Coverage, United States, November 2017.

Vaccine, 2018 January 25; 36(4): 442–452, Pernille Jorgensen, Jolita Mereckiene, Suzanne Cotter, Kari Johansen, Svetla Tsolova, and Caroline Browna, How close are countries of the WHO European Region to achieving the goal of vaccinating 75% of key risk groups against influenza? Results from national surveys on seasonal influenza vaccination programmes, 2008/2009 to 2014/2015.

American Council on Science and Health, Influenza Vaccination Is Global But Not The Same, Chuck Dinerstein, February 2, 2018.

Natural Resources Available Today and in the Future (book), Dahlquist and Hellstrand, editors, published by Springer, June 14, 2017, p. 4.

Petsecure, A Guide to Worldwide Pet Ownership.

Walker Table Systems http://www.wdtablesystems.com/pjm-technology/Copybook_Vials_plastic_vs_glass.

Current Medical Research and Opinion, Volume 32, 2016 - Issue 1, Pages 177-181, 13 Nov 2015, Reaching more children with vaccines in developing countries: key challenges of innovation and delivery, Olga Popova, Patricia Ibarra de Palacios.

ScienceDirect, Volume 34, Issue 48, 21 November 2016, Pages 5984-5989, Chaevia Clendinen, Yapei Zhang, Rebecca N.Warburton, Donald W. Light, Manufacturing costs of HPV vaccines for developing countries.

BMC Infect Dis. 2017; 17: 779, 2017 December 19, Patrick G. Ilboudo and Jean-Bernard Le Gargasson, Delivery cost analysis of a reactive mass cholera vaccination campaign: a case study of Shanchol™ vaccine use in Lake Chilwa, Malawi.

Gavi, the Vaccine Alliance: Supply and Procurement Strategy 2016-20.

ScienceDirect, Volume 36, Issue 12, 14 March 2018, Pages 1700-1709, Jeff Sedita, Stefanie Perrella, Matt Morio, Michael Berbari, Jui-Shan Hsu, Eugene Saxon, Courtney Jarrahan, Annie Rein-Weston, Darin Zehrung, Cost of goods sold and total cost of delivery for oral and parenteral vaccine packaging formats.

Vaccine, 2017 Apr 19;35(17):2272-2278, Doses per vaccine vial container: An understated and underestimated driver of performance that needs more evidence, Heaton, Krudwig, Lorensen, Burgess, Cunningham, Steinglass.

The New England Journal of Medicine, Heat-Stable Carbocin versus Oxytocin to Prevent Hemorrhage after Vaginal Birth, Mariana Widmer, M.Sc., Gilda Piaggio, Ph.D., Thi M.H. Nguyen, Ph.D., Alfred Osoti, M.P.H., Olorunfemi O. Owa, M.D., Sujata Misra, M.D., Arri Coomarasamy, M.R.C.O.G., Hany Abdel-Aleem, M.D., Ashalata A. Mallapur, M.D., Zahida Qureshi, M.D., Pisake Lumbiganon, M.D., Archana B. Patel, Ph.D., et al., for the WHO CHAMPION Trial Group, June 27, 2018.

SF Gate, Kathleen Hennessey, Associated Press, Clinic's reused needles may have exposed 40,000 to hepatitis, HIV, March 6, 2008.

Vaccine Wastage Assessment, UNICEF, April 2010, Field assessment and observations from National stores and five selected states of India.

PATH, Increasing access to lifesaving vaccines, Dec. 2013.

PATH, A History of Vaccines, April 2015.

The Journal of the American Osteopathic Association, May 2018, Vol. 118, 311-320. Iatrogenic Hepatitis C Virus Transmission and Safe Injection Practices.

AIDS Committee of North Bay & Area, Theresa Boyle, Experts Warn Against Use of Multi-Dose Vials.

PATH, Challenges and Innovations in Vaccine Delivery, 10th Annual African Vaccinology Course (AAVC): Developing Vaccinology Expertise for Africa, 10–14 November 2014 Cape Town, South Africa, by Darin Zehrung, Senior Technical Officer and Portfolio Leader, Delivery Technologies, Vaccine and Pharmaceutical

Technologies Group, 13 November 2014.

WHO, WHO Activities on Injection Safety and Related Infection Control.

WSJ, Footage From 1976 Documents Discovery of Ebola Virus, Oct. 16, 2014.

WHO, Universal health coverage and health financing http://www.who.int/health_financing/universal_coverage_definition/en/

WHO, Health systems/equity, <http://www.who.int/healthsystems/topics/equity/en/>

The Independent, Worldwide 20% of Children Go Unvaccinated, Sarah Morrison, 21 April 2013 <https://www.independent.co.uk/life-style/health-and-families/health-news/worldwide-20-per-cent-of-children-go-unvaccinated-8581495.html>

UNICEF, The State of the World's Children <https://www.unicef.org/sowc05/english/poverty.html>

Missed opportunities and barriers for vaccination: A descriptive analysis of private and public health facilities in four African countries, Comfort Zuyali Olorunsaie, Margaret Shaw Langhamer, Aaron Stuart Wallace, Margaret Lyons Watkins, Global Immunization Division, Centers for Disease Control and Prevention; Emory University.

PATH, Reflections on Innovations in Global Health, The Radically Simple Uniject Device https://path.azureedge.net/media/documents/RMER_uniject.pdf

WHO, Safe Injection Global Network http://www.who.int/medical_devices/collaborations/network/en/

BD Medical - Pharmaceutical Systems, BD Uniject™ Prefillable Injection System Technical Manual, Edition 4, June 2009.

Rommelay Engineering <https://www.rommelay-engineering.com/en/info/aseptic-filling/>

Rommelay Engineering <https://www.rommelay-engineering.com/en/bfs/>

Immunization Action Coalition, Administering Vaccines, immunize.org/catg.d/p3085.pdf

Australian Diabetes Educators Association (ADEA), Clinical Guiding Principles for Subcutaneous Injection Technique, October 2015.

WHO, Bulletin of the World Health Organization 2011; 89:221-226. doi: 10.2471/BLT.10.079426, 05 January 2011, Intradermal delivery of vaccines: potential benefits and current challenges, JK Hickling, KR Jones, M Friede, D Zehrung, D Chen, D Kristensen.

World Health Organization, WHO Best Practices for Injections and Related Procedures Toolkit, March 2010. TechRadar, What is NFC? Everything you need to know, Cameron Faulkner May 09, 2017.

WHO, Effective Vaccine Management (EVM) Initiative http://www.who.int/immunization/programmes_systems/supply_chain/evm/en/

WHO, UNICEF, Achieving immunization targets with the comprehensive effective vaccine management (EVM) framework, March 2016.

<https://www.statista.com/topics/2256/it-industry-in-india/>

<http://www.forbesindia.com/article/leaderboard/indian-it-services-sector-time-for-a-reboot/49671/1>

<https://www.statista.com/statistics/628210/mhealth-services-and-devices-market-size-in-india/>

https://economictimes.indiatimes.com/articleshow/52048195.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

PATH, Pentavalent Vaccine in the Uniject™ Injection System: Health Care Waste Management Considerations, September 31 2014.

Delivery cost analysis of a reactive mass cholera vaccination campaign: a case study of Shanchol™ vaccine use in Lake Chilwa, Malawi. Patrick G. Ilboudo and Jean-Bernard Le Gargasson. BMC Infect Dis. 2017; 17: 779. December 19 2017. DTwP-HepB-Hib vaccine available in a compact, pre-filled auto-disable injection technology. UNICEF, Information

THE TEAM BEHIND APIJECT: Marc Koska and Jay Walker

MARC KOSKA, OBE, SOCIAL ENTREPRENEUR

The inventor of Apiject, the first BFS cPAD device, is Marc Koska, one of the world's most respected and successful social entrepreneurs.



In the mid-1980s, Mr. Koska invented the K1 Auto-Disable Syringe, a device that stops the spread of blood-borne disease and infection by making it impossible to reuse medical needles and syringes. In 2005 he founded the nonprofit SafePoint Trust to educate children about the danger of employing used needles. To date Marc's invention and leadership are estimated to have saved 10 million lives. In 2015, WHO Director

Dr. Margaret Chan announced a new global policy on injection safety, promoting auto-disable syringes. The K1 is now licensed by 14 global manufacturers. Among many other honors bestowed on Mr. Koska, he was made an Officer of the Order of the British Empire for his "contribution to global healthcare."

Email: marc@apiject.com

JAY WALKER, INVENTOR, ENTREPRENEUR

Jay Walker leads Apiject's technology efforts as well as its business and commercialization activities. He is best known as the Founder of Priceline and Curator of TEDMED.



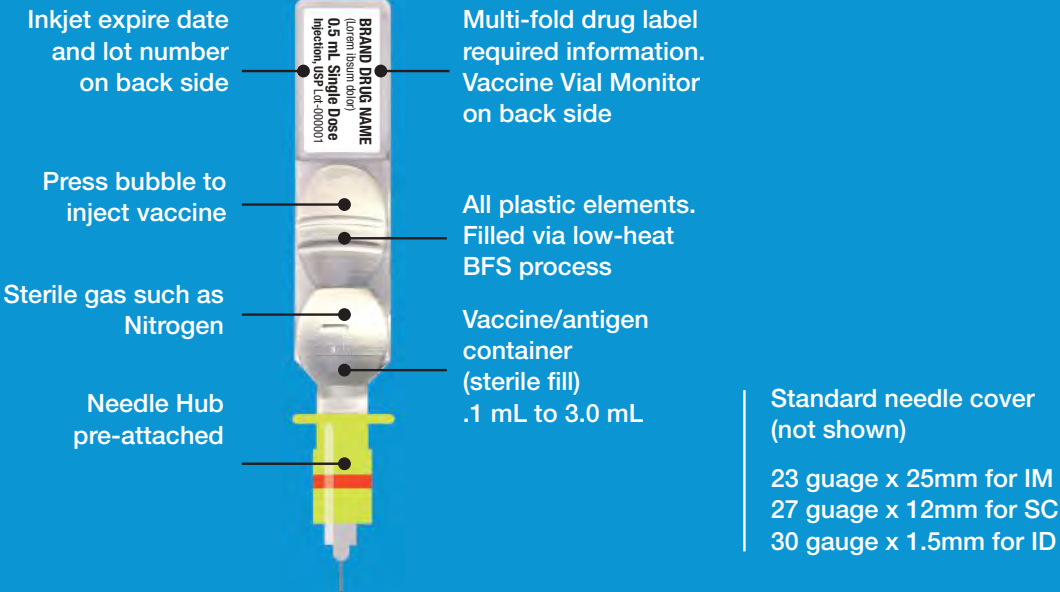
A serial entrepreneur, Mr. Walker has founded three companies that have gone from launch to 50 million customers each. Mr. Walker is the world's 10th most patented living inventor, with more than 750 issued US patents in technology-related fields. Active in the field of medicine since 2012, Mr. Walker serves as Chairman and Curator of TEDMED, the health and medicine edition of the world-famous TED conference.

He is also Chairman of Upside, a travel and technology company that serves the unmanaged business traveler. A passionate student and practitioner of imagination, Mr. Walker founded and curates the Library of the History of Human Imagination, which *Wired* magazine called "the most amazing private library in the world."

Email: jay@apiject.com

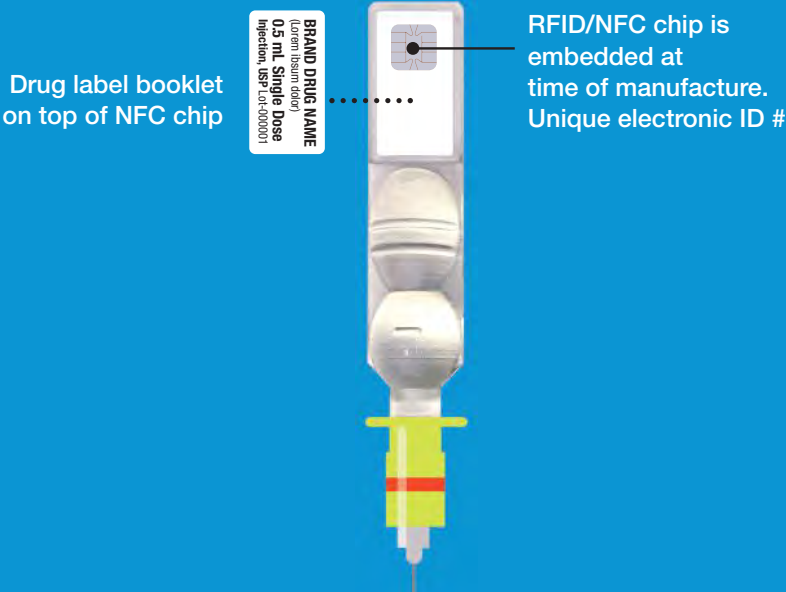
Phase 1 – BFS Container + Needle Hub

Factory pre-attached (actual size)



Phase 2 – BFS Container + Needle Hub + RFID/IoT

Factory pre-attached (actual size)



For more information, please send a note to info@apiject.com

