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# Neurologic Examination of the Diabetic Foot to Prevent Diabetic Foot Ulcer

*by Imroatul Farida*

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# Neurologic Examination of the Diabetic Foot to Prevent Diabetic Foot Ulcer at Puskesmas Kebonsari Surabaya, Indonesia

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## ABSTRACT

**Background:** Neuropathy is a complication of DM that changes the structure and function of peripheral nerves, causing diabetic neuropathy due to peripheral nerve degeneration. Neuropathy examination is used to prevent Diabetic Foot Ulcers (DFU), but it is still rarely done or has not become a routine examination in health services. Alternative examination of neuropathy with the Ipswich Touch Test (IpTT). The aim of this study was to identify neurosensory-peripheral disorders in the diabetic foot. **Methods:** The research design used a quantitative description with a cross-sectional approach involving 40 respondents. Intervention with diabetic foot examination using the Ipswich Touch Test (IpTT) instrument which the neurosensory peripheral measurement decreased if the IpTT score was below 2-6. Sampling technique with accidental sampling approach. **Results:** The results of the neurosensory peripheral examination in patients with type 2 diabetes mellitus through the IpTT examination had an average value of 3.85 out of a total score of 6, which means that the respondent experienced a decrease in sensory function. **Conclusion:** The majority of patients with diabetes mellitus type 2 have decreased neurosensory peripheral function, so it will be high risk of diabetic foot ulcers. Nurses can perform an Ipswich Touch Test (IpTT) on diabetic feet to assess peripheral neurosensory function to prevent diabetic foot ulcers.

**Keywords:** Neuropathy; Neurosensoriperipheral; Ipswich Touch Test (IpTT); Diabetes Mellitus

## INTRODUCTION

Neuropathy is a change in the structure and function of the motoric, sensory, and autonomic peripheral nerves, which causes diabetic neuropathy due to peripheral nerve degeneration (Sembiring, Simbolon & Lase, 2018). Neuropathy causes pain, tingling, numbness or numbness, muscle stiffness, cramps, hypersensitivity to impaired bladder control, and muscle weakness. The problem of neuropathy in people with diabetes mellitus is also exacerbated by a decrease in the immune system so that they are susceptible to infection. Patients with diabetes mellitus (DM) who experience the slightest wound will be very easy to experience tissue necrosis which ends in amputation if not handled properly (Sembiring, Simbolon & Lase, 2018). People with diabetes may develop several different foot problems as a result of nerve damage (Abo Deif & Abdelaziz, 2019). Neurological examination to prevent Diabetic Foot Ulcers (DFU) in patients with type 2 diabetes mellitus is

still rarely done or has not become a routine examination at the Kebonsari Health Center Surabaya. The reality in the field is that there are still many people with diabetes mellitus who experience neurological disorders of the feet, both micropathies, and macropathies, who have not had a neurological examination to reduce the risk of DFU. Patient's autonomy rises in importance, it becomes increasingly important for patients to assume responsibility for their health care (Rosli *et al.*, 2022).

According to The Foundation for Peripheral Neuropathy, DM sufferers who experience peripheral neuropathy are as much as 25% of DM patients in the world (Hicks & Selvin, 2019). Peripheral neuropathy is the most common complication in DM patients and 50% of type 2 DM patients (Tabatabaei-Malazy *et al.*, 2011). The PERSI and Information Center (Indonesian Hospital Association) stated that the prevalence of neuropathy in 2011 in DM patients in Indonesia was more than 50%. This statement is reinforced by the Basic Health Research (Riskesdas, 2018) which shows that the most

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diabetes complications are neuropathy. BPJS patients data in 2016 stated that DM patients who experienced chronic complications of neuropathy were recorded at the Internal Medicine Poly Hospital of Dr. M. Soewandhi was still quite high in 2016 as many as 691 people (71.90%) of which 497 people were caused by type 2 DM (Putri, 2015). The results of a preliminary study at the Kebonsari Public Health Center in Surabaya found that out of 10 patients with diabetes mellitus type 2 were examined, there were 8 people (80%) with neurological disorders in diabetic feet and 2 people (20%) with normal diabetic feet.

DM with neuropathy will increase the risk of DFU seven times higher than DM patients without neuropathy (Soheilykhah *et al.*, 2018). Patients with DM if blood glucose levels are not controlled will occur chronic complications in the form of nerve disorders called neuropathy. Neuropathy causes changes in nerve tissue due to the accumulation of sorbitol and fructose resulting in loss of axons, decreased speed of induction, paresthesias, decreased muscle reflexes, muscle atrophy, excessive sweating, dry skin, and loss of taste, accelerate the occurrence of diabetic foot ulcers (Alport & Sander, 2012).

Efforts to detect neuropathic disorders in diabetic feet to prevent diabetic foot ulcers need a neurological examination. A neurological examination can be done through sensitivity examination using the Ipswich Touch Test (IpTT). IpTT is a method for early detection of Diabetic Foot ulcers (DFU) that is easy to do, fast, effective, does not cost money, is sensitive, specific, and does not require other instruments (Sharma *et al.*, 2014). How to use IpTT by touching the tips of the first, third, and fifth toes using the examiner's finger for 1-2 seconds. The touch should be light and gentle. If the patient does not feel the touch 2 points then it is declared neuropathy (Diabetes, 2012). The purpose of this study was to identify peripheral neurosensory disorders in the diabetic foot.

**METHODOLOGY**

The research design used descriptive quantitative with a cross-sectional approach. The study was conducted in May 2020. The population in this study was 45 people with diabetes mellitus type 2 at Puskesmas Kebonsari Surabaya. The sample of this study amounted to 40 people using accidental sampling. The population data questionnaire was used to examine the population data of respondents which included gender, age,

education, work history, cigarette consumption, diabetic foot exercise, taking DM medication, and blood sugar control. Intervention for neurosensory peripheral examination of the diabetic foot using the Ipswich Touch Test (IpTT) instrument (Basir *et al.*, 2020; McLaren & Lu, 2022; Sulistiani, Djamaluddin & Rahim, 2022). The method of using IpTT is that the tip of the patient's toe is touched with the examiner's finger. Touch for 1-2 seconds is gentle and smooth and no pushing, tapping, or piercing is given to the six points of the patient's toes who have been asked to close the eyes during the examination. Foot sensitivity assessment at 6 locations including the tip of the right big toe, the tip of the little toe of the right foot, the tip of the left big toe, the tip of the little finger of the left foot, the tip of the middle finger of the right foot, the tip of the middle finger of the left foot. If touch 2 is no sensation, there may be damage to the neurosensory peripherals. The maximum value is 6 and the minimum value is 0. The statistical test uses descriptive numerals.

**RESULTS**

Characteristics of Respondents in DM Type 2 Patients at the Kebonsari Health Center Surabaya

*Table 1: Characteristics of Respondents in DM Type 2 Patients at the Kebonsari Health Center Surabaya in May 2020*

No.	Characteristics of Respondents	Frequency	Percentage	
1.	Gender	Man	18	45%
		Women	22	55%
2.	Age	49-55 years	5	12.5%
		56-61 years	16	40%
		62-67 years	19	47.5%
3.	Last education	Elementary school	6	15%
		Junior high school	12	30%
		Senior high school	20	50%
		College	2	5%
4.	Job Experiences	Farmworkers	7	17.5%
		Housewife	16	40%
		Government employees	3	7.5%
		Pensioner	1	2.5%
		Enterpriser	13	32.5%
6	Cigarette consumption	Yes	11	27.5%
		No	29	72.5%
7	Diabetic Foot Gymnastics	Yes	10	25%
		No	30	75%
8	Take DM drugs	Regular	36	90%
		Irregular	4	10%
9	Blood Sugar Control	Regular	31	77.5%
		Irregular	9	22.5%

Table 1 shows that the characteristics of respondents in DM type 2 sufferers are mostly female, aged 62-67

years, last high school education, work as a housewife, do not consume cigarettes, do not exercise diabetic feet, take DM medication, and control blood sugar regularly.

Sensory nerve examination results with IpTT examination in DM type 2 patients at the Kebonsari Health Center Surabaya

**Table 2: Sensory Nerve Examination Results with IpTT Examination in DM Type 2 Patients at the Kebonsari Health Center Surabaya In May 2020**

IPTT Score (There is a sensation)	Frequency	Percentage
0	0	0%
1	0	0%
2	3	7.5%
3	14	35.0%
4	12	30.0%
5	8	20%
6	3	7.5%
Total	40	100%
Average value	3.85	

Table 2 shows that the 40 respondents who underwent neurosensory peripheral examination using IpTT had a score of 2 as many as 3 people (7.5%), a score of 3 as many as 14 people (35.0%), a score of 4 as many as 12 people (30.0%), a score of 4 5 as many as 8 people (20.0%) and score 6 as many as 3 people (7.5%). The average value of the neurosensory peripheral examination using IpTT was 3.85.

**DISCUSSION**

Based on the research data obtained in table 2, in general, the results of the neurosensory peripheral examination in patients with diabetes mellitus type 2 through the IpTT examination have an average value of 3.85 out of a total score of 6, which means that the respondent has decreased sensory function. This is because people with diabetes mellitus experience sensitivity disorders due to damage to large nerve fibers. These nerve fibers supply the distal part of the foot and cause the foot to lose light and touch sensation. Increased oxidative stress will interfere with impulse delivery so people with diabetes mellitus will lose foot protection. Symptoms that arise will make people with diabetes mellitus not feel any touch or pressure on the tips of the toes (Deli *et al.* 2014).

According to Bare & Smeltzer (2002) loss of protective sensation of the feet is caused by chronic hyperglycemia which disrupts cell metabolism

resulting in microangiopathy and macroangiopathy. This disorder causes a decrease in blood flow to nerve cells and tissues, which can lead to hypoxia in nerve cells. Nerve cell hypoxia can cause myelination and axon stasis in nerve cells and Schwann cells so that nerve conduction can be disrupted (Sanjaya, Yanti & Puspita, 2019). Disturbances in the sensory nerve fibers/conductors of the feet have an impact on the decrease in the sensitivity of the nerves in the feet that function as protective sensations. Loss of protective sensation makes DM patients more prone to diabetic foot ulcers (Sanjaya, Yanti & Puspita, 2019).

The results of research conducted by Purwanti & Maghfirah (2016) using IpTT, showed as many as 29 people with diabetes mellitus with a percentage (85.3%) experiencing impaired foot sensitivity. Another study using IpTT said that 52 out of 93 with a percentage (55.9%) of diabetic ulcer patients had impaired foot sensitivity. Based on the researcher's observations in table 2, the assessment of peripheral neurosensory function using IpTT examination to assess foot sensitivity at 6-point locations (tip of the right big toe, tip of the little finger of the right foot, tip of the left big toe, tip of the little finger of the left foot, tip of the middle toe of the foot right, middle fingertip of left foot) the majority had decreased neurosensory peripheral function. As evidenced by the results of the IpTT score obtained a score of 2 to 4 as many as 26 respondents from 40 respondents. This means that respondents cannot feel two or more touches on their toes, then the patient is said to have decreased sensation and is at risk of developing diabetic foot ulcers.

Based on the researcher's observations in table 1, the decrease in neurosensory peripheral function is also influenced by several factors, including gender, and age, and the majority of respondents do not exercise diabetic feet. Data on the characteristics of the respondents in table 1, the female gender tends to be more, as many as 22 people (55.0%) and as many as 18 people (45.0%) the males. This is because women tend to be more at risk of developing diabetes mellitus associated with a large body mass index and menstrual cycle syndrome and during menopause which results in easy accumulation of fat which results in inhibition of glucose transport into cells (Imelda, 2019).

Age can also affect a person's sensory level decline. Based on table 1, most of the respondents aged 62-67 years were 19 people (47.5%), while those aged 56-61

years were 16 people (40.0%), while those aged 49-55 years were 5 people (12.5%). The results of this study prove that with increasing age, the risk of neuropathic complications increases (Putri & Waluyo, 2019). This is because insulin resistance increases with advancing age. Factors that contribute to insulin resistance are decreased muscle mass (sarcopenia), being overweight, reduced physical activity, and the pancreas not functioning as well as in younger people (Sujana, 2019). It is different from Kamaru, Mohd & Hussein (2018), research showed that there was no significant relationship between age, duration of diabetes, body image, occupation, monthly income, and level of education with the knowledge and the level of foot care.

Based on the characteristics of the respondents in table 1, the majority of respondents did not do diabetic foot exercises as many as 30 people (75%), and those who did diabetic foot exercises as many as 10 people (25%). Respondents who do not do diabetic foot exercises are at risk of decreased peripheral neurosensory function because they do not move, the sensation in the nerves of the feet will die, but if they do movement or exercise then there is stimulation of peripheral blood flow to increase so as not to worsen the level of neuropathy to decrease. Diabetic foot exercises can increase the use of glucose in the muscles, many cell capillaries are open so that insulin receptors become more active. This can affect controlled blood glucose levels (Sembiring, Simbolon & Lase, 2018). Diabetic foot exercise helps improve blood circulation, which carries oxygen and nutrients to the cells and nerve tissue, which will affect the metabolic processes of Schwann cells so that axon function can return to normal. Optimal nerve cell function in DM patients will maintain the function of foot sensitivity (Brahmantia *et al.*, 2020). Diabetic foot exercise can be used as an alternative intervention to increase the value of the ABI (Ankle Brachial Index) in patients with type 2 DM (Bakara & Kumiyati, 2021).

Based on the data in table 2, although the majority of respondents experienced a decrease in neurosensoriperipheral function, some respondents did not experience a decrease in (normal) neurosensoriperipheral function. These respondents had an IpTT score of 3 people (7.5%) and an IpTT 5 score of 8 people (20%) from 40 respondents, which means that respondents can feel the touch of all their toes or do not feel the touch of only one of their toes. Then the patient is said to have normal foot sensation and is not at risk of developing diabetic foot ulcers.

This is because respondents do not smoke, regularly control blood sugar and regularly take DM medication as evidenced by table 1 that respondents who do not smoke are 29 people (72.5%) and respondents who smoke are 11 people (27.5%). Respondents who regularly take DM medication are 36 people (90%) and respondents who do not regularly take DM medication are 4 people (10%). Respondents who regularly control blood sugar as many as 31 people (77.5%) and who do not regularly control blood sugar were 9 people (22.5%).

Respondents who do not smoke help improve blood pressure in the ankle and have a large effect on reducing complications (Simatupang, Pandelaki & Panda, 2013). Complications that can occur are angiopathy which causes a decrease in blood flow to nerve cells and tissues that it can cause hypoxia in nerve cells. Nerve cell hypoxia can cause myelination and axon stasis in nerve cells and Schwann cells so that nerve conduction can be disrupted (Sanjaya, Yanti & Puspita, 2019). (Respondents who are obedient or regularly take DM medication will control their blood sugar, therefore, being obedient or regularly taking DM medication can control blood sugar to prevent complications (Nanda, Wiryanto & Triyono, 2018). Knowledge and adherence to medication are very important for controlling diabetes (Al-Amedy, Yoong & Ahmed Saido, 2018).

## CONCLUSION

The majority of patients with diabetes mellitus type 2 at the Kebonsari Public Health Center in Surabaya have decreased neurosensory peripheral function, so it will be a high risk of diabetic foot ulcers.

## Conflict of Interest

The authors declare that they have no conflict of interests.

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## Ethical Approval

This current research received ethical approval from the Health Research Ethics Committee of Sekolah Tinggi Ilmu Kesehatan Hang Tuah Surabaya, Indonesia, with a Certificate of Ethical Eligibility Number: PE/35/ VI/2020/KEPK/SHT, dated 05<sup>th</sup> June 2020.

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# Neurologic Examination of the Diabetic Foot to Prevent Diabetic Foot Ulcer

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