

Accepted Manuscript

Implications of variation of epinephrine auto-injector needle length

Sten Dreborg, Gina Tsai, Harold Kim

PII: S1081-1206(19)30326-6

DOI: <https://doi.org/10.1016/j.anai.2019.04.027>

Reference: ANAI 2900

To appear in: *Annals of Allergy, Asthma and Immunology*

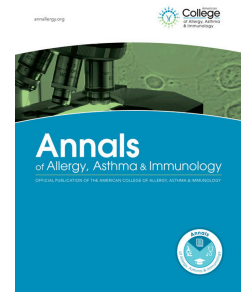
Received Date: 19 October 2018

Revised Date: 25 April 2019

Accepted Date: 29 April 2019

Please cite this article as: Dreborg S, Tsai G, Kim H, Implications of variation of epinephrine auto-injector needle length, *Annals of Allergy, Asthma and Immunology* (2019), doi: <https://doi.org/10.1016/j.anai.2019.04.027>.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Implications of variation of epinephrine auto-injector needle length

Sten Dreborg¹, Gina Tsai³, Harold Kim^{3,4}

Short title: Variation of needle length

- 1) Child and Adolescent Allergology, Women's and Children's Health, University of Uppsala, Sweden
- 2) Department of Medicine, Western University, Canada.
- 3) Department of Medicine, McMaster University, Canada

Corresponding author: Sten Dreborg, Women's and Children's Health, Uppsala University, Academic Hospital, SE-751 85 Uppsala, Sweden; +46-733423341; sten.dreborg@kbh.uu.se.

ORCID ID Sten Dreborg 0000-0002-3544-1557
 Harold Kim 0000-0002-0497-844X

Abbreviations

EAI	Epinephrine Auto-injector
HPEAI	High pressure EAI
LPEAI	Low pressure EAI
STMD	Skin to muscle distance
STBD	Skin to bone distance
STMD _{min}	Skin to muscle distance, low pressure
STMD _{max}	Skin to muscle distance, high pressure, 8 lb
STBD _{min}	Skin to bone distance, low pressure
STBD _{max}	Skin to bone distance, high pressure, 8 lb

Financial disclosure statement: None.

Title: Words: 8
Short title: Words: 6
Manuscript word count: Words: 2406
Figures: 3
Tables: 4
References: 15

Contributors' Statements

Sten Dreborg: Dr Dreborg carried out the original analyses, drafted the original manuscript, revised the manuscript, and approved the final manuscript as submitted.

Gina Tsai: Dr Tsai participated in designing the study, reviewed and revised the manuscript and approved the final manuscript as submitted.

Harold Kim: Dr Kim conceptualized and designed the study, reviewed and revised the manuscript and approved the final manuscript as submitted.

Conflicts

Sten Dreborg and Gina Tsai have no conflicts of interest. Harold Kim has been on the advisory boards for Kaleo and Pfizer.

Introduction

In a series of papers, we have presented results from three primary papers (1-3) and two discussion papers (4,5) based on studies performed by Dr. Harold Kim's group in Ontario, Canada. High pressure epinephrine auto-injector (HPEAI) Epipen[®]/EpipenJr[®] (4) is the most commonly prescribed EAI, in North America and Europe. Other HPEAI are Jext[®] (5) and Auvi-Q[®] (6). These EAI require high pressure to release the needle and the dose of epinephrine. Since there have been problems with possible periosteal/intraosseous injection in small children using HPEAIs, a HPEAI with shorter needle, Auvi-Q[®] 0.1 mg epinephrine (6.4 mm – 8.9 mm), has recently been introduced (6). In Europe, a low pressure EAI (LPEAI), Emerade[®], has recently been launched (7). For proper injection, it requires less pressure (8). The current LPEAIs have longer needles than the HPEAIs (Table 1).

Recently, we reported (9) on the risk of subcutaneous injection and the risk of periosteal/intraosseous injection using the declared mean needle length as given in the respective product specifications. In this communication, we investigate the influence of the variation of the needle length as reported by the manufacturers of the four presently most commonly used EAI. In all production processes there is some variation in needle lengths of the EAI. Thus, the length of the EAI needle penetrating the skin will vary depending on the variations in manufacturing of the needle and the assembly and the EAI. Both of these issues have some inherited variation. Therefore, it would be optimal to assess the upper and lower limits of the “exposed” needle lengths accepted by the manufacturers as an important criterion with the release of new batches of EAI. Using these minimal and maximal limits, the risks of subcutaneous or periosteal injections was estimated using the recommended weight groupings of subjects for EAI used in our initial publications (1-3).

Methods

Patients

As reported earlier (1-3), 401 consecutive patients with food allergy were included. Three groups of children and adolescents participated: Group 1: Children less than 12 years of age weighing less than 15 kg (n=100) (2), Group 2: Children less than 12 years of age weighing 15-30 kg (n=102) (3), Group 3: Adolescents, 12 – 18 years of age weighing > 30 kg (n=100) (3). In total, 302 children and adolescents were included, 125 girls and 177 boys. Furthermore, 99 adults (18-72 years), 69 of whom were females (1) were included. Patient characteristics have been previously published (1-3). The Lawson Health Research Institute Research Ethics Board at Western University in London, Ontario, Canada approved the studies. (1-3).

Ultrasound estimation of the distance skin to muscle (STMD) and skin to bone (STBD)

An ultrasound of the anterolateral aspect of the right mid-thigh was completed on all of the subjects using a Sonosite Titan[®] ultrasound machine. The pressure was applied to simulate the pressure required to trigger the HPEAI, approximately 40 N as identified by Schwirtz et al. (10). To mimic the pressure applied to the low-pressure epinephrine autoinjector (LPEAI) low pressure was applied. Recently, we published on pressure inducing needle release and the variation in pressure accepted by manufacturers and authorities for new batches of EAI (8).

As reported (1-3), four ultrasound measurements were collected on each patient: skin-to-muscle depth with low pressure (STMD_{min}), skin-to-muscle depth with high pressure (STMD_{max}), skin-to-bone depth with low pressure (STBD_{min}) and skin-to-bone depth with high pressure (STBD_{max}). The STMD was measured from the skin surface to the inner aspect of the fascia of the vastus lateralis muscle and the STBD was measured from the skin surface to the outer aspect of the periosteum of the femur.

53

54 **Weight limits**

55 The weight limits used in our studies were 15, 30 and 60 kg. The limit, 60 kg for Emerade®
 56 with 0.5 mg dose, originates from the Swedish recommendations (11). Children weighing less
 57 than 15 kg were treated separately, as epinephrine 0.15 mg has not been recommended by
 58 manufacturers, societies or authorities to children weighing <15 kg. Recently, a new EAI with
 59 shorter needle length, Auvi-Q® 0.1 mg epinephrine, has been marketed (Table 1) (6).

60

61 **Analysis**

62 In previous papers, we have analyzed our data using the mean needle length of EAI as
 63 reported publicly by the manufacturers. However, like all other medical products and devices
 64 produced, the needle lengths of EAI will vary. Therefore, in this paper, we investigate the
 65 risks of intraosseous and subcutaneous injection using the longest and the shortest needles that
 66 may be delivered to patients. The needle length variations have been provided to us by the
 67 EAI manufacturers. To illustrate the risks associated with using the longest or the shortest
 68 needles within the accepted range, we used the maximum lengths and the minimum lengths
 69 that are accepted by the manufacturers (Table 1). The effective needle lengths are shown in
 70 Table 1 and 2.

71

72 Recently, Diacono et al. (12) found that, for proper administration of an intramuscular
 73 injection, the whole needle orifice must pass completely into the muscle. The injection jet will
 74 not penetrate the fascia if the epinephrine is released before the whole needle orifice has
 75 passed through the fascia. Furthermore, if part of the orifice is within the epimysium during
 76 the injection, epinephrine may spread within the loose epimysium tissue. Based on
 77 information from the manufacturers, we considered all needle orifices to be 2 mm in length
 78 (9). Therefore, the needle length was reduced by 2 mm when estimating the $STMD_{max}$ and

STMD_{min} (Table 2). In Table 3 and 4, the “risk” of penetrating the bone or injecting into subcutaneous tissue are shown.

Outcome variables

We used two primary outcome variables: the proportion of children with STBD less than the total needle length and STMD more than the needle length minus 2 mm (Table 2).

Statistics

Basic statistical significances and correlations have been reported (1-3).

We estimated the proportion of subjects who would likely receive epinephrine intraosseously/periosteally and subcutaneously, respectively, using high and low pressure EAs. Since distances measured are short and differences in exposed needle length are small, we classified these risks into 4 groups: No or minimal risk (0-2 %), low risk (3 – 9 %), intermediate risk (10 – 19 %) and high risk (> 20 %). The limits for these groups are arbitrary but are those used in previous reports by this group. .

Results

Since the EAI brands had different limits for acceptable minimum and maximum lengths of the needles, the impact of variation in lengths was analyzed per respective brand.

Skin to bone distance, STBD

Using Epipen[®] in children weighing less than 15 kg, the risk of intraosseous/periosteal penetration was as high as 60% in the event that the longest needle accepted for distribution was used. Even children weighing 15-30 kg had a risk of bone penetration (29%), whereas adolescents and adults had a lower risk, Table 3, Figure 1.

The risk for intraosseous/periosteal penetration was negligible using the shortest needle passing the production controls or using the recently introduced Auvi-Q[®] EAI, Table 3. The Auvi-Q[®] 0.10 mg was specially designed to avoid bone penetration for children less than 15 kg. Using the longest needles approved for commercial use, the risk of bone penetration using the Auvi-Q[®] EAI remained low in children weighing >15 kg receiving the Auvi-Q[®] 0.15 mg EAI and even in adolescents weighing > 30 kg receiving the Auvi-Q[®] 0.3 mg EAI (Table 3 and Figure 1).

When using the longest needle of Jext[®], the risk of bone penetration in children weighing < 15 kg and 15-30 kg was high (43 and 22% respectively). However, the risk was not reduced to the same extent as that of using Epipen[®] and Auvi-Q[®], Table 3, when using shorter needles, due to the smaller range of acceptable needle lengths (Table 1 and 3, Figure 1). Using Jext[®], there was a low risk of intraosseous/periosteal injection among adolescents weighing more than 30 kg and adults (Table 3).

There was a negligible risk of bone penetration when using the LPEAI, Emerade[®] (Table 3).

Skin to muscle distance, STMD

Epipen Jr[®] had no risk of subcutaneous injection using the longest of the approved needle lengths, Table 4 and Figure 2. However, due to the relatively large variation in length between the longest and the shortest needles, there was a low to medium risk of subcutaneous injection when using the shortest approved needles (Table 4). In contrast, there was no risk of subcutaneous injection using the shortest approved needles of Jext[®] in children weighing less than 30 kg.

Using the shortest needles for Epipen[®] or Jext[®] 0.3 mg epinephrine EAIs in adolescents and adults would result in subcutaneous instead of intramuscular injection in a medium and high proportion of patients, respectively. This risk was reduced, but not abolished, using the longest needles approved (Table 4, Figure 2).

In children weighing less than 15 kg, there was a high risk of subcutaneous injections using both the shortest and even the longest needles of Auvi-Q[®] 0.1 mg epinephrine EAI approved for clinical use. There was also a high risk of subcutaneous injection in adults using the Auvi-Q[®] 0.3 mg epinephrine EAI, Table 4.

Using the shortest needles of Emerade[®] approved for distribution in adults, the risk of subcutaneous injection would be intermediate and with the longest needles the risk would be low. (Table 4, Figure 3).

BMI

Figures with BMI indicated by the symbols indicate that to use BMI as a basis for selection of EAI seems to be of limited value in adults. Investigating the possible use of BMI instead of weight in children is difficult since the limits for overweight varies with age and development of puberty.

Discussion

There is a risk of subcutaneous or intraosseous injection of epinephrine using EAI. In this paper, we analyzed 401 patients aged 0.2 to 72 years, 302 children and 99 adults. We compared STMD and STBD versus weight, commonly recommended for dosing epinephrine. The true distance from skin to muscle and bone during the delivery of epinephrine with an EAI will vary with the pressure applied to release the needle of the EAI (8).

The aim of the present study was to assess the influence of the variation in needle lengths, due to the manufacturing process of EAIs, on the risk for subcutaneous and intraosseous/periosteal injection. We used the limits for acceptance of needle lengths obtained from the manufacturers. For this study, all four manufacturers supplied the variation in needle length of their respective EAIs. In general, the risk of bone penetration was most pronounced in small children and the risk of subcutaneous injection most common in adult, obese individuals. The new HPEAI Auvi-Q® 0.1 mg showed no risk of bone penetration but a high risk of subcutaneous injection. The device was introduced to be able inject a lower dose in children weighing less than 15 kg. Furthermore, the intention was to reduce the risk of intraosseous/periosteal injection. However, using the shortest needle would result in an increased risk for subcutaneous deposition. According to our data, with the risk of subcutaneous injection being high, this product is suitable for subcutaneous injection, rather than intramuscular injection.

The needle length variation was greatest for EpiPen® and EpiPen Jr® devices at 5 mm. This potential variation in needle length leads to varied risks for intraosseous/periosteal injection. The risk for the longest accepted EpiPen Jr® needle hitting the bone is 60% in children weighing less than 15 kg, whereas the shortest needles had a risk of only 1% in the same

group. In comparison, children weighing less than 15 kg had no risk of intraosseous/periosteal injection using Auvi-Q® 0.1 mg EAI.

Jext®, with similar mean needle length as Epipen®, but only 2 mm variation between the longest and shortest accepted needles, showed a lower risk of bone penetration using the longest Jext® needles. That risk was reduced further when using the shortest Jext® needles.

The risk for subcutaneous injection in adults was most common among obese women using Epipen® and Jext®. Even using the LPEAI, Emerade®, the risk of subcutaneous injection in overweight and obese adults was 12 % using the shortest needles approved. It seems possible to launch longer needles for the obese and overweight adults having the risk of subcutaneous injection. However, as mentioned, the risk of subcutaneous injection was highest when using the Auvi-Q® 0.1 mg in children weighing less than 15 kg.

In our series of papers (1-3, 9), we used approximately 8 pounds or about 40 N as high pressure and we applied a minimal pressure to mimic the required pressure to release the needle of HPEAIs and LPEAIs, respectively. Recently, we received information from three of the manufacturers on the pressure that should be applied to the respective EAIs. This data that has been published elsewhere (8). As stated previously (8), to improve the applicability of these studies, we recommend the pressure applied to the ultrasound probe should be that declared to be the lowest and the highest according to the specifications for each device (8). There are instruments that can apply a specified pressure to the ultrasound probe (13, 14). Furthermore, we propose the probe should have the same footprint as that of the specific EAI to be studied (14).

When employing the present high pressure technique, it is probably impossible to find a needle length that would have no risk of both intraosseous injection and subcutaneous injection. In the weight groups less than 15 kg, Epipen Jr® and Jext® have a high risk of intraosseous/periosteal injection. This “risk” for Epipen Jr®, Jext® 0.15 mg and Auvi-Q® 0.15 mg in children 15-30 kg is still significant. On the other hand, Auvi-Q 0.1 mg, with a much shorter needle, designed to have a low risk of intraosseous injection, has no risk of intraosseous injection, however, a very high risk of subcutaneous injection.

The majority of studies investigating the properties of EAI have not used injection of active substance, but different surrogate methods, most often ultrasound investigating the risk of subcutaneous and intraosseous/periosteal injections. The aim of EAI is to inject epinephrine intramuscularly as this leads to a more rapid increase of blood epinephrine levels and symptoms of epinephrine effect (15). Future ultrasound EAI studies should be complemented by using active EAI, to document whether epinephrine is deposited intramuscularly or subcutaneously and leads to adequate plasma levels.

In summary, based on our ultrasound estimations of the STBD and STMD, the variation in needle length causes a high degree of variation in the risk of both subcutaneous and intraosseous/periosteal injection among EAI currently available in North America and Europe.

References

1. Tsai G, Kim L, Nevis IF, Dominic A, Potts R, Chiu J, et al. Auto-injector needle length may be inadequate to deliver epinephrine intramuscularly in women with confirmed food allergy. *Allergy, asthma, and clinical immunology : official journal of the Canadian Society of Allergy and Clinical Immunology*. 2014;10(1):39.
2. Kim L, Nevis IF, Tsai G, Dominic A, Potts R, Chiu J, et al. Children under 15 kg with food allergy may be at risk of having epinephrine auto-injectors administered into bone. *Allergy, asthma, and clinical immunology : official journal of the Canadian Society of Allergy and Clinical Immunology*. 2014;10(1):40.
3. Dreborg S, Wen X, Kim L, Tsai G, Nevis I, Potts R, et al. Do epinephrine auto-injectors have an unsuitable needle length in children and adolescents at risk for anaphylaxis from food allergy? *Allergy, asthma, and clinical immunology : official journal of the Canadian Society of Allergy and Clinical Immunology*. 2016;12:11.
4. EpiPen®/EpiPen® Jr. Prescribing Information . Dey Pharmaceuticals; 2014.
5. Jext adrenaline tartrate 2018 [cited 2018 August 25th]. Available from: <https://hcp.jext.co.uk/resources/>.
6. AuviQ prescribing information, US. Bridgewater. NJ: SanofiAventis US; 2017.
7. Product resume Emerade (FASS). MEDECA Pharma AB; 2017.
8. Dreborg S, Kim H. Authors response. *Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology*. 2018;under publication.
9. Dreborg S, Kim L, Tsai G, Kim H. Epinephrine auto-injector needle lengths: Can both subcutaneous and periosteal/intraosseous injection be avoided? *Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology*. 2018;120(6):648-53 e1.
10. Schwirtz A, Seeger H. Comparison of the robustness and functionality of three adrenaline auto-injectors. *Journal of asthma and allergy*. 2012;5:39-49.
11. Gottberg L, Editor. Anafylaxi. Rekommendationer för omhändertagande och behandling. (Anaphylaxis. Recommendations for care and treatment). Stockholm; 2013 2013.
12. Diacono D, Pumphrey RS, Sharma V, Arkwright PD. The deep fascia of the thigh forms an impenetrable barrier to fluid injected subcutaneously by autoinjectors. *The journal of allergy and clinical immunology In practice*. 2015;3(2):297-9.
13. Andersen HH, Lundgaard AC, Petersen AS, Hauberg LE, Sharma N, Hansen SD, et al. The Lancet Weight Determines Wheal Diameter in Response to Skin Prick Testing with Histamine. *PloS one*. 2016;11(5):e0156211.
14. Kim H, Dinakar C, McInnis P, Rudin D, Benain X, Daley W, et al. Inadequacy of current pediatric epinephrine autoinjector needle length for use in infants and toddlers. *Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology*. 2017;118(6):719-25 e1.
15. Simons FE, Gu X, Simons KJ. Epinephrine absorption in adults: intramuscular versus subcutaneous injection. *J Allergy Clin Immunol*. 2001;108(5):871-3.

Legends to figures

Figure 1 Epipen® and Auvi-Q® 0.15 mg have a high risk of intraosseous injection in small children that is largely avoided by using Auvi-Q 0.1 mg.

Skin to bone distance, $STBD_{max}$, versus weight. The full length of the EAI needles with upper and lower limits (red lines) for Epipen®/EpipenJr® shown with the variation indicated by the red area, and Auvi-Q® (yellow area, black lines). The vertical lines indicate the shift in dose from 0.1 mg to 0.15 mg and 0.15 mg to 0.3 mg epinephrine, respectively. BMI symbols are indicated in the left upper corner.

Figure 2 Epipen 0.3 mg and Auvi-Q 0.3 mg have a high risk of subcutaneous injection in adults and adolescents weighing more than 50 kg.

Skin to muscle distance, $STMD_{max}$, versus weight. The length of the EAI needles minus 2 mm with upper and lower limits (red area) for Epipen®/EpipenJr® shown with the variation indicated by the red area, and Auvi-Q® (yellow area). The vertical lines indicate the shift in dose from 0.1 mg to 0.15 mg and 0.15 mg to 0.3 mg epinephrine, respectively. BMI symbols are indicated in the left upper corner.

Figure 3 Emerade® has a risk of subcutaneous injection in some, but not all, overweight and obese adults weighing more than 70 kg.

Skin to muscle distance, $STMD_{min}$, versus weight. The full length minus 2 mm of Emerade® needles with upper and lower limits (red lines), the variation indicated by the red area. The vertical lines indicate the shift in dose from 0.15 to 0.3 mg epinephrine and 0.3 mg to 0.5 mg epinephrine, respectively. BMI symbols are indicated in the left upper corner.

Table 1

Autoinjector needle lengths according to the product specifications provided by the manufacturers.

Brand	Mini- mum	Maxi- mum	Mean	Variation mm
HPEAI				
EpipenJr[®]	10	15	12.5	5
Epipen[®] 0.3 mg	13	18	15.5	5
Jext[®] 0.15 mg	12	14	13	2
Jext[®] 0.3 mg	14	16	15	2
Auvi-Q 0.1 mg	6.4	8.9	7.65	2.5
Auvi-Q 0.15 mg	11.4	14.0	12.7	2.5
Auvi-Q 0.3 mg	14.7	17.3	16	2.6
LPEAI				
Emerade[®] 0.15 mg	15	16.7	15.8	1.7
Emerade[®] 0.3 mg	22.1	23.6	22.8	1.5
Emerade[®] 0.5 mg	22.1	23.6	22.8	1.5

Table 2

Auto-injector needles available in North America and Europe in 2019.

Needle lengths and their variation are given according to the manufacturers' approved specifications.

The distance to muscle is modified based on Diacono et al. (12) by subtracting 2 mm from the penetrating needle length. See methods.

EAI	Lower and upper limits for needle length	Needle length. mm		Pressure against the thigh
		Full needle length - 2 mm = STMD	Full penetrating needle length = STBD	
HPEAI*				
Epipen Jr® 0.15 mg	Lower limit	8	10	Press hard
	Upper limit	13	15	
Epipen® 0.3 mg	Lower limit	11	13	
	Upper limit	16	18	
Jext® 0.15 mg	Lower limit	10	12	Thrust
	Upper limit	12	14	
Jext® 0.3 mg	Lower limit	12	14	
	Upper limit	14	16	
Auvi-Q 0.1mm	Lower limit	4.4	6.4	Push firmly
	Upper limit	6.9	8.9	
Auvi-Q 0.15 mg	Lower limit	9.4	11.4	
	Upper limit	12	14	
Auvi-Q 0.3 mg	Lower limit	12.7	14.7	
	Upper limit	15.3	17.3	
LPEAI**				
Emerade® 0.15 mg	Lower limit	13.0	15.0	Slight pressure
	Upper limit	14.7	16.7	
Emerade® 0.3+ 0.5 mg	Lower limit	20.1	22.1	
	Upper limit	21.6	23.6	

* These devices are high-pressure epinephrine autoinjectors, HPEAIs.

** This device is a low-pressure epinephrine autoinjector, LPEAI.

Table 3. The “risk” for intraosseous/periosteal injection is highest in young children using the longest EAI needles

STBD in relation to weight. The full length was used in calculation of STBD using the weight limits < 15 kg, 15-30 kg, adolescents weighing >30 kg and adults.

White color indicates very low “risk”, 0-2 %, green color indicates low “risk”, 3-9 %, orange color indicates medium “risk”, 10-19%, red color high “risk”, >20 %, for injection into the bone (STBD). The exposed needle lengths are given in mm.

	STBD		Children			Adults
	Exposed needle length	Full length mm	< 15 kg	15 – 30 kg	>30 kg	
n			102	100	100	99
HPEAI						
EpipenJr®	minimum	10	1	1		
	maximum	15	60	29		
Epipen®	minimum	13			1	0
	maximum	18			14	3
Jext® 0.15 mg	minimum	12	15	6		
	maximum	14	43	22		
Jext® 0.3 mg	minimum	14			3	0
	maximum	16			7	1
Auvi-Q® 0.1 mg	minimum	6.4	0			
	maximum	8.9	0			
Auvi-Q® 0.15 mg	minimum	11.4		3		
	maximum	14		22		
Auvi-Q® 0.3 mg	minimum	14.7			3	0
	maximum	17.3			12	1
LPEAI						
Emerade® 0.15 mg	minimum	15.0	0	0		
	maximum	16.7	2	0		
Emerade® 0.3 mg	minimum	19.1			0	
	maximum	23.6			1	
Emerade® 0.5 mg	minimum	19.1				0
	maximum	23.6				0

Table 4. The “risk” of subcutaneous injection increases with decreasing EAI needle length and is highest in adults and young children using Auvi-Q 0.1 mg.

STMD in relation to weight. The full length -2 mm was used to compensate for the distance from outside fascia lata in to the muscle, Table 2.

Regarding “risk” classification see statistics and the legend of Table 3.

		Lower and upper limits for needle length	Full needle length minus 2 mm	Children			Adults
				< 15 kg	15 – 30 kg	>30 kg	
n			102	100	100	99	
HPEAI							
EpipenJr®	minimum	8	13	8			
	maximum	13	0	0			
Epipen®	minimum	11			16	41	
	maximum	16			4	14	
Jext® 0.15 mg	minimum	10	1	1			
	maximum	12	0	0			
Jext® 0.3 mg	minimum	12			13	36	
	maximum	14			9	28	
Auvi-Q® 0.1 mg	minimum	4.4	94				
	maximum	6,9	28				
Auvi-Q® 0.15 mg	minimum	9.4		3			
	maximum	12		0			
Auvi-Q® 0.3 mg	minimum	6,4			7	38	
	maximum	8,9			1	22	
LPEAI							
Emerade® 0.15 mg	minimum	13.0	1	0			
	maximum	14.7	0	0			
Emerade® 0.3 mg	minimum	20.1			2		
	maximum	21.6			2		
Emerade® 0.5 mg	minimum	20.1				12	
	maximum	21.6				8	

Acknowledgements

Several people participated in the initial field-work and Laura Kim, BSc wrote the second paper that the present communication is based on.

