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Addressing Needle Dread, Fear, and Phobia 2023

History, Physiology, Trajectory, and Practical Considerations to Overcome Injection Hesitation

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Special Notes

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Abstract

Objective

To summarize the past 50 years of needle pain research, including the causes and consequences of needle phobia, the physiology of vasovagal syncope and its conflation with fear, and to discuss the impact of needle fear on adherence, with research-supported options to address injection reluctance and nonadherence.

Methods

All papers discussing needle fear for the past 50 years were identified with a PubMed search. In addition, bibliographies of reviews of needle fears were evaluated, as well as source documents of CDC vaccine schedules from inception in the US. The author's NIH research and presented publications at the 2019 American Academy of Allergy, Asthma & Immunology Annual Meeting, as well as published references on needle pain mitigation, were evaluated for relevance.

Summary

Needle fear correlates with a traumatic experience between age 4-7 years. The incidence began abruptly increasing in the US when multiple booster injections were introduced in 1982, peaking when the vaccine schedule included 36 separate injections in 2000. Consequently, contrary to conventional wisdom, the level of fear correlates with birth year rather than age. The overall percentage of patients expected to have needle fear can be roughly estimated based on the age of the target population. While overt phobia leading to nonadherence can be reduced to a manageable fear over time (approximately 3 experiences without pain), dread and fear reactions are the norm for all patients requiring periodic painful injections.

Vasovagal symptoms of lightheadedness, weakness, nausea, and syncope can be, but are not always, associated with anxiety. Patients may state they fear needles, when in fact they have a physiologic reaction that can be addressed without the need for a psychological intervention. Asking about fear responses directly does not increase them, and allows for a pain plan to mitigate the impact of needle fear on adherence.

Conclusion

Needle fear, phobia, and fainting are separate entities that are all increasing and quantifiable. Understanding the history leading to the development of fear, the interventions proven to reduce fear and pain, and the most effective ways to involve the patient in the process are all increasingly important parts of the successful adoption of any injected medication protocol.

Keywords

adherence, needle pain, needle fear, needle phobia, vasovagal syncope, BDRI, injectable

Background

Phobias are a part of the human experience. When a natural fear exceeds the actual threat, resulting in behavior that is NOT adaptive, the protective mechanism has progressed to become a phobia. While fears of the dark, spiders, and groups of people who are waiting for a speech have been with us since there WAS an "us," needles are something new. Penetration with sharp objects tends to be uncomfortable. For some, though, any procedure involving a needle comes with sufficient fear and anxiety that procedures are not done at all.

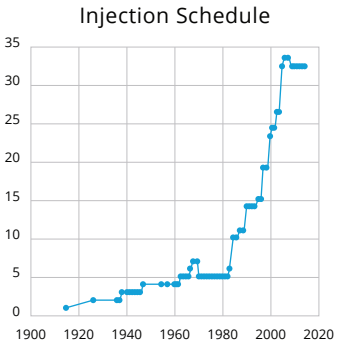
The official DSM-V diagnostic term "Blood-Injection-Injury phobia," is an extreme fear of medical procedures involving injections or needles. The spectrum beyond dislike to dread to fear to phobia, however, is not a straight continuum. In addition to the relative contribution of pain, an aversion to needle procedures is complicated by physiologic "vasovagal" fainting reactions that may be entirely uncoupled from fear. The purpose of this white paper is to give practical and evidence-based methods to cope with sharp stressors, predict the likelihood and timeframe of difficulty with injections or adherence, and provide a roadmap to create a patient support structure.

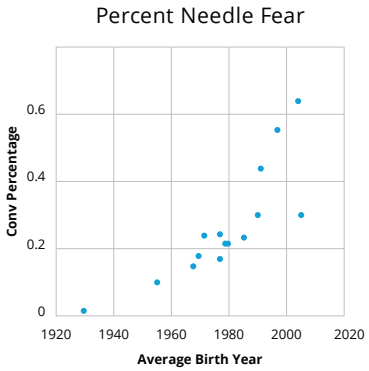
Unlike primordial fears of spiders, snakes, or the dark, the first cases of needle phobia could not have arisen before 1844, when the hollow metal needle was invented by Irish physician Francis Rynd. While "phobia" connotes wide-eyed screaming or running away, most needle fear, and most research, refers to a dislike coupled with avoidance.[1] While needle fatigue and dread may result from an accumulation of repeated painful injections, phobias tend to be classically conditioned with a single event. Like most phobias, the frightening or stressful event tends to be sandwiched early in life between the development of verbal memory around age 3 years, and the acquisition of abstract thought; retrospective interviews place needle fear around age 4-5 years of age.[2] Positive healthcare experiences during this window are critical, so that patients will accept future healthcare interventions.

Concern for pain in children too young to talk can last a lifetime: the effects of untreated pain are remembered even by preverbal children and may amplify with age.[3] Adolescents avoid medical treatment,[4, 5] almost 40% of adults refuse blood sampling, and adult patients refuse flu shots due to fear of needle pain.[6, 7]

The health implications of needle phobia extend beyond the affected individuals: HIV patients continued to infect others while delaying blood tests,[8] and potential blood donors in 16-75% of adults surveyed worldwide refused due to needle fear.[9, 10]

In 1995, James Hamilton, M.D., published one of the first papers evaluating the prevalence of needle fear and its effect on accessing healthcare. Based on previous studies and interviews, he concluded that the estimated fear of needles was 10% in adults and 25% in children.[2] By 2008, more thorough work examined competing theories about when and why the fear of needles developed.[11] A meta-analyses of needle fear in 2019 found a wide range of prevalence in studies. Rather than the general adult/child dichotomy, the study found a wide range of 10-50% in both adults and children.[12] The key to the puzzle lay in 2012 research studies completed half a continent away: both found an incidence in 10-year-olds of 63%, while one documented that fear in adults had bounced to 24%.[13, 14] This consistency and elevation was borne out in subsequent studies of patients of different ages. What happened to jump fear up 252% over Hamilton's findings?





Age group	% of population	# of needle fearing population
0-4	20M (Not counting)	
5-9	20M x 0.63 = 12.6	12.6M
10-19	40M x 0.63 = 25.2	25.2M
20-29	45M x 0.36 = 16.2	16.2M
30-39	42M x 0.24 = 10.08	10.08M
40-64	104M x 0.16 = 16.64	16.64M
65+	52M x 0.10 = 5.2	5.2M
Total	303M x 0.284 = 86	86M

- Lee VY, Caillaud C, Fong J, Edwards KM. Improving vaccine-related pain, distress or fear in healthy children and adolescents a systematic search of patient-focused interventions. Hum Vaccin Immunother. 2018;14(11):2737-2747 "CONCLUSION: Interventions using coolant and vibration together, as well as a combination ofsite-specific and patient-led interventions, showed the most consistent effects in reducing self-reported pain, fear or distress
- Ballard A Khadra C, Adler S, Doyon-Trottier E, Le May S. Efficacy of the Buzzy® Device for Pain Management during Needle-Related Procedures: A Systematic Review and Meta-analysis. Clin J Pain. 2019 Feb 28 (N=1138, pain reduction-1.11; 95% confidence interval [CI]: -1.52 to -0.70; P<0.0001), anxiety reduction(SMD -1.37; 95%CI: -1.77 to -0.96; P<0.00001)
- Redfern RE, MichamJ, Seegert S, Chen JT. Influencing Vaccinations: A Buzzy® Approach to Ease the Discomfort of a Needle Stick – a Prospective, Randomized Controlled Trial. Pain Management Nursing, 2019 Apr;20(2):164-169. (N=497 pain 0.87 v 1.12 p=.035, better than previous experiences 62% Buzzy® 23.9% controlp<.0001.)
- Sahin M. Effect of Buzzy® application on pain and injection satisfaction in adult patients receiving intramuscular injections. Pain Management Nurs 2018Dec:19(6):645. Diclofenac, (N=65, average age 52, Pain 74% reduced, satisfaction 95 v. 84. P<.001 both)
- Alshawan M. A Prospective comparison between skin cooling and skin vibration in reducing the pain of local anesthetic injection. J CosmetDermatol 2019 Sept 26 epub ahead of print. "Skin vibration may be more effective than skin cooling in alleviating the pain caused by local anesthetic infiltration. (Buzzy® without ice)."
- Russell K, Nicholson R, Naidu R. Reducing the pain of intramuscular benzathine penicillin injections in the rheumatic fever population of Counties ManukauDistrict Health Board. J PaediatrChild Health. 2014 Feb;50(2):112-7. [N=118, Nonadherent group, pain and fear reduced 50%, teens and adults]

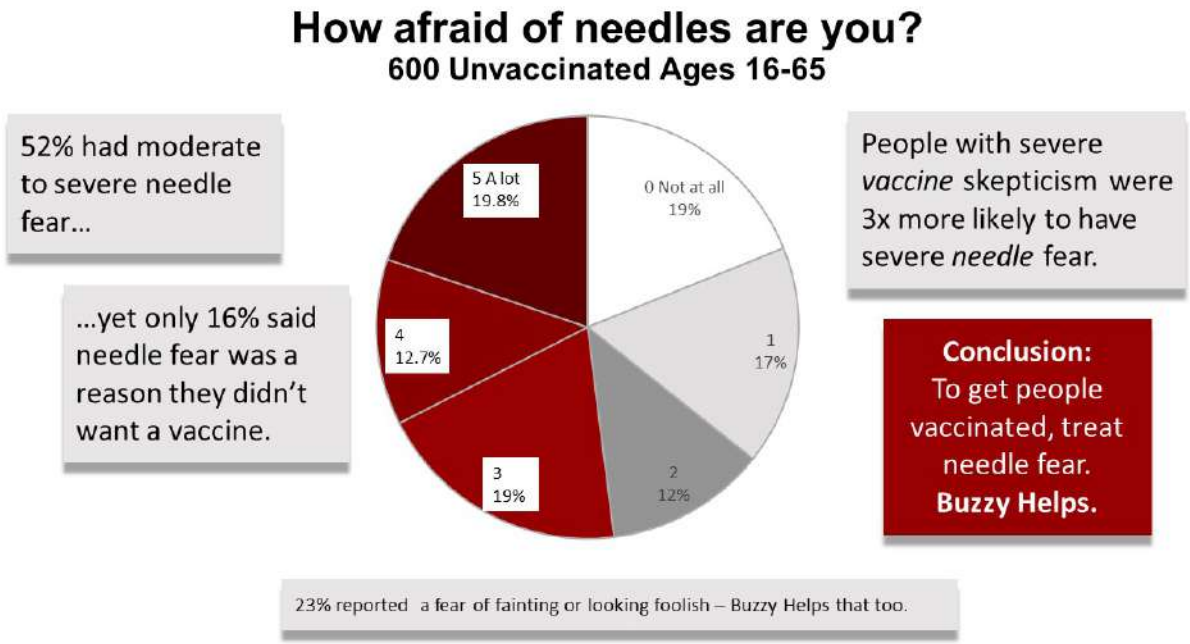
Figure 1. Scheduled by year in the USA (cdc.gov, Eliot J 1955) compared to reported needle fear in 18 studies from 1958-2015. Of 8459 subjects, 36% were under the age of 18, and average birth year ranged from 1931 to 2003. ©2020 Baxter AL info@paincarelabs.com

Causes and Consequences of Needle Fear

The key was not age, but birth year. A 2016 presentation analyzing needle fear noted a strong correlation (r = 0.86) between birth year and needle fear. More specifically, the correlation appeared to be related to the CDC vaccine schedule at the time of birth. When booster injections were added for children age 4-6 years, they remembered, and for some the fear persisted.

Pre-1983, children received only six shots before age six. Until vaccine boosters were introduced, these injections were given before age 2, thus before the advent of memory. When the vaccine history of the 2012 cohort of ten to twelve-year-olds' needle fear was evaluated, a strong correlation was noted between the number of four to six-year-old boosters given on the same day in a dose-dependent manner.[14]

The CDC-approved window for the boosters is the 4 year period inclusive between age 4 and the last day before the child's 7th birthday. For those in the study who received one injection with most pediatric visits, none were in the highest quartile of fear as adolescents. Interestingly, 9% of those who got at most two injections per visit and 26% of those who got three on one day during age four to six were in the highest quartile of needle fear. Of preschoolers who were given four or five injections on the same day, 50% were in the highest quartile of fear five years later. Moreover, all but 6 of 120 preteens stated some degree of fear, a hitherto unprecedented finding.



During COVID multiple investigators found previous needle fear correlated with reluctance to vaccinate. The survey phrasing impacted answers. (Fig. 2) Relevant to the findings of Baxter et al, in the UK 15% were estimated to avoid vaccination due to fear, while in the US it was 23% or higher. The US preschool vaccination schedule includes varicella, thus the most common number of injections is 4 rather than 3.

Figure 2. Pollfish Survey, Administered April 10, April 14 2020.

Patient Rituals and Repeated Medications

While research and the media focuses on needle phobia, there is a less drastic but equally draining phenomenon impacting people requiring frequent sharp procedures. “Needle fatigue” is different from fear or phobia. Externally patients exhibit no drama, or fainting, but internal low-intensity dread can delay administration of medicines for days. Needle fatigue is less of an “oh, no!” and more of a “not again.”

Research showed 94% of insulin pump users still had physiologic fear symptoms with each insertion.[15] Ongoing fight or flight responses like increased heart rate, blood pressure, and cortisol release can burn patients out, even when the mind is willing.

“Ongoing fight or flight responses like increased heart rate, blood pressure, and cortisol release can burn patients out, even when the mind is willing.”

In some patients, needle fatigue can lead to nonadherence to a treatment plan. Nonadherence increases healthcare costs, outpatient visits, disease complications, and in extreme cases, the likelihood of death.[16] Obviously, many factors contribute to nonadherence beyond the needle— transportation, cost, schedule, comprehension of medication timing, side effects, trust in the medical system, cultural acceptance of a treatment plan.

As researchers have determined, even the needles are not exclusively to blame for needle fatigue. The entire process, from the start of showing symptoms to learning about self-injection to finding a medication that works, is an exhausting experience. Emotional resentment of doctors or the disease itself, rotating between new medications, and trial and error of medicine administration all contribute to a suboptimal experience and could lead to quitting a medication altogether.

The opportunities to intervene and improve the patient’s journey begin even before the diagnosis is verified, when the patient does not know the right questions to ask.

Over time, patients develop elaborate rituals to take medications that are especially challenging. These include medications that are more painful or time consuming, risk systemic after-effects, or require multiple or large-bore delivery needles.

When medications become less painful, the need for rituals can disappear. “Before they took the citrate out of Humira, I had an elaborate plan. I’d take a bath, get a glass of red wine, get my music queued up, and call my friend in California who was doing the same thing. She’d listen to my music, and at the same time we’d count down and give it together. Once the shot didn’t burn anymore, I could just do it anywhere, anytime.” Patient Advocate, Rheumatoid Arthritis.

Vasovagal Syncope

Fainting because of an injection is much more likely to be a physical, not a psychological, response. Feeling nauseated, light-headed, or faint when poked with a needle is often due to a biological feedback loop reaction called vasovagal syncope.

This response is 70% inherited.[17] It is a physiologic, genetic predisposition. If someone who has a severe physical response to blood or needles faints, they often have a parent or relative who does the same. While 3 to 5% of the population has a genetic predisposition to the condition, only 0.1 to 0.3% actually faint. These factors increase the likelihood of losing consciousness: being female, having low body weight, or already having low blood pressure.[18] While vasovagal syncope does not necessarily result from needle phobia or vice versa, the two conditions potentiate each other.

Of those with vasovagal syncope, 47.9% are reported to be afraid of needles.(19) "Vaso" refers to the large vessels in the legs which dilate, dropping the pressure and quantity of blood flowing to the brain. "Vagal," from the same Latin root as "vagabond," refers to the Vagus nerve, a part of the parasympathetic system designed to lower blood pressure after an injury. Recent research from the CDC found that severe vasovagal symptoms with adolescent injections were 25% less common when a vibrating ice pack (Buzzy®) that may mimic a sympathetic response was used.(20)

"While vasovagal syncope does not necessarily result from needle phobia or vice versa, the two conditions potentiate each other."

Because the vagus nerve wraps around veins, needles inserted superficially or tattoos may not evoke the response, while even a painless venous access procedure does.

With fear symptoms, the vagus nerve is more active and more likely to drop blood pressure, thus increasing the chances of a loss of consciousness. Those with vasovagal syncope should let their healthcare professionals know about their condition so they can be prepared in case of fainting.

Interventions that reduce anxiety can thus reduce reactions to needles. In addition, sympathetic stimuli, like caffeine or physical activity, can reduce the severity of reactions. The most studied and effective long term intervention is learning physical interventions that mechanically push more blood to the brain. These include lifting a knee, tensing stomach muscles, or taking a deep breath and bearing down.

Psychological interventions, extinction therapy, and other interventions effective for phobias like flying or spiders were not found to have long term benefit, most likely due to the physiologic rather than psychological source.[20]

Needle-Free Interventions and Fear

In an effort to reduce the nonadherence associated with needle fear, some technologies remove the needle entirely. The concept of propelling a jet of liquid through the skin began accidentally after a 1937 report in JAMA. Injection of grease resulted in skin penetration (and subsequent loss of a hand), but provided proof of concept. In the 50's and 60s inventors developed jet techniques to improve the speed of vaccination. Dr. Robert Hingson's "Hingson Peace Gun" sped the administration of smallpox vaccination.[21] While the devices simplified the administration and obviated the need for waste disposal, they didn't reduce the pain. They were broadly adapted in the military until a mass transmission of hepatitis C brought the practice to an end.

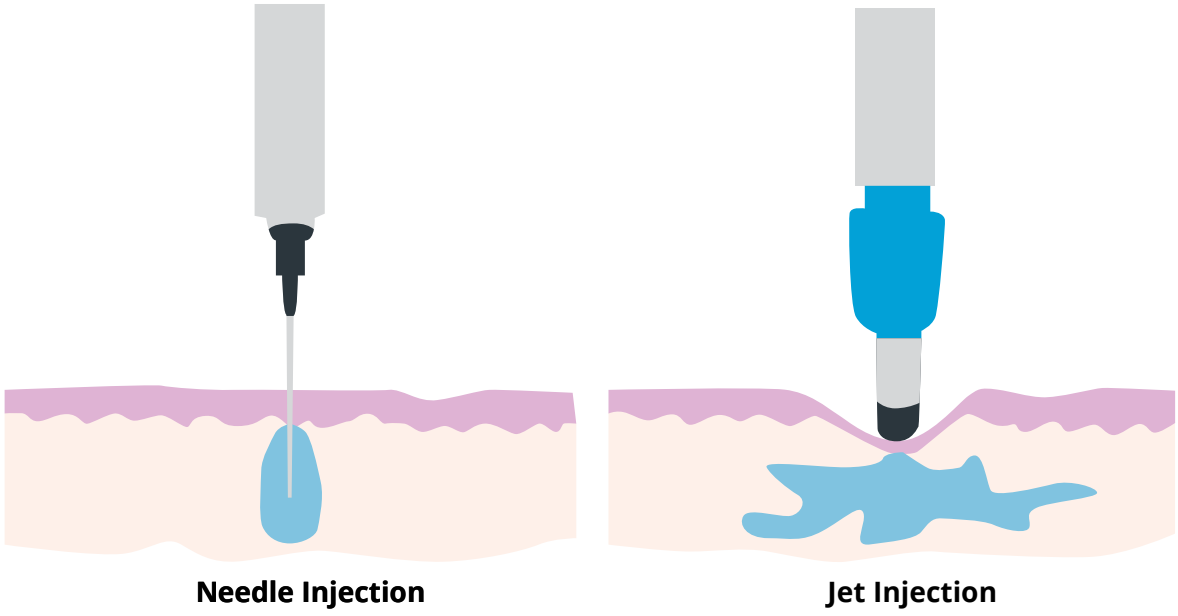


Figure 3. Needle injection vs. jet injection

The increase in needle fear and concerns with accidental needle sticks in healthcare workers have led to a recent resurgence of interest in needle free administration. Microneedles combine thin tubules capable of administering vaccines and medications painlessly in the form of a patch.

While multiple needle-free administration projects assume the removal of a needle will remove the fear, research has not borne this out. With the exception of a large prospective trial of insulin administration in China, jet injection of vaccines and medications shows no reduction in anxiety.[22, 23] One caveat is that the vaccine schedule in China didn't include 4-6 year boosters until 2008. Consequently, the percentage of patients fearing needles in China likely has a lower baseline than in other countries that adopted the Western vaccine schedule sooner.

For those already afraid, the likelihood is that the process and anticipation figure more prominently in the process than the actual visualization of a needle. Jet injectors for home use often involve complication, ramping up the time period for fear and the focus on the process. In contrast, auto-injectors that make it easier to administer an injection without having to think about the process show better results.[22].

Needle Technology and Pain

While multiple needle manufacturers have attempted to innovate with the needle itself, the outsized impact of fear negates minor improvements from bevel, coating, or gauge changes. Much of the difficulty in studying pain impact comes from the barriers recruiting needle phobic patients to a study requiring multiple needle sticks. While a cohort who is willing to thoughtfully focus on the degree of pain from a 5-sided needle versus a traditional hypodermic may perceive a difference, the nuance is lost on patients whose pain perception is coming from the brain, not the skin.[24]

Pain increases logarithmically with the number of attempts. For this reason, interventions that improve the success rate can substantially reduce pain. However, the introduction of technology for difficult IV access itself is difficult to study - the incidence of a hard to access individual is small enough to make recruitment for such studies prone to subjective bias.

Aspects of pH, viscosity, speed of injection and volume contribute more to the pain of an injectate than the engineering of the needle.[25, 26] The development of auto-injectors calibrated to these considerations and able to be controlled somewhat by the patients are more likely to improve the patient experience.

Physiology/Fear/Control Construct

The brain's perception of pain is tied intimately to risk assessment. Athletes will tolerate a degree of pain in order to win that, in the absence of competition, would be intolerable. A needle fearing patient may initially use a pain-reducing intervention, but as the pain quantity becomes better known and the fear is lessened due to familiarity, they may be less invested in complicated rituals or interventions. Contrariwise, an extremely painful injection may lead to increased fear over time. Patient control impacts fear and pain significantly. Experimentally, pain that can be stopped the moment a subject asks is rated as more tolerable than the same stimuli with no control.

When a patient is in control, simply reducing pain may be sufficient. However, when anxiety is present in any degree, improving fear while addressing pain is integral. One strong method to reduce pain and fear is task-driven distraction. Immersive Virtual Reality (IVR) can require interpretation and change in focus for both adult and pediatric patients, allowing even severely painful procedures to be completed. As David Patterson and Hunter Hoffman demonstrated with their "Snow World," passive viewing of the environment was not as effective at reducing pain as blinking to shoot snowballs.[27]

For needle fear, the combination of a vibrating unit and cold for pain is as effective as the distraction of virtual reality.[28] Adding distraction further enhances pain relief, and can be as simple as asking decision-making questions about pictures. In general, distraction can reduce pain 50%. When added to pain reduction, the pain is reduced 88%. This "Physiology/Fear/Control" construct is a critical part of any adherence plan in patients who express a concern about needle pain.[29]

Figure 4. XX

Creating a Needle Fear Intervention Through Pain Reduction

Creating a plan to address needle fear begins with assessment. Chris France PhD, in part of his groundbreaking work on responses to blood donation, found that simply asking "are you afraid of blood coming out of your arm?"[19] had no increasing effect on the incidence of vasovagal symptoms. While not significant, the study of over 1000 blood donors found those asked the question were less likely to experience faintness rather than more. He hypothesized that bringing up the subject may increase the opportunity for dialogue and preventive measures. Likewise, Schiff's research on the consequences of nonadherence showed that patients who were more likely to have poor experiences with needle adherence noted they felt they had not asked enough questions, did not understand enough about the process, and were not sufficiently informed about the medication options and side effects.

"The concepts of control and empowerment through knowledge figure strongly into adherence."

The concepts of control and empowerment through knowledge figure strongly into adherence. Two of the largest complaints from rheumatology patients were that they did not get enough choice and education about their new medicine. While insurance companies play a large part in what treatment a patient receives, giving patients some choice in medications can help patients feel more in control of their new diagnosis. All treatment options should be explained thoroughly, including how they are administered, how long it takes to see results, possible side effects, and a realistic expectation of site reactions so they can make complete, informed decisions.

Patients are less satisfied when they are told to learn from a booklet, rather than being shown and taught the administration process. Self-injecting and maintaining a medical routine are best learned by guided "doing," not reading or hearing. By doing the first injection with the patients, including adequate description and instruction, patients will feel more self-assured to do it themselves the next time. While educating patients on their new treatment, providers should inform them on common mistakes and explain what it looks and feels like when the medicine is administered improperly, so that use errors do not become habituated.

For many patients, the stinging or burning of the medication is worse than the needle.[30] To prevent patients from going through a lengthy trial-and-error process, instructions that first assess where patients are, then coach patients to come up with a routine with examples may be the most effective. While there still may be some trial-and-error for the patients, this learn-by-doing approach can help smooth the transition to incorporate their new treatment plan into their daily lives.

Introducing a Needle Fear Friendly Intervention

After identifying that a patient is concerned about needle fear, there are multiple modalities to offer for pain management. Allowing patients to choose their pain management option as needed may be sufficient to support success.

The table below illustrates the relative merits - including efficacy, cost, time, and clinical support - of available injection pain relief measures. Currently there is only one proven over the counter distraction intervention specifically for needle pain (DistrACTION® Cards, Pain Care Labs, Atlanta GA)

The empowered patient will be involved in selecting the best option to promote a successful injection protocol, addressing PAIN, rituals, contexts, rewards and interventions to reduce FEAR, and physical, mental, visual, and sensory interventions to relieve the FOCUS from pain. For the patient prescribed multiple or chronic injections, the good news is that with advanced planning and the patience for trial and error, needle fear will reduce over time, making the process not only bearable but routine.

Each * indicates one peer reviewed publication for the procedure indicated with statistically improved outcomes compared to control. X is trials without improvement compared to intervention or no intervention, + is each trial with equivalent outcome compared to another intervention.

Pain Reliever	Cost/ home use $USD	Prep time	Ease of use	Duration	Pain Relief	RCTs IVs*	RCTs for injections*	Head to head
Buzzy® high frequency mechanical stim, Ice	$0.20	1 min	****	1 min	****	******* ******* ******* ****++X	***** ***** *+	Potts: LMX = Buzzy® for IV; Canbulat: Buzzy® > Shotblocker IM
DistrACTION® Cards	$0.01	10 sec	*****	n/a	***	****	n/a	97% say better phlebotomy experience(11)
EMLA®- Eutectic mixture local anesthetics	$6.00	60 min	*	2 hours	***	****** ****** ****** **+	X*	Vasoconstricts until 90 min; Emla> Buzzy® for IV <6 year olds
LMX-4® - liposomal 4% lidocaine formulation	$4.00	20 min	**	20 min	***	****** ***++		Try Glad Press-n-Seal instead of Tegaderm for comfort(13)
Ice Pack	$0.10	1 min	***	30 seconds	**		**	
Shotblocker® - plastic with prongs	$0.05	1 min	***	0 seconds	**		*+XXX	SB = Buzzy® for insulin; SB < Buzzy® vaccines

Table 1. XX

References

1. Kleinknecht RA. Acquisition of blood, injury, and needle fears and phobias. Behav Res Ther. 1994 Nov;32(8):817-23.
2. Hamilton JG. Needle phobia: a neglected diagnosis. J Fam Pract. 1995 Aug;41(2):169-75.
3. Taddio A, Katz J, Ilersich AL, Koren G. Effect of neonatal circumcision on pain response during subsequent routine vaccination. Lancet. 1997 Mar 1;349(9052):599-603.
4. Vika M, Raadal M, Skaret E, Kvale G. Dental and medical injections: prevalence of self-reported problems among 18-yr-old subjects in Norway. Eur J Oral Sci. 2006 Apr;114(2):122-7.
5. Clark SJ, Cowan AE, Filipp SL, Fisher AM, Stokley S. Understanding Non-Completion of the Human Papillomavirus Vaccine Series: Parent-Reported Reasons for Why Adolescents Might Not Receive Additional Doses, United States, 2012. Public health reports (Washington, DC : 1974). 2016 May-Jun;131(3):390-5.
6. Corp T. Target Survey Shows Adult Americans May Avoid the Flu Shot Due to Fear of Needles. online suvey; 2012.
7. Allsup SJ, Gosney MA. Difficulties of recruitment for a randomized controlled trial involving influenza vaccination in healthy older people. Gerontology. 2002 May-Jun;48(3):170-3.
8. Spielberg F, Branson BM, Goldbaum GM, et al. Overcoming barriers to HIV testing: preferences for new strategies among clients of a needle exchange, a sexually transmitted disease clinic, and sex venues for men who have sex with men. J Acquir Immune Defic Syndr. 2003 Mar 1;32(3):318-27.
9. Harrington M, Sweeney MR, Bailie K, et al. What would encourage blood donation in Ireland? Vox Sang. 2007 May;92(4):361-7.
10. Wiwanitkit V. Knowledge about blood donation among a sample of Thai university students. Vox Sang. 2002 Aug;83(2):97-9.
11. Kennedy RM, Luhmann J, Zempsky WT. Clinical implications of unmanaged needle-insertion pain and distress in children. Pediatrics. 2008 Nov;122 Suppl 3:S130-3.
12. McLenon J, Rogers MAM. The fear of needles: A systematic review and meta-analysis. Journal of advanced nursing. 2019 Jan;75(1):30-42.
13. Taddio A, Ipp M, Thivakaran S, et al. Survey of the prevalence of immunization non-compliance due to needle fears in children and adults. Vaccine. 2012 Jul 6;30(32):4807-12.
14. Baxter AL, Cohen LL, Burton M, Mohammed A, Lawson ML. The number of injected same-day preschool vaccines relates to preadolescent needle fear and HPV uptake. Vaccine. 2017 Jul 24;35(33):4213-9.
15. Kruger DF, LaRue S, Estepa P. Recognition of and steps to mitigate anxiety and fear of pain in injectable diabetes treatment. Diabetes, metabolic syndrome and obesity : targets and therapy. 2015;8:49-56.
16. Schiff M, Saunderson S, Mountian I, Hartley P. Chronic Disease and Self-Injection: Ethnographic Investigations into the Patient Experience During Treatment. Rheumatology and therapy. 2017 Dec;4(2):445-63.

17. Sheldon RS, Sandhu RK. The Search for the Genes of Vasovagal Syncope. Frontiers in cardiovascular medicine. 2019;6:175.
18. Deveau AP, Sheldon R, Maxey C, Ritchie D, Doucette S, Parkash R. Sex Differences in Vasovagal Syncope: A Post Hoc Analysis of the Prevention of Syncope Trials (POST) I and II. The Canadian journal of cardiology. 2020 Jan;36(1):79-83.
19. France CR, France JL, Kowalsky JM, et al. Assessment of donor fear enhances prediction of presyncopal symptoms among volunteer blood donors. Transfusion. 2012 Feb;52(2):375-80.
20. Smith M, Walter EB et al. Preventing Post-Vaccination Presyncope and Syncope in Adolescents Using Simple, Clinic-based Interventions. 2023 Pediatric Academic Soc. Washington, DC. (A)
21. Hingson RA. The development of the hypospray for parenteral therapy by jet injection. Anesthesiology. 1949 Jan;10(1):66-75.
22. Andre AD, Brand-Schieber E, Ramirez M, Munjal S, Kumar R. Subcutaneous sumatriptan delivery devices: comparative ease of use and preference among migraineurs. Patient preference and adherence. 2017;11:121-9.
23. Guo L, Xiao X, Sun X, Qi C. Comparison of jet injector and insulin pen in controlling plasma glucose and insulin concentrations in type 2 diabetic patients. Medicine. 2017 Jan;96(1):e5482.
24. Beirne PV, Hennessy S, Cadogan SL, Shiely F, Fitzgerald T, MacLeod F. Needle size for vaccination procedures in children and adolescents. The Cochrane database of systematic reviews. 2015 Jun 18(6):Cd010720.
25. Hirsch L, Gibney M, Berube J, Manocchio J. Impact of a modified needle tip geometry on penetration force as well as acceptability, preference, and perceived pain in subjects with diabetes. Journal of diabetes science and technology. 2012 Mar 1;6(2):328-35.
26. Gibney MA, Fitz-Patrick D, Klonoff DC, et al. User experiences with second-generation 32-gauge × 4 mm vs. thinner comparator pen needles: prospective randomized trial. Current medical research and opinion. 2020 Oct;36(10):1591-600.
27. Hoffman HG, Chambers GT, Meyer WJ, 3rd, et al. Virtual reality as an adjunctive non-pharmacologic analgesic for acute burn pain during medical procedures. Ann Behav Med. 2011 Apr;41(2):183-91.
28. Gerçeker G, Binay Ş, Bilsin E, Kahraman A, Yılmaz HB. Effects of Virtual Reality and External Cold and Vibration on Pain in 7- to 12-Year-Old Children During Phlebotomy: A Randomized Controlled Trial. J Perianesth Nurs. 2018 Dec;33(6):981-9.
29. Baxter L. Common office procedures and analgesia considerations. Pediatric clinics of North America. 2013 Oct;60(5):1163-83.
30. Sørensen K, Skirbekk H, Kvarstein G, Wøien H. Children's fear of needle injections: a qualitative study of training sessions for children with rheumatic diseases before home administration. Pediatric rheumatology online journal. 2020 Feb 7;18(1):13.

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Not all treatments or supplements are appropriate for all pain conditions. This list contains evidence-based interventions and physical therapy options evaluated by Pain Care Labs which may not be appropriate for every pain condition. Check with your physician to determine optimal recommendations.

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