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Research Paper

Optimizing insulin injection technique and its effect on blood glucose control☆

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ABSTRACT

Purpose: The purpose of the study is to assess whether proper Injection Technique (IT) is associated with improved glucose control over a three month period.
Methods: Patients ($N = 346$) with diabetes from 18 ambulatory centers throughout northern Italy who had been injecting insulin ≥ four years answered a questionnaire about their IT. The nurse then examined the patient's injection sites for the presence of lipohypertrophy (LH), followed by an individualized training session in which sub-optimal IT practices highlighted in the questionnaire were addressed. All patients were taught to rotate sites correctly to avoid LH and were begun on 4 mm pen needles to avoid intramuscular (IM) injections. They were instructed not to reuse needles.
Results: Nearly 49% of patients were found to have LH at study entry. After three months, patients had mean reductions in HbA1c of 0.58% (0.50%–0.66%, 95% CI), in fasting blood glucose of 14 mg/dL (10.2–17.8 mg/dL, 95% CI) and in total daily insulin dose of 2.0 IU (1.4–2.5 IU, 95% CI) all with $p < 0.05$. Follow-up questionnaires showed significant numbers of patients recognized the importance of IT and were performing their injections more correctly. The majority found the 4 mm needle convenient and comfortable.
Conclusions: Targeted individualized training in IT, including the switch to a 4 mm needle, is associated with improved glucose control, greater satisfaction with therapy, better and simpler injection practices and possibly lower consumption of insulin after only a three month period.

Introduction

Most physician visits with insulin-injecting patients involve discussions about glucose control and dose adjustments, but very little time is spent on improving Injection Technique (IT). However IT may in certain cases be just as important to diabetes management as the type of insulin or dosage used.

This study was the outgrowth of a survey performed in 21 hospitals in northern Italy in 2011 by the ANIED Group – *Associazione Nazionale Infermieri in Endocrinologia e Diabetologia* (National Association of Nurses in Diabetology and Endocrinology; see Acknowledgments section) [1]. That study, termed the Swansdown Survey and done in the same centers as our study, involved 472 injecting patients and consisted of training to improve their injecting technique. Patients were using a variety of needle lengths (12.7 mm [1.2%], 8 mm [37.7], 6 mm [35.4%], 5 mm [18.4%], 4 mm [7.6%], unknown [5%]). No needle length changes were proscribed by the study. Patients were followed up at 3 and 6 months for effects of the training on their glucose control and injection technique knowledge. No significant changes were found in HbA1c or fasting glucose levels, but understanding of injections was improved. The Survey had initially revealed that the greatest educational needs were in older patients who had been injecting insulin for over ten years and who had outdated practices. By study conclusion a majority of patients showed improved understanding of injecting devices (including shorter, finer-gauge needles), the care and maintenance of injection sites, the means for avoiding complications such as lipohypertrophy (LH) and the necessity for rotating injection sites. As a result of this

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survey, ANIED felt this training should include both general education in optimal IT as well as individualized and targeted attention to specific needs as revealed by patient questionnaires and hands-on nurse examinations.

Studies have been published in recent years supporting the safety, efficacy and patient preference for the 4 mm pen needle (PN) [2–9]. These needles have been shown to provide equivalent glucose control compared to longer needles while reducing both the risk of IM injections as well as injection pain. For these reasons it was felt that the 4 mm PN played an integral role in optimizing IT and should be the needle of choice for all injecting patients in the participating centers. Since the switch to this needle was planned anyway, we decided to study several glucose control and IT parameters at the same time. We evaluated the effects of an integrated IT educational approach which included general and targeted training, advice on rotation of sites and needle reuse as well as a switch to the shortest PN (4 mm).

Methods

Patients with diabetes from 18 ambulatory centers throughout the Piedmont region of northern Italy (Table 1) who had been injecting insulin for at least four years were queried by their nurse/educator using a questionnaire (Table 2) about their IT. The nurse then examined the patient's injection sites for the presence of abnormalities including LH. A general IT education session lasting approximately 15 min was given using the BD Educational Starter Kit® (Becton Dickinson, Inc., Franklin Lakes, NJ, USA). The kit contains site rotation grids, an educational injection technique leaflet and a blood-glucose log-book. The 'look and feel' of LH was taught using a BD 'Lipobox'®, which provided visual and tactile practice on typical LH lesions. This general training was followed by an individualized training session in which sub-optimal IT practices highlighted in the patient's questionnaire were addressed. All patients were taught how to rotate sites correctly to avoid LH and all were begun on the BD Micro-Fine™ 4 mm 32G pen needle (Becton Dickinson, Inc., Franklin Lakes, NJ, USA) to avoid intramuscular (IM) injections. They were also instructed not to reuse the needles. Furthermore each patient received an information card in which ANIED underlines the importance that IT has in achieving optimal glucose control.

The nurses involved in this study were trained at the time of the Swansdown Survey [1] in 2011 on correct IT using the published New Injection Recommendations [10]. The questionnaire used by patients and nurses was reviewed point by point and each nurse was certified on proper methodology for administrating the questionnaire as well as for performing the physical exam. Shortly before our study began in 2012, the same nurses met for a 4-h roundtable in Turin, managed by the ANIED scientific board, to review and discuss the Swansdown results [1], and to create the ANIED Card. This card teaches patients correct IT. At the same roundtable the nurses reviewed the new trial protocol, with emphasis on inclusion and exclusion criteria. All participating nurses were then trained on the 'ANIED Card' which would then be used to train all patients on correct IT during the general education session. The entrance and exit questionnaires were reviewed point-by-point with explanation and discussion of every question. There were instructions on minimizing drop-out and ensuring follow-up. Each nurse had to demonstrate expertise in history taking, gathering of laboratory data in an appropriate manner as well as in the use of a uniform methodology for observing and palpating injection sites. Hands-on certification was required in the proper use of the Starter Kit® and Lipobox®. Structured education techniques were taught and certified including the correct explanation of injection rotation, the use of a 4 mm needle and detailed LH management.

Inclusion Criteria for patients included age >12 years, having type 1 diabetes (T1D) or type 2 (T2D) and being on injection therapy for at least four years. It was felt that subjects injecting for less than four years might have already been exposed to the most up-dated teaching in IT. By four years, however, subjects were felt to have already established habits which might need corrective education and training. Nevertheless, if subjects were still in their teens (13–19 years old) the four-year requirement was waived. Subjects of all body mass index (BMI) and using all marketed needle lengths were accepted into the study.

Because of the time commitments needed to administer the questionnaire and provide both general and individual training, it was often not possible to include all patients seen on a daily basis in any center. Hence nurses were instructed to admit to the study either the first one or two patients of the day who satisfied the inclusion criteria or the first and last patients of the day who satisfied the inclusion criteria. If time permitted, all patients who satisfied the inclusion criteria in a day were included. While not strict randomization, this approach helped prevent selection bias.

Table 1
Participating centers and subjects

Province	City	Center	Total PTS	PTS with HbA1c at exit
AL	Novi Ligure	CAD Osp. San Giacomo	105	98
	Acqui Terme	CAD Osp. Civile Monsignor Galliano		
	Tortona	CAD Osp. SS Antonio e Margherita		
	Alessandria	CAD A.S.O. SS Antonio Biagio e Cesare Arrigo		
CN	Cuneo	CAD A.S.O. Santa Croce e Carle	39	32
	Fossano	CAD Osp. SS Trinita'		
	Fossano	F.A.N.D.		
TO	Torino	CAD A.S.O. C.T.O. (Città della Salute e della Scienza)	116	91
	Torino	CAD Osp. Regina Margherita (Città della Salute e della Scienza)		
	Torino	CAD Via Monginevro ASL To1		
	Torino	CAD Osp. Maria Vittoria		
	Torino	CAD S.G.A.S. (Città della Salute e della Scienza)		
	Torino	CAD A.S.O. Ordine Mauriziano Umberto I		
BI VCO VL	Omegna	CAD Osp. Madonna del Popolo	86	38
	Verbania	CAD Osp. Castelli		
	Domodossola	CAD Osp. San Biagio		
	Vercelli	CAD P.O. S. Andrea		
	Biella	CAD Osp. Degli Infermi		
		Total	346	259