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A Review of Insulin Pen Devices and Use in the Elderly Diabetic Population

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Abstract: The prevalence of diabetes mellitus (DM) in the elderly population currently represents almost one-half of the overall diabetic population. Treatment of DM often requires a multidrug regimen that includes insulin therapy; however, due to concomitant comorbidities such as dementia, vision loss, neuropathies, poor mobility, and poor manual dexterity, elderly patients may be at increase risk for hypoglycemia and other dosing errors that are associated with insulin administration. Insulin pen devices have been shown to provide more reliable, accurate, and simplified dosing, and therefore may be a safer, easier, and more acceptable method of insulin delivery in the elderly population. This review will describe the various insulin pen devices available today, as well as discuss the potential advantages of these devices in the elderly population.

Keywords: insulin, pen device, elderly

Clinical Medicine Insights: Endocrinology and Diabetes 2010:3 53–63

doi: [10.4137/CMED.S5534](https://doi.org/10.4137/CMED.S5534)

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Clinical Medicine Insights: Endocrinology and Diabetes 2010:3

53

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Introduction

The number of patients diagnosed with diabetes mellitus (DM) in the United States in 2007 totaled almost 18 million people. An additional 5.7 million people are considered undiagnosed, which brings the total to 8% of the US population considered to have DM.¹

While this disease affects a large percentage of the overall population, it also affects a large number of elderly patients. The prevalence of DM in patients 60 years of age or older was estimated to be greater than 12 million in 2007, which represents almost one-quarter of the elderly population and over one-half of the overall DM population.¹ This number will almost surely continue to rise as a result of several factors, most notably the increase in the size of the elderly population. In 2000, an estimated 12% of the US population was 65 years of age or older. This number is projected to grow to over 16% by the year 2020.² Additionally, an estimated 35% of the elderly population has impaired fasting glucose, which could later progress to DM.¹

The treatment of Type 2 DM often requires a multi drug regimen that includes insulin in order to maintain glycemic control. The American Diabetes Association (ADA) consensus algorithm lists basal insulin as a possible option in step 2 therapy after lifestyle changes and metformin have inadequately controlled glucose levels, as well as in patients with an HbA1c >8.5%.³ Statistics in 2007 showed that 14% of those diagnosed with DM are on insulin alone, and 13% are on a combination of insulin and oral medications.¹ Additionally, a 2006 survey found that nearly 32% of the elderly population who were diagnosed in their middle-age were on insulin, and almost 7% of those who were classified as elderly when diagnosed were on insulin.⁴ These numbers will continue to rise not only as the proportion of the elderly population increases, but also as the role of insulin in treatment of DM continues to evolve and guidelines continue to place more of an emphasis on insulin therapy.

While many patients of all ages are treated with insulin for DM, concerns arise over the safety and efficacy of this high-alert medication in the elderly population. The use of insulin in this population is often complicated by multiple comorbidities such as dementia, vision loss, neuropathies, poor mobility, and poor manual dexterity. These factors can affect the patient's ability to self-inject insulin, increase

reliability on caregivers, and ultimately may limit the use of insulin in treatment of DM in this population.

Safety, especially hypoglycemia, is always a concern when using insulin, and individual studies have shown that the overall incidence of hypoglycemia in the elderly may be between 21%–27%.³ Additionally, it has been shown that many patients, including the elderly, may make significant errors in drawing up the correct insulin dose for injection, furthering safety and efficacy concerns.

As a result of these complications and concerns, there is a need to simplify insulin regimens and dosing in the elderly population. One option for doing this is through the administration of insulin with a pen device rather than the traditional vial and syringe method of delivery. Insulin pen devices were first marketed in the mid-1980s, and since that time the design of these devices has continued to evolve. The result is a device which may allow for more elderly patients to be treated with insulin as administration of insulin is possibly made safer, easier, and more acceptable.

The purpose of this review is to describe the various insulin pen devices available today, as well as discuss the potential advantages of these devices in the elderly population. The safety, efficacy, patient preference, and overall patient satisfaction with regards to ease of use will be reviewed in order to determine the role of these devices in the utilization of insulin therapy in the elderly population.

Insulin Pens versus Insulin Vials and Syringes

In order to determine if insulin pen devices have a role in the treatment of elderly DM patients, it is important to understand the advantages these devices offer over traditional vials and syringes. Many patients find that these devices are more convenient as they eliminate the need for drawing up a dose.⁵ The ability to dial up the desired dose may lead to greater accuracy and reliability, especially for low doses which are often needed in the elderly.^{7,8} The sensory and auditory feedback associated with the dial mechanism on many pens may also benefit those with visual impairments. Pen devices are also more compact, portable and easier to grip, which may benefit those with impairments in manual dexterity. Finally, less painful injections and overall ease of use may contribute

to the increased patient preference seen with the pen devices.^{5,6}

Despite the advantages associated with pen devices there are potential disadvantages. Most importantly the devices are more costly than the insulin vial, and this may be difficult for many elderly patients. It should be noted, however, that most insurance plans, including Medicare part D, charge the patient the same amount for a month supply of insulin in the pen device as insulin in the vial. Patients may also find that pen devices take longer to use, as they must remain in the subcutaneous tissue for 5–10 seconds after dose release.⁵ Lastly, not all forms of insulin are available in the pen device; this is discussed in more detail below.

Dosing and Safety

An important consideration with insulin administration in the elderly population is the possibility of dosing errors.⁹ Correct administration and accurate dosing is important in order to prevent serious complications, such as hypoglycemia and hyperglycemia. The traditional vial and syringe method of insulin administration involves several steps, including injecting air into the vial, drawing an amount out of the vial into a syringe with small measuring increments, and verifying the correct dose visually.¹⁰ In addition to the complexity of insulin administration, visual impairment, joint immobility, and peripheral neuropathy in elderly patients with diabetes may contribute to inaccurate dosing, and insulin pen devices may be beneficial in terms of safety for elderly patients due to these visual or physical disabilities.⁷ Additionally, insulin pens may provide ease in setting and reading the amount of insulin to be injected and are also preferred for smaller doses of insulin due to improved dose accuracy.⁷

Studies have demonstrated that patients using a traditional vial and syringe method of delivery have a higher risk of inaccurately drawing up the insulin dose, with a relative error of approximately 19% seen in accuracy of dosing.¹¹ Higher inaccuracies may be seen in the elderly population. Puxty and colleagues found that a 12% variation in drawing up and expelling 20 units was seen with syringe users (average age 66 years).¹² These errors in administration could lead to either an increased risk of hypoglycemia or an increased risk of inadequate glycemic control.

The occurrence of hypoglycemia is one of the most important barriers to achieving tight glycemic control, and rates of hypoglycemia may be more common in the elderly patient. However, use of insulin pen devices may actually improve rates of hypoglycemia often seen with the traditional vial and syringe method of delivery. One observational study demonstrated that patients treated with insulin pens experienced a significant improvement in rates of hypoglycemia ($P < 0.05$), and another analysis of third party claims found that the initiation or addition of a pen device both increased medication adherence while decreasing hypoglycemic events.^{13,14} In Korytkowski et al two serious hypoglycemic events occurred in those patients using the vial/syringe method. There were no cases of hypoglycemic events in those patients who used the pen device.¹⁵ In contrast, Coscelli et al reported no significant difference in the incidence of hypoglycemic episodes in patients 60 years of age or older using the vial/syringe compared to the pen.⁹

Dose accuracy may be an advantage to insulin pen devices over the traditional vial and syringe method especially with smaller doses (<5 units).⁷ Some products also allow for dosage correction, and if too many units are dialed, the dose can be corrected by dialing backwards. According to Korytkowski et al 73% of patients reported more confidence in injecting the correct dose with the insulin pen device compared to 19% of patients using the vial/syringe method.¹⁵ When assessing dose accuracy in the Humalog[®] KwikPen[™] compared to the vial/syringe method, Ignaut et al found that moderate to high doses (30–60 units) prepared with the pen were more accurate than vial and syringe.¹⁶

Insulin pen devices may also be especially advantageous for those patients with visual impairment or dexterity issues due to the availability of larger digits in a dose window or digital dose display. Some of the pens also provide audible clicking with dosage selection and injection completion which can help with accurate dosing. In a trial assessing safety and efficacy of the prefilled disposable pen compared to vial and syringe administration, 85% of patients reported they found the dose scale on the prefilled pen easier to read.¹⁵ The patient questionnaire reflected that 82% of patients reported greater confidence with setting the required dose when using the insulin pen device.¹⁵ Additional studies note that patients find selection of

the correct insulin dose easier compared to the vial and syringe method of insulin administration.^{9,17,18}

Other considerations for safety in choosing an insulin pen device for an elderly patient may include the type of device. The device types and features will be discussed in further detail later in this review; however, when discussing the dosing accuracy of pen devices, it should be noted that minimum and maximum dosage, as well as the minimum dosage increments, should be considered when individualizing therapy. Many elderly patients may only require small doses of insulin, and therefore pen devices allowing 0.5 unit adjustments may be advantageous. Digital dose displays and memory features are also available with specific products such as the OptiClik[®] and HumaPen[®] Memoir[™] and may help the patient obtain a more accurate dose.^{19,20} It should also be noted that pen devices need to be primed prior to use. The insulin pen devices require an “air shot”, “safety shot”, or priming in order to prevent the injection of air and ensure accurate dosage for delivery. This is an important area of education for elderly patients in order to ensure dose accuracy.

Efficacy

It is estimated that less than half of patients with diabetes achieve a HbA1c goal of <7% as set forth by the ADA, and this amount is even higher when considering a HbA1c goal of ≤6.5% as set forth by the American Association of Clinical Endocrinologists (AACE); up to two thirds of patients do not reach this level of glucose control.^{21,22} As diabetic complications are often the result of inadequate glucose control, it is important to also consider the efficacy of available insulin pen devices in comparison to the traditional vial and syringe method. Few studies have evaluated an objective direct association between glycemic control and the use of pen devices; often it is the patient's perception of efficacy and dosing accuracy that lead to an assumption of improved glycemic control. However, several studies have evaluated both the perceived and actual clinical efficacy of insulin pen devices in the overall population as well as the elderly.

In one 12 week crossover study in patients with an average age of 57 years, the use of biphasic 70% insulin aspart protamine suspension and 30% insulin aspart in both the prefilled insulin pen

device (FlexPen)[®] and the vial/syringe method was compared.¹⁵ In this study, there was an overall statistically significant improvement in glycemic control, with a mean reduction in HbA1c values of 0.3% ($P < 0.05$), regardless of which method of insulin delivery was used.¹⁵ Another 12 week crossover study conducted in patients who were over the age of 60 compared the NovoLet pen device to the vial/syringe method.⁹ Investigators found that pre-lunch glucose levels were significantly lower in the patients who used the pen device ($P < 0.01$); however, no significant differences were found in HbA1c values or other prandial glucose levels.⁹

A study involving 25 elderly patients who were suboptimally controlled on two doses of NPH alone found significant decreases in HbA1c, from 7.8% to 7.6%, preprandial breakfast and lunch glucose levels, and postprandial breakfast and dinner glucose levels ($P < 0.05$ for all values) when subjects were given an alternate pen device. Interestingly, a decrease was seen in the total daily insulin dose when patients received therapy with the pen device. Although no patients were optimally controlled at study entry, 29% of patients were able to reach HbA1c goals at the end of the three month period.²³

Patient perception of clinical efficacy may also impact use of insulin therapy. A comparison of the FlexPen[®] device and the vial/syringe method found that patient perception of clinical efficacy was found to be higher with the FlexPen[®], with the greatest improvement seen in insulin-naïve patients ($P < 0.001$).²⁴

While insulin has been shown to decrease complications that may arise from uncontrolled hyperglycemia, the method of injection should be considered. Insulin pen devices have shown comparable efficacy to the traditional vial/syringe method, and some evidence exists to suggest that this efficacy is also similar and potentially better in the elderly population. Additionally, the perception of efficacy has been shown to be higher in patients using pen devices.

Ease of Use

Ease of use is an important aspect to consider when choosing insulin delivery devices for all patients, but particularly in the elderly as older patients may need more time than younger patients to learn the various functions of the different available pen devices.²⁵

Diabetic patients often experience age-related complications such as poor vision or impaired manual dexterity, which can lead to inaccuracies in dosing.^{12,17,26} Visual impairment in particular is common in the aging diabetic population; 16 to 27% of diabetic patients ages 65 to 75 have a visual acuity of approximately 20/40 feet or worse, respectively.²⁷ Pen devices offer several features, such as single-unit dosing increments, an easy-to-push release button, an audible click when dialing doses, large dose selectors, and a dial that clearly shows the selected dose that make pen devices easier to use than the traditional vial/syringe method.²⁸

In one 12 week study of elderly diabetic patients age 60 years and older, patients were assessed on their ability to use a pre-filled insulin pen device compared to the vial/syringe method. Patients were randomly assigned to either the vial/syringe or the pen device for 6 weeks and were then switched to the other delivery system for an additional 6 weeks. At weeks 2 and 6 of pen device insulin delivery, patients were asked to complete a questionnaire that assessed the patients' ability to use the pen device versus the vial/syringe method of delivery; 90% of patients rated the pen device either very easy or easy to understand.⁹ Likewise, Korytkowski et al found that 85% of patients found it easier to read the insulin dose scale with the pen device in comparison to the 10% of patients using the vial/syringe; overall 74% of patients found that the pen device was easier to use than the vial/syringe method of insulin delivery.¹⁵

Shelmet et al followed 79 elderly diabetic patients who had visual and/or motor disabilities severe enough that they experienced ongoing difficulties with insulin injection with the vial/syringe method of insulin delivery or required the assistance of a caregiver. Patients were randomized to receive either the vial/syringe method or the InnoLet[®] pen device for six weeks and then were switched to the alternate regimen for an additional six weeks. The study also found that while 60% and 36% of patients required assistance in drawing up the appropriate dosage and injecting insulin, respectively, over half of the study population (53%) were able to independently administer insulin with the pen device.¹⁷ Another interesting aspect of this study is that costs associated with daily nursing assistance were significantly reduced as a result of the increase in independence found with the pen device.¹⁷

Despite the above findings, ease of use cannot necessarily be considered equal with all pen device delivery systems. Haak et al assessed usability and pen features for SoloStar[®], Humulin/Humalog[®] (Lilly pen), and the FlexPen[®] device.¹⁹ Usability involved completing such tasks including removing the cap, attaching the needle, activation of the dose knob, delivering a safety dose, dialing a 40 unit dose, and delivering the dose. A comparison of the SoloStar, FlexPen[®], and the Lilly Disposable pen in patients 60 years of age and older found that a higher percentage of patients were able to correctly complete the assessed steps with the SoloStar (90%) and FlexPen[®] (83%) versus the Lilly Disposable pen (47%). Likewise, patients with visual and manual dexterity impairments were more able to complete the steps when using either SoloStar (94% and 91%) or FlexPen[®] (84% and 89%); in comparison, only about 50% of patients using the Lilly Disposable pen were found able to complete the assessed steps.¹⁸ Lower injection force associated with the SoloStar[®] pen may contribute to the success of this device in those with dexterity issues and this finding has been seen in other studies as well.²⁹ Additionally, several studies have found that patients prefer the ease of use associated with the FlexPen[®] device in comparison with other insulin pen devices. One simulation study comparing the Humalog Pen to the FlexPen[®] demonstrated that patients scored the FlexPen[®] significantly higher in overall ease of use, including ease of dose setting ($P < 0.001$), ease in pressing the release button ($P < 0.01$), and simplicity ($P < 0.01$); the higher rating for the FlexPen[®] was consistent for patients with both visual and manual dexterity impairments as well.³⁰ Similarly, another study comparing the FlexPen[®] to the Humalog pen device found that 74% of patients preferred the FlexPen[®] for overall ease of use, including the following parameters: ease of reading the dose scale, ease of feeling the click for each unit increment, ease of depressing the injection button, ease of turning the dose selector, and ease of determining that push button was completely depressed.³¹ Health care professionals have also expressed a preference for the ease of use of the FlexPen[®] device when compared to both the Humulin Pen and the OptiSet; of 102 health care professionals supervising patients initiating therapy, 85% thought that it would be easy to teach patients to use the FlexPen[®], and 71% thought that less induction time would be required for FlexPen[®].³²

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