# An Insight into Patient Usability Preferences for Injection Devices

#### Natalie SHORTT

Medical Device Usability Ltd, United Kingdom

**Abstract.** There is little early-stage usability research into the factors that drive patient preference for injection device design. This study aimed to gain insight into patient preferences and underlying drivers in relation to the user-interface for self-injection devices. 128 patients across the US and UK answered dichotomous questions and gave reasons for each choice. An inductive analysis was performed; clear trends emerged in the data, which could aid in heuristic analysis and usability goals for injection device design concepts.

Keywords. Healthcare, Usability, Concept-Design, injection-devices

#### 1. Introduction

Mainstream administration of injected medication has been practiced for near a century, as the anniversary of the invention of insulin draws near (discovered 1921). The design of the syringe and the injection devices that have since followed have had few usability-orientated enhancements, however modern technology has lent its hand to the improvement of safety of medical devices. In turn patients are allowed more independence. This advance in technology has meant a shift in the primary user from a trained professional to... anyone at all. Usability testing provides evidence that the risk associated with use is reduced to a residual level.

The World Health Organisation (2003) found adherence for long-term chronic illnesses in developed countries averaged at 50%. Some of the main self-reported barriers to medication adherence included; 'a lack of perceived need', 'experiencing an adverse event' and 'injection concerns' (Spain et al., 2016). Injection concerns included aversion to needles, needle size and pain, and these concerns can be addressed directly through a usability engineering process applied from conception to materialisation of a device. Research has previously been conducted into the usability of injection devices, however this lacks a focus on patients: Published research is often sponsored by manufacturers to specifically evaluate their own devices (Aronson et al., 2013), or is funded to determine what injection device would complement a particular medication (Demary et al., 2014. Roth et al., 2015). Usability testing to evaluate a complete product is too late, as formative usability testing 'should begin early and continue iteratively' (62366-1:2015) through medical device design.

Some manufacturers appear to believe that 'the needs of the patient do not originate from the patient themselves' but are 'better articulated through a hierarchy of health professionals' (Money et al., 2011). Patient reported outcomes (PROs) are taken into consideration after release, which not only risks a costly mistake, but is also a potentially damaging experience for the device users themselves.

From an ergonomic perspective, it is necessary to incorporate a 'human factor' into the design of injection devices i.e. to include the intended user and avoid the five fundamental fallacies of ergonomics (Pheasant & Haslegrave, 2005). There is a view in industry that 'every person approached for feedback has a different view' (Money et al., 2011), giving rise to a culture where talking to patients seems like a pointless endeavour. This culture is detrimental to the safety, comfort and efficiency of medical devices use by patients. This research aims to provide new insights into what usability features patients prefer, and what drives these preferences. Ultimately, this study seeks to advance the theoretical knowledge of usability of injection devices when the intended user is the patient themselves.

# 2. Methodology

## 2.1 Methods applied prior to data collection

Participants were approached after participating in other usability studies. They were asked if they would be happy to complete an optional questionnaire as a separate piece of research. The inclusion criteria for participation was to have a condition where it was possible to be prescribed or were already prescribed self-injected medication. If a participant did not have a qualifying medical condition, then they were excluded.

The questionnaire was designed to capture participant preferences for a series of design and aesthetic features that contribute to an injection device's user interface. Dichotomous questions were used, e.g. 'Would you prefer an injection device to be silent or to make a sound?' Profiling data was also captured for each participant. The design features chosen were done so based on their relevance to the usability of the user interface. These features cover usability (size of device, audible feedback and speed of injection) and features that could influence psychological reception of an injection device (needle visibility and aesthetics). Participants were also given the opportunity to write a brief explanation for each preference chosen. This was to gather insight into what drove the patient's preferences.

#### 2.2 Methods applied to data analysis

A mixed methodology was applied. Trends were first identified in quantitative data and then qualitative data was analysed to identify underlying drivers.

Each dichotomous question was analysed using an inductive approach (Thomas, 2006); the research objectives were defined as; 'to understand why patients prefer the design features that they do', and 'to determine if participant's preferences were driven by the same motivations'. Research findings emerged from the most frequent trends that addressed the research objectives. As usability testing seeks to understand the user's perspective, using the most frequent trends as opposed to the analyst's interpretation meant that the participants' views led the findings. These frequent trends were grouped together as general (upper-level) categories. The categories were refined into specific (lower-level) categories.

## 3. Results

## 3.1 Profile of patients

128 participants completed the questionnaire, 97 in the United Kingdom (UK) and 31 from the United States of America (USA). A profile of the sample is displayed in Table 1.

Characteristic	Profile of Participants (n=128)			
Age (years)	Mean = 51.9			
	Range = 18 - 80			
Sex	Male = 39 Female = 89			
Injection experience	Currently self-inject = 42			
	Previously injected but not currently = 23			
	Injection naïve = 59			
	Did not answer the question $= 4$			
Disease profile	Diagnosis of Rheumatoid Arthritis (n = 104)			
	Diagnosis of Crohn's Disease (n=8)			
	Diagnosis of Ankylosing Spondylitis (n=8)			
	Diagnosis of Psoriatic Arthritis (n=8)			

Table 1 Participant Profile

There was a similar number of participants that were injection na $\ddot{v}e$  (59/128) and injection experienced (65/128).

## 3.2 Trends in data

The data in Table 1 shows the number of participants who chose each option. Despite being asked to select one option some participants wrote 'no preference' or did not answer. These data points were not included in Table 1.

When asked if they would prefer to see the needle, 71/128 participants said they would prefer to see the needle in advance of the injection; however 67/128 said they would prefer not to see the needle during insertion.

106 upper-level categories were established and then condensed. The resulting lower-level categories were accepted as representing participant drivers of preference. Table 2 displays each dichotomous question and the accompanying lower-level categories. The categories are organised in descending order, starting with the most prevalent on the left. **Note:** Participant responses could be represented multiple times, as one answer may be interpreted in multiple ways. This meant that the total number of data-points in a category is not necessarily 128.

Question	Lower-level Categories identified from analysis of the qualitative data					
	←Strongest tr	rend (%*	of responses)	Weakest trend $\rightarrow$		
See or not see the needle prior to insertion?	Correct Injection Technique (29.8)	Reducing Worry (23.6)	Ability to Brace Themselves (for injection) (22.4)	Fear (16.8)	Disliking Injections (7.5)	
Inject yourself or be injected by someone else?	Freedom (39.2)	Confidence to inject (30.1)	Lack of confidence to inject (13.1)	Own level of experience (12.4)	Squeamishness (5.2)	
See or not see the needle during insertion?	Correct Injection Technique (27.1)	Ability to Brace Themselves (for injection) (19.5)	Disliking Injections (18.8)	Reducing Worry (15.8)	Fear (14.3)	
Plain coloured device or a brightly coloured device?	Rational thinking (45.7)	Reducing Anxiety (25.7)	Improving Device Safety (16.2)	Aesthetics (12.4)	None	
Small or large?	Practicality (37.4)	Usability (35.1)	Perception (13.7)	Health (6.1)	None	
A silent device or a device that makes a sound?	Support (from device) (68.8)	Reducing Anxiety (16.5)	Reducing Irritation (8.3)	Noise being perceived as a tertiary feature (6.4)	None	
Look like a medical or a consumer device?	Grounded Thinking (40.7)	Peace of Mind (35.4)	Self-consciousness (23.9)	None	None	
Quick injection or slow injection?	Reduction of Time taken (63.3)	Reduction of Pain (Draw, 16.7)	Increasing Skill	Fear (3.3)	None	

Table 2 Lower-level categories identified in the Qualitative data

\*Totals may not be 100% due to rounding

Raw data files were exclusively categorised within the dichotomous question they were in response to. The rule that describes low-level categories is: the title should answer the question 'what drives patient preferences? – (Insert category title).' The format would be as follows - 'What drives patient preferences? – Correct Injection Technique'.

## 4. Discussion

Despite the features participants preferred, participants shared similar drivers, contrary to the belief each patient will provide different responses if asked for feedback (Money et al., 2011). The strongest drivers show participants recognise the responsibility associated with self-injecting (correct injection technique, rational and grounded thinking), usability (practicality and support from device) and personal well-being (freedom). 'Reduction of time taken' was the strongest category, however the response (or some variant) was 'to get it over with quickly.' (64/76). This response is too vague to identify the true driver. It is clear that participants want injections to be completed quickly, however there is a wide array of potential reasons – fear of needles or a busy lifestyle, for instance.

The categories were cross-analysed to search for links between drivers across participants. Three links were established amongst the lower-level categories. Categories suggested participants either wanted to achieve a positive outcome (for example to gain peace of mind), to avoid a negative outcome (fear of pain would be described as avoiding the pain – pain being a negative outcome of injecting) or had reasons that were neutral (i.e. neither positive nor negative).

'Positive' categories are considered as conveying positivity towards self-injecting – for example, 'freedom' which would in turn improve the overall injecting experience. Negative categories suggested participant's preferences were driven by negative preconceptions of injecting. The preferences with negative drivers also reduced the amount of interaction the participant would have with the device (18 participants would rather a silent device because a sound would cause anxiety – auditory feedback would be an interaction between the device and user). 'Neutral' categories are linked together by being neither 'positive' nor 'negative'.

All the 'Negative' categories tend to refer to a person's individual perspective of injecting, such as fears of needles and lack of self-confidence, whereas the 'Positive' and 'Neutral' categories tend to focus on improving usability.

'Reducing anxiety' was included in 'Positive' when referring to the colour of the device, but 'Negative' when referring to 'sound or silence'. The category can be argued to comply with the rules of both links when altering the context.

## 4.1 A Positive Outlook on the injection process

The positivity link connected 17/32 categories, which are outlined below in Table 3. The positivity link connects the most categories, suggesting participants were prioritising the usability of an injection device over their own desires.

Table 3 Categories linked by 'Positivity'

Categories that could be considered as contributing to a 'Positive Outlook' Correct injection technique (x2), reducing worry (x2), freedom, confidence to inject, reducing anxiety, improving device safety, practicality, usability, health, support (from Categories that could be considered as contributing to a 'Positive Outlook' device), reducing irritation, peace of mind, reduction of time taken, reduction of pain and increasing skill

Alternatively, it suggests that participants own desires were harmonised with usability, which is supported by the profiling data. 68/128 participants were relaxed towards needles whilst the next greatest attitude was 'dislike needles' (33/128). Without a fear or dislike towards needles participants may be more driven towards improving the injection process. An example of linking categories through 'Positivity' would be to take some categories and interpreting them, as so: 'support from device', 'freedom', 'correct injection technique' and 'improving device safety'. 'Freedom' has connotations of a better quality of life than someone who is trapped, whilst the other three categories can be recognised as participant's idea of a usable device: to be able to 'inject correctly' with a 'safe device' that provides 'support' in the form of feedback. If the participants had a device that met this criteria, participants would choose to self-inject, and the new-found 'freedom' would improve their quality of life. Less described by participants were reasons based on emotion (categories such as reducing worry, aesthetics), however those categories still show participants trying to improve the injection experience. Some drivers/categories are measured during the usability testing process, such as device safety.

## 4.2 A Negative Perspective on injection devices

Eleven categories were linked by the 'Negative Perspective' of injection devices, as described in Table 4.

## Table 4 Categories linked by 'Pessimism'

Categories that could be considered as contributing to a 'Negative Perspective' To Brace (x2), fear (x2), disliking injections (x2), lack of confidence, squeamishness, reducing anxiety, perception, self-consciousness

'Ability to brace' is the strongest category linked by this idea of a 'Negative Perspective' of injecting. People brace to prepare for pain (a preconception), but bracing causes muscle tension and during intramuscular injections muscle tension 'can and will increase the subjective experience of pain' (Cox et al. 2006). Adhering to the suggestion 'patients should see the needle so they can brace for the injection' would in actuality contribute towards increasing discomfort felt by patients. Participants also wanted to see the needle to reassure themselves it was safe to use, so although participants should possibly see the needle, it would be more beneficial to include instruction explaining that they should try not to brace. Categories linked by 'Negativity' of the injection system should be acknowledged and explored further in an attempt to use human factors to 'design out' these learned behaviours. If the design features that contribute towards these preconceptions can be fully understood, eventually the negative 'social norms' associated with injecting could be reduced.

Some of the categories that are linked by a 'Negative Perspective' of 'injection concerns', as described by Spain et al. (2016), are prevalent amongst the sample. The 'Perception' category includes trends in fear and psychological pain, both suggested to reduce adherence (Spain et al. 2016). Within the 'Perception' category, participants that were driven by 'fear' preferred a small device, stating that 'small' suggests a smaller needle. The 'Psychological Pain' trend was also in full support of a small device, whereby participants felt a smaller device would

seem less painful. This does not mean all injection devices should be small to allay fear and preconceived pain, but does suggest that size should be considered as a part of the wider user-interface: affecting perception of the device prior to initiating use.

A design consideration would be that bold colours give the illusion that objects are larger whilst dull colours produce the opposite effect. If a device needs to be large, the colour could be dull to reduce the perceived size. Further research into how design features produce a 'Negative perspective' may allow manufacturers to avoid including such features. Removing patient 'injection concerns' (Spain et al. 2016) by reducing fear and psychological pain would improve adherence.

#### 4.3 Neutral

The remaining five categories were not linked by 'Positivity' or 'Negativity'. 'Neutral' categories had the most presence in questions relating to colour of device and appearance (i.e. consumer or medical). These categories were – 'Rational thinking' (including the trends – 'cost (reduce)', 'colour is unimportant' and 'identification (of the device)') and 'Grounded' reasoning (including the trends – 'easy to identify', 'safety', 'travel' and 'passive'). Grounded reasoning data-points were for a 'medical-looking device' 93.5% of the time, which supports the idea that participants understand that there must be safety measures when bringing injection devices into the home and hands of the general public.

There was little difference (9) in the number of participants who would prefer a bright injection device over a plain one. The category 'Rational thinking' had 48 data-points, 24 justifying each preference. This suggests that neither 'plain' nor 'bright' is perceived as more relevant for an injection device, however participants shared the same drive (Rational, 45.7%). 28 participants stated 'no preference' for either colour, despite the fact participants were instructed to only choose between the two options presented. This further reinforces the idea that participants recognise colour as largely irrelevant to the use of the device.

## 5. Conclusion

The results of this study suggest that patient preference is often propelled by a common set of underlying drivers, even when their stated preferences differ. In some cases patients are motivated towards achieving a positive outcome whilst others are motivated by avoiding a negative outcome. Further research should be done into these drivers, 'fine-tuning' the design principles of injection devices from a usability perspective, improving overall usability and patient satisfaction when self-injecting.

When considering how this data improves the usability process, the 'Positive outlook' that drove participant choice could be used as 'Usability Goals' in early device design, to help maintain a user-centred focus throughout the design process. It could also be suggested that the 'Negative' drivers of preference could be investigated further to determine heuristic usability principles of poor device design.

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