

# EVALUATION OF THE DIABETIC FOOT

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## ABSTRACT

Diabetic foot disease accounts for 700 lower limb amputations annually in Singapore. The feet should be examined comprehensively annually to identify risk factors predictive of ulcers. The comprehensive foot examinations can be accomplished in the physician primary care clinic. The feet are classified by risk of ulceration and a system of reviews set up with the patient. High-risk foot should be referred to the specialist for further evaluation. Practical footcare guidelines should be taught to every diabetic patient. Advice on daily inspection, foot hygiene, and proper footwear can markedly reduce the incidence of diabetic ulcer formation. Routine follow-up visits present opportunities to detect and treat incipient foot problems. The presence of symptoms suggestive of neuropathy and vascular insufficiency is evaluated. The examination for neuropathy, peripheral vascular disease, structural abnormalities, and footwear will allow the identification of problems for intervention before they pose a danger to limb and life. A reduction of lower extremity amputations (LEA) by 50% is possible.

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## INTRODUCTION

Foot problems are an important cause of morbidity in patients with diabetes. They account for 700 lower extremity amputations (LEA) annually in Singapore (MOH, 2001)<sup>1</sup>. The best predictors of future limb amputations are a history of a previous foot ulcer, the presence of neuropathy and peripheral arterial disease, and poor glycaemic control<sup>2,3</sup>.

Foot amputation can be prevented with early recognition and preventive therapy<sup>4,5,6,7</sup>. There are four major warnings that must be looked for to predict future foot problems – impaired vascular circulation, neuropathy, structural abnormalities, and lack of self care<sup>8</sup>.

For the diabetic patient, the feet should be examined comprehensively annually to identify risk factors predictive of ulcers. At each routine follow-up visit, questioning for foot discomfort and visual inspection of the feet should be performed.

## PATHOPHYSIOLOGY

The risk of peripheral arterial diseases is increased with the duration of Type 2 diabetes. Al-Delaimy et al<sup>5</sup> in a study of 48,607 men found that the relative risk of peripheral arterial disease in Type 2 diabetics compared to non-diabetics was 1.4 and 4.5 for 1 to 5 years and > 25 years of diabetes respectively,

even after controlling for other cardiovascular risk factors. The risk of peripheral arterial disease is accelerated with poor diabetic control.

The prevalence of diabetic neuropathy in patients with Type 2 diabetes has been estimated by Young et al and Franklin et al to be 32% overall<sup>4,2</sup> and more than 50% in patients over the age of 60 years. The lifetime risk of a foot ulcer for a diabetic patient is 15%. Neuropathy promote ulcer formation by decreasing sensation of pain and perception of pressure, by causing muscle imbalance leading to anatomical deformities, and by impairing the microcirculation and the integrity of the skin. More than 80% of patients with foot ulcers had neuropathy. Once the ulcer is formed, healing will be delayed once infection sets in as this tends to penetrate deep into the tissues.

Structural abnormalities are a potent cause of foot ulceration. These may range from biomechanical abnormalities like hammertoes, bunions, and Charcot deformities; to gait abnormalities causing uneven pressure on the foot; small muscle atrophy of the foot due to neuropathy causing abnormalities like claw toes from unopposed action of the larger muscles in the tibial compartment and subluxation of the proximal interphalangeal joints; to uneven weight bearing problems causing ulceration<sup>1,8,9</sup>.

Autonomic neuropathy results in decrease sweating and shunting of blood from arteries to veins. The skin becomes dry and cracks, predisposing to infection. Decrease perfusion from the shunting of blood results in poor wound healing.

## SYSTEMATIC FOOT EVALUATION

Instituting a system of foot care evaluation and education can substantially reduce the morbidity and mortality. The screening process can be done with simple office equipment and a simple program can easily be implemented in the office setting. Studies show that a systematic screening, treatment and patient education protocol can reduce LEA by 44-85%<sup>9,10,11,12</sup>.

### Identifying diabetic foot-related risk conditions

Effective care begins with a partnership between patients and professionals, and all decision making should be shared. This will enhance the patient's motivation to present for assessments and also to take responsibility for the day-to-day self management of the feet. Arrange for annual reviews of the feet as part of ongoing care. As part of such a review, examine the patient's feet to detect risk factors for ulceration. This should include<sup>9</sup>:

- κ testing of foot sensation using a 10g monofilament or vibration
- κ palpation of foot pulses
- κ inspection of any foot deformity and footwear.

The details<sup>1</sup> are shown in Table 1.

### Classification and follow-up frequency

Based on the examination findings, classify foot risk in respect to ulcer formation as: low current risk; increased risk; high risk; and emergency and ulcerated foot<sup>9</sup>. People with one or more foot risk conditions should be evaluated more frequently for the development of additional risk factors<sup>10</sup>. For those at high risk of foot pathology, a referral to the community or hospital specialist footcare team should be considered<sup>14</sup>. See Table 2<sup>9</sup>.

### Patient education to reduce amputation risk

Foot care advice should be given to all patients who are diabetic. Table 3<sup>1</sup> shows the practical footcare guidelines that can be printed out and given to the patient to read up and use.

Of the list of do's and don'ts in Table 3, the following are the key items to checkout with the patient at each review:

- κ Avoid smoking, walking barefoot, use of heating pads or hot water bottle, and hot springs bath.
- κ Trim toe nails across and not too short.
- κ Inspect the feet daily for areas of skin breaks, blister, swelling or redness between and underneath the toes.
- κ Wear shoes that are snug, not tight and socks that are made of cotton and loose fitting. Those with misshapen foot may benefit from a custom made shoe<sup>15</sup>.
- κ Wash the feet daily with a mild soap and tepid water and pat dry especially between the toes.
- κ If the feet are dry, apply moisturising lotion to both feet.

**Table 1. Diabetic foot-related risk conditions**

Description	Signs & Symptoms
Ulceration or prior lower extremity amputation	<ul style="list-style-type: none"> <li>o History of ulceration</li> <li>o History of Lower extremity amputation</li> </ul>
Peripheral neuropathy ?	<ul style="list-style-type: none"> <li>o Negative monofilament* sensation</li> <li>o Negative pin prick sensation</li> <li>o Negative tuning fork 128Hz (vibratory perception threshold) sensation</li> <li>o Presence of paraesthesia or anaesthesia</li> </ul>
Peripheral vascular disease	<ul style="list-style-type: none"> <li>o Absent pedal pulses</li> <li>o Absence of hair</li> <li>o Absence of gradual temperature gradient</li> <li>o Intermittent claudication/rest pain</li> </ul>
Altered biomechanics	<ul style="list-style-type: none"> <li>o Bony deformity</li> <li>o Gross foot deformity</li> <li>o Limited joint mobility</li> <li>o Osteoarthopathy (Charcot joint)</li> <li>o Abnormal gait</li> </ul>
Dermatological & nail pathologies	<ul style="list-style-type: none"> <li>o Presence of ulceration (with/without infection)</li> <li>o Callus with haemorrhage</li> <li>o Ingrown toenails, mycotic toenails, onychogryphotic nails</li> <li>o Evidence of neglect or poor foot hygiene</li> <li>o Interdigital maceration</li> <li>o Fissuring (especially heels)</li> <li>o Skin and/or tinea pedis infections</li> </ul>
Poor Footwear	<ul style="list-style-type: none"> <li>o Slippers, "flip-flops", "thongs"</li> <li>o Tight or ill-fitting shoes</li> <li>o Abnormal wear patterns</li> </ul>

Footnote \* Semmes-Weinstein 5.07 monofilament

Source: CPG on Diabetes mellitus, MOH, 2006

**Table 2. Classification and follow-up frequency of diabetic foot disorders**

Category of foot risk & frequency of review	Care needs
<b>Low current risk of foot ulcers</b> (normal sensation, palpable pulses) κ Annual review	κ Agree a management plan including foot care education with each person. See Table 3.
<b>Increased risk of foot ulcers</b> (neuropathy or absent pulses or other risk factor) κ Arrange regular review, 3–6 monthly, by foot protection team.	κ At each review: <ul style="list-style-type: none"> <li>– inspect patient's feet</li> <li>– consider need for vascular assessment</li> <li>– evaluate footwear</li> <li>– enhance foot care education.</li> </ul> κ NB If patient has had previous foot ulcer or deformity or skin changes manage as high risk
<b>High risk of foot ulcers</b> <b>(neuropathy or absent pulses plus deformity or skin changes or previous ulcer)</b> κ Arrange frequent review : (1–3 monthly) by foot protection team.	κ At each review: <ul style="list-style-type: none"> <li>– inspect patient's feet</li> <li>– consider need for vascular assessment</li> <li>– evaluate and ensure the appropriate provision of               <ul style="list-style-type: none"> <li>o intensified foot care education</li> <li>o specialist footwear and insoles</li> <li>o skin and nail care.</li> </ul> </li> </ul> κ Ensure special arrangements for those people with disabilities or immobility.
<b>Foot care emergencies and foot ulcers</b> (new ulceration, swelling, discolouration) κ Refer to multidisciplinary foot care team within 24 hours.	κ Expect that team, as a minimum, to: <ul style="list-style-type: none"> <li>– investigate and treat vascular insufficiency</li> <li>– initiate and supervise wound management:               <ul style="list-style-type: none"> <li>o use dressings and debridement as indicated</li> <li>o use systemic antibiotic therapy for cellulitis or bone infection as indicated</li> </ul> </li> <li>– ensure an effective means of distributing foot pressures, including specialist footwear, orthotics and casts</li> <li>– try to achieve optimal glucose levels and control of risk factors for cardiovascular disease.</li> </ul>

Table 3. Practical footcare guidelines

DO's	DON'Ts
<b>Inspect Your Feet Everyday</b> <ul style="list-style-type: none"> <li>κ <b>Do</b> look on top, underneath, in between toes, around heels.</li> <li>κ <b>Do</b> look for cuts, scratches, abrasions or any broken skin.</li> <li>κ If found, <b>Do</b> wash with saline, dress with dry sterile dressing daily.</li> <li>κ If wound doesn't start to heal within 2 days, <b>Do</b> consult your doctor or podiatrist.</li> </ul> <b>Foot Hygiene</b> <ul style="list-style-type: none"> <li>κ <b>Do</b> wash feet daily using mild soap and warm water. Pay attention to in between toes.</li> <li>κ <b>Do</b> test water temperature with wrist or arm first to ensure it is not too hot.</li> <li>κ <b>Do</b> pat dry especially in between toes.</li> <li>κ If feet are dry, <b>Do</b> use moisturizing cream nightly except in between toes.</li> </ul> <b>Socks / Hosiery</b> <ul style="list-style-type: none"> <li>κ <b>Do</b> ensure socks/stockings are not too tight.</li> <li>κ <b>Do</b> change socks/stockings daily.</li> <li>κ <b>Do</b> ensure proper fit i.e. no bunching or wrinkling underneath.</li> </ul> <b>General Hints</b> <ul style="list-style-type: none"> <li>κ <b>Do</b> cut toenails straight across and not too short.</li> <li>κ <b>Do</b> seek help from your doctor, podiatrist or nurse educator if you are unsure of anything on your feet.</li> <li>κ <b>Do</b> exercise.</li> <li>κ <b>Do</b> maintain good diabetes control.</li> </ul>	<b>Foot Neglect</b> <ul style="list-style-type: none"> <li>κ <b>Don't</b> neglect your foot as small problems can turn into big problems quickly.</li> </ul> <b>Bathroom Surgery</b> <ul style="list-style-type: none"> <li>κ <b>Don't</b> cut hard skin, ingrown toe nails yourself.</li> <li>κ <b>Don't</b> use corn plasters, corn cures.</li> </ul> <b>General Hints</b> <ul style="list-style-type: none"> <li>κ <b>Don't</b> smoke</li> <li>κ <b>Don't</b> walk barefoot. Always wear footwear inside and outside the house.</li> </ul>

Source: CPG on Diabetes mellitus, MOH, 2006

## EVALUATION DURING ROUTINE VISITS

### History

Routine follow-up visits of the diabetic patient provide opportunities to provide foot care. The patient should be questioned about leg discomfort. If present, following the simple guide outline below can be used to quantify the significance of the symptoms. These symptoms may be the result of neuropathy alone or both neuropathy and peripheral vascular insufficiency.

Points	Sensation	Location	Wakefulness	Timing	Relieving
0	Elsewhere			Day only	Sitting or lying
1	Fatigue, cramping or aching	Calves	Awaken at night because of pain	Day and night	Standing
2	Burning, numbness or tingling	Feet		Night only	Walking around

The total symptoms are tabulated and then determined:

- ⌘ 0 to 2: normal
- ⌘ 3 to 4: mild
- ⌘ 5 to 6: moderate
- ⌘ 7 to 9: severe

### Physical Examination

The aim of the foot examination in such situations is to assess for the presence of neuropathy, peripheral arterial disease, structural abnormalities, as well as footwear suitability and footwear pattern.

### Testing for neuropathy in a symptomatic foot

There are three basic screening tests for peripheral neuropathy, vibration, pressure, and temperature.

- ⌘ Vibration sense is conducted using a 128-hz tuning fork applied to the bony prominence at the dorsum of the big toe. The patient is asked to report the start of the vibration and the cessation of the vibration.
- ⌘ Pressure sensation can be tested and quantified by using various monofilament (figures 2 and 3). The 5.07 (10g) monofilament is placed on designated sites on the dorsum of the foot and pressure is gradually applied till the filament buckles. The patient is asked to report if he or she felt the pressure of the filament. See Figure 1. Missing more than 1 site is a positive test.
- ⌘ Pain and temperature can be tested using a disposable sharp toothpick and test tubes filled with warm water respectively.

The neuropathic signs score can then be quantified based on the physical findings similar to the symptoms score outline above.

Points	Archilus reflex	Vibration sense	Pin prick	Temperature
1 for each foot	Present with reinforcement	Absent or reduced	Absent or reduced	Reduced
2 for each foot	Absent			

The scores are tabulated and totalled:

- ⌘ 0 to 2: normal
- ⌘ 3 to 5: mild
- ⌘ 6 to 8: moderate
- ⌘ 9 to 10: severe

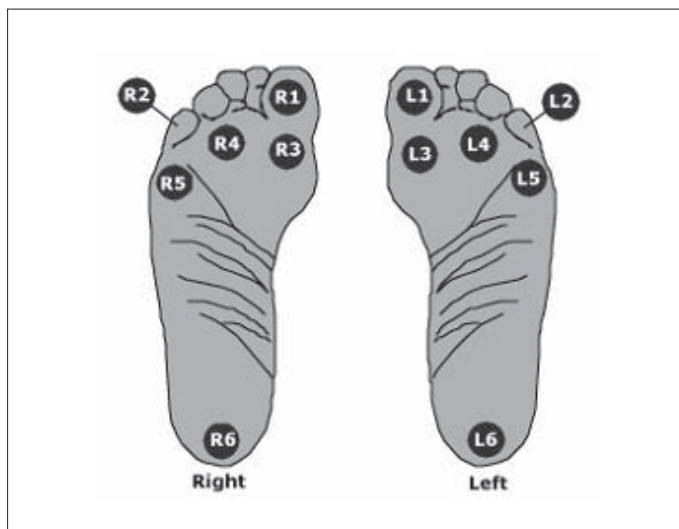


Figure 1. Test sites for neuropathy using a 10g monofilament

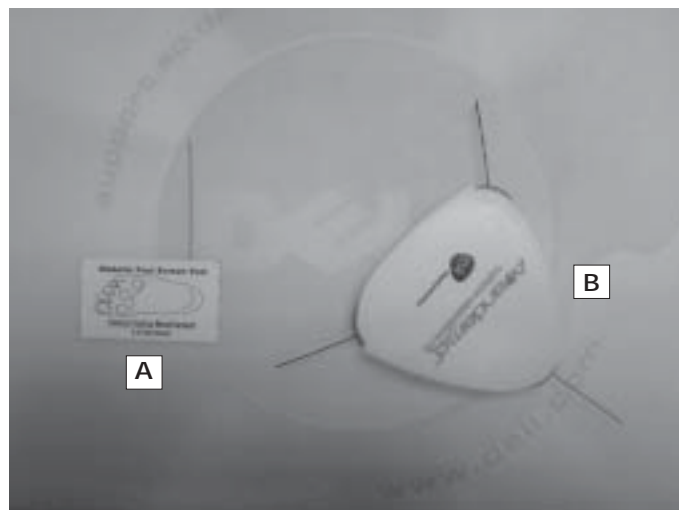


Figure 2. A: 5.07(10-g) monofilament, B: monofilament of various sizes for quantification of sensation

Peripheral neuropathy is considered to be present if there are moderate to severe signs (6 or more) even in the absence of symptoms or if there are mild signs (3 to 5) in the presence of symptoms. A high score of 8 is associated with a high-risk foot.

Simple screening methods described above have similar specificity and sensitivity for diabetic neuropathy<sup>15</sup>. One study found that failure to detect pressure from a 5.07 (10g) monofilament at any of the 12 places on the foot was the single most practical measurement of risk assessment<sup>16</sup>.

#### **Testing for peripheral arterial disease (PAD)**

In addition to evaluation for neuropathy the diabetic foot should be examined for signs of peripheral arterial disease such as absence of foot pulses, decrease in skin temperature, thin skin, lack of hair and bluish skin colour. During questioning a history of claudication should be obtained. Patients at risk should have their ankle brachial index assessed, as many patients with peripheral arterial disease are asymptomatic.

**Ankle Brachial Index (ABI).** The ABI should be measured in both legs in patients suspected of PAD to confirm the diagnosis as well as to establish a baseline. The systolic blood pressure (by Doppler probe) in the Brachial and posterior tibial are measured. The division of the ankle blood pressure and brachial pressure calculates the ABI. The normal ABI is 1 to 1.3, since the pressure is higher in the ankle than in the arm. An ABI of 0.9 has 95% sensitivity of detecting angiogram positive PAD and is associated with greater than 50% stenosis in one major vessel. 0.4 to 0.9 suggest a degree of arterial obstruction associated with claudication. Less than 0.4 indicates severe ischaemia. A stress ABI can be obtained in a patient whom you strongly suspect of PAD but the resting ABI is normal.

#### **Evaluating structural abnormalities**

The feet should be also evaluated for:

- ▯ Signs of current and past ulcers
- ▯ Lesions between adjacent toes due to pressure of cramping them together
- ▯ Macerated areas between the toes. These are painless and if neglected can lead to infections
- ▯ Bunions.

Diabetic foot ulcers, if present, can be graded and classified based on a schema devised by Wagner<sup>17</sup>:

- ▯ Grade 0: No ulcer in a high-risk foot
- ▯ Grade 1: Superficial ulcer involving the full thickness but not the underlying tissues
- ▯ Grade 2: Deep ulcer, penetrating down to the ligaments and muscle, but no bone involvement or abscess formation
- ▯ Grade 3: Deep ulcer with cellulites or abscess formation, often with osteomyelitis
- ▯ Grade 4: Localised gangrene
- ▯ Grade 5: Extensive gangrene involving the whole foot

#### **Evaluation of footwear**

Uneven wear on the footwear shows the pressure bearing areas on the foot and also indicates the areas likely to breakdown as ulcers<sup>18</sup>.



Figure 3. Testing the feet with the 5.07 monofilament



## Actions to take in the symptomatic foot

Tables 2 and 3 provide the guidance on action to take. The patient footcare guidelines need to be reviewed with the patient and any difficulty in adherence managed.

## DISCUSSION

What reduction in lower extremity amputation can we expect? Lavery et al's study<sup>13</sup> of 2738 patients in San Antonio, Texas in a disease management programme compared with a baseline study of 1708 patients showed that after 28 months, the incidence of amputations decreased 47.89% from 12.89 per 1000 diabetics per year to 6.18 ( $p < 0.05$ ). The number of foot-related hospital admissions decreased 37.8% from 22.86 per 1000 members per year to 14.23. The conclusions are clear. A population-based screening and treatment programme for the diabetic foot can dramatically reduce hospitalizations and clinical outcomes.

## CONCLUSIONS

Evaluation of the diabetic foot is the important first step to reduce the risk of lower extremity amputations. This may be a systematic, annual assessment of the foot. In addition, the follow-up visits of diabetic patients provide opportunities for routinely enquiring for symptoms and inspection of the feet. These actions may be timely in nipping many brewing foot problems in the bud before they are allowed to escalate to threaten limb or life.

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## PATIENT INFORMATION NOTES: EATING OUT GUIDE

### INTRODUCTION

We are what we eat. Healthy eating is part of self management. In this eating out guide, tips for making healthier choices are given. Pay attention to making healthier choices in the intake of fats, sugars, salt, and fibre.

### YOUR DAILY RECOMMENDED REQUIREMENTS (ADULTS SEDENTARY WORK)

Nutrient	Male	Female
Calories (kcalories)	2000	1700
Fat (tsp)	13	11
Sodium (mg)	2000	2000
Sugar (tsp)	10	8
Fruit & Vegetables (servings)	4	4

### EATING MORE AND EATING LESS

Four tips to note from the food pyramid:

- κ Eat less food high in fats, and also salt – first tier of the pyramid
- κ Choose lean meat and low fat items – second tier of the pyramid
- κ Choose 2 servings of fruits and vegetables per day; control the fruit serving portions – third tier of the pyramid
- κ Control carbohydrate portions to control glycemic level – base of the pyramid.

### FATS

Daily Fat Allowance For Adults: 13 teaspoonfuls.

Types Of Fats:

- κ Saturated fatty acids (SFA) – raise LDL cholesterol levels – found mainly in – meat, fat, milk and milk products; also



Source: Health Promotion Board, Singapore

in coconut, palm kernel oil, and cocoa butter.

- κ Monosaturated fatty acids (MUFA) – lower LDL-cholesterol and raise HDL-cholesterol – found in – canola, olive, and peanut oils; almonds and avocados
- κ Polysaturated fatty acids (PUFA) – Lowers LDL-cholesterol – found in – nuts, seeds, and oily fish e.g. herring, sardine, salmon and mackerel.

#### Food Choices towards less fats

Choose less of saturated fatty acids, choose more mono-saturated, and polysaturated fatty acids. Together they must add to below 13 teaspoonful.

1 tsp fat = 5 g = 45 kcalories

#### Try these tips:

- κ Reduce deep fried food, snacks, and creamer
- κ Replace fried noodles with soup noodles
- κ Replace flavoured rice with plain rice
- κ Remove skin and visible fat from meat
- κ Request lower fat portions, less oil
- κ Leave gravy behind.

Choose these	Tsp fat	In place of these	Tsp fat
Steamed chicken bun	2	Curry puff	4
Fresh banana	0	Jemu-jemut pisang	2
Plain tea/plain coffee	0	Tea/coffee with creamer	1
Mee soup/mee soto	2	Mee goreng	4
Fishball noodles soup	1	Fried kway teow	8
Plain rice	0	Nasi lemak/flavoured rice	3
½ plain rice with chicken skin	2	Chicken rice	3
Laksa (leave gravy behind)	3	Laksa	6
Satay (10 sticks) with half bowl peanut sauce	7	Satay (10 sticks) with full bowl peanut sauce	11
McDonald's grilled chicken foldover	3	McChicken	6
McDonald's berrynice yohurt	1	McFlurry Crep	4

## SALT

Daily Salt Allowance For Adults: Not exceed 2000mg

Sauces		
Light soy sauce	1 tsp	370 mg
Dark soy sauce	1 tsp	200 mg
Oyster sauce	1 tsp	190 mg
Tomato sauce	1 tsp	50 mg
Chilli sauce	1 tsp	60 mg
Processed items		
Fish cake	1 piece	280 mg
Luncheon meat	1 slice	400 mg
Preserved salted vegetables	100g	1860 mg
Salted egg	1 medium	350 mg
Lap cheong (preserved Chinese sausage)	1 whole piece	730 mg
Dishes		
Laksa	1 bowl	1590 mg
Chicken rice	1 plate	1290 mg
Fishball noodles (soup)	1 bowl	2880 mg

### Try these tips:

- κ Slowly cut down on the amount of salt used – the taste buds will adjust after about a month.
- κ Limit dipping your food into sauces, use lemon/lime juices instead.
- κ Taste food before you add salt or sauces.
- κ Ask for less salt, gravy, and sauces.

## FIBRE

Fruits and vegetables provide the fibre that we need.

Remember to aim to take two servings of fruits and two servings of vegetables a day.

Fruits – examples of 1 serving:

- κ 1 small apple/pear/orange
- κ 1 medium banana
- κ 1 wedge of papaya/watermelon
- κ 10 grapes
- κ ¼ cup of dried fruit
- κ 1 cup pure fruit juice

Vegetables – example of 1 serving

- κ 100 g cooked vegetables (¾ cup)

### Try these tips:

- κ Include at least one vegetable-based dish for lunch and for dinner
- κ Include a serving of fruit with every meal
- κ Ask for more vegetables
- κ Replace meat dishes partially with beans or legumes
- κ Choose a dessert that has fibre:
  - o Black glutinous rice (bubur pulot hitam)
  - o White wheat (burbur terigu)
  - o Green bean soup (with less coconut)
  - o Red bean soup (with less coconut)

## SUGARS & STARCHY FOODS (CARBOHYDRATES)

### Food Choices towards less sugars

1 tsp sugar = 5 g = 20 kcalories

Choose these	Tsp sugar	In place of these	Tsp sugar
Diet drinks	0	Sweetened soft drinks	10
Canned unsweetened tea	0	Canned teas	5
Chiffon cake	3	Cake with icing	5
Soya bean curd	3	Chendol	7
Muesli bar (50 g)	2	Chocolate bar (50 g)	6

### Try these tips:

- o Choose more often – carbohydrate items that raise blood glucose slowly – brown rice, brown bread, white tofu
- o Take in moderation – carbohydrate items that raise blood glucose moderately – white rice, white bread, noodles
- o Take sparingly – carbohydrate items that raise blood glucose rapidly – sweet desserts, sweetened soft drinks, sweet cakes, and condensed milk.

\* Eat Well, Eat Healthy \*

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