Chapter 2

Insulin – Overview, Infections and Benefits of Immunization and Insurance

Ashish Chauhan

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.81346

Abstract

From the time the earliest description of diabetes appeared around 552 BC in the *Ebers Papyrus*, people have been searching for a cure for it. The term 'diabetes' was introduced by Aretaeus of Cappadocia, a Greek physician, (129–199 AD). Before the availability of insulin, any child who had diabetes had a very poor life expectancy, and the prognosis was also poor for any adult having the disease. In 1921, Canadian physician Frederick Banting and medical student Charles H. Best discovered the hormone insulin in the pancreatic extracts of dogs. Earlier, several injections of insulin were required daily; in the 1930s, H.C. Hagedorn, a chemist in Denmark, added protamine to the preparation and found that it prolonged the action of insulin. It was not until 1978 that the first recombinant DNA human insulin was prepared by combining the insulin A- and B-chains. Credit goes to David Goeddel and his colleagues (of Genentech) for this. Some innate (cytokines, complement) humoral immune functions are decreased and some remain the same in patients with diabetes mellitus (DM) compared to those without DM. We all know why diabetics are more prone to infections by this point. The science keeps the mind going but what keeps the heart going? Probably a big size chocolate bar for a diabetic with a blood sugar of. But no! Resistance is a key. If we are not going to resist that candy bar, nor are the bacteria or other organisms causing infection going to. There is not a lot we can do after this point, but there is quite a lot that could be done before—immunisation. Diabetes is an uphill battle for those that suffer from it; but the new health insurance schemes offered by the government should ease a little bit of the pressure. Insulin is not a definitive cure for diabetes but is definitely a form of life support. As of now, there is no complete cure for diabetes, but there may be one to wipe it out in the future due to the advancing technologies in the field of science.

Keywords: diabetes, insulin, immunisation, insurance

1. Introduction

Laughter is the best medicine. Definitely, if someone has diabetes, insulin would probably be needed to be started depending on the clinical scenario.

What is diabetes anyway? Diabetes is the disability of the body to produce or take up insulin, which leads to abnormal carbohydrate anabolism that implies an increase in glucose in the blood. Basically, any food that a person takes in has a certain relative value called 'glycaemic index', which indicates how much food is broken down into sugars and circulated to the rest of the body and utilised by organs for their proper functioning.

However, there is a saying in Chinese, wù jí bì fǎn. In layman terms, this means 'too much of a good thing is bad'; that is where insulin comes into play. Insulin is a protein hormone produced by the beta cells of pancreas and is apparently defective, diminished or even absent in about 415 million people globally, out of which 72.9 million people reside in India according to a 2018 census. It allows body to use sugar (glucose) from carbohydrates in the food that one eats for energy or to store glucose for future use. Insulin helps to keep the blood sugar level from getting too high (hyperglycaemia) or too low (hypoglycaemia).

2. A little bit of history

The term 'diabetes' was first used by the Greeks. It was given by Aretaeus of Cappadocia, a Greek physician, (129–199 AD). It means 'to pass through'; they used it to signify the large amount of water consumed and urine produced by diabetics. The term 'mellitus' was added by the Romans, meaning 'sweet as honey', when they noticed that the urine of diabetics was sweet.

In 1921, Canadian physician Frederick Banting (November 14, 1891 to February 21, 1941) and medical student Charles H. Best discovered the hormone insulin in the pancreatic extracts of dogs. Because the early insulin preparation required several injections daily, scientists worked hard to find ways to prolong its duration of action. H.C. Hagedorn, in the 1930s, who was a chemist in Denmark, prolonged the action of insulin by adding protamine. The first genetically engineered, synthetic 'human insulin' (first recombinant DNA human insulin) was produced in 1978 by David Goeddel and his colleagues (of Genentech) using *E. coli* bacteria.

3. Diabetes and insulin

There are two types of diabetes, type 1 which is hereditary because of variants in the HLA DQA1, HLA DQB1 and HLA DRB1 genes, which are crucial for forming certain proteins in the body, and type 2 which is acquired due to sedentary lifestyle or family predisposition.

Insulin is composed of two peptide chains, chain A which is made up of 21 amino acids and chain B which is made up of 30 amino acids. Both these chains are linked together by two disulphide bonds. Insulin causes the liver to convert more glucose into glycogen by a process

called glycogenesis and primarily forces muscle and fat tissue cells to take up glucose from the blood through the GLUT4 transporter, thus decreasing blood sugar. So, if there is a defect in production of insulin or its uptake, then there will be a rise in blood sugar which can lead to fatal complications if untreated.

These complications are lethal, not going to sugarcoat it because these may worsen it for a diabetic! It starts off with increased risk of developing cardiovascular disease, including atherosclerosis, stroke, peripheral artery disease and kidney disease. Diabetic neuropathy, diabetic nephropathy and stroke are some terminal complications.

Diabetes can be controlled in the form of tablets initially, but progressive stages require subcutaneous administration of insulin. Modern methods include transdermal patches or nasal spray.

Administration of insulin can be tricky if it is by the subcutaneous method. Repeated issuing of insulin into the same area can cause lipohypertrophy, a condition of excess accumulation of fat at the site of injection. The most fatal complication that can arise is hypoglycaemia.

Overdose or improper timing of administration of insulin can lead to dangerously low levels of insulin. Low sugar level initially causes hunger, sweating and shaking, but in the long run, it deprives the brain of its fuel, leading to the patient falling into a coma. Hence, it is always advised for a diabetic to have some food around which is ironic.

One can avoid this menace of a disease by altering the modern-day couch potato lifestyle. Keeping oneself hydrated is a good start, exercise is very important as well. Both these components of a healthy manner of living go hand in hand and can naturally lower blood sugar levels. Decreasing the carbohydrate intake and increasing the protein in an individual's diet may also be of great help. Avoidance of sugary food and drinks is a step in the right direction.

Insulin is not a definitive cure for diabetes but is definitely a form of life support. As of now, there is no complete cure for diabetes, but there may be one to wipe it out in the future due to the advancing technologies in the field of science. Strict adherence to medication and exercise can cause the severity of diabetes to lower down, but a normal lifestyle cannot be guaranteed.

If diabetes is so prevalent around the world, it must mean that the population below poverty line and lower middle class are affected as well up to some extent. Insulin can be costly, as it is not a definitive cure, but more of a life support as mentioned above. This is where health insurance is of maximum necessity, which will be shortly discussed in detail.

Diabetes is not something that should be overlooked. Let us say a 68-year-old, uncontrolled diabetic man came to an ophthalmologist with complaints of clouded vision for a long time, and is required to undergo a cataract surgery as soon as possible. If the surgery takes place without letting the sugar levels normalise, this can lead to a lot of postoperative ocular complications such as endophthalmitis, diabetic retinopathy and other diseases which can terminate in complete loss of vision. Such a simple act of patience like waiting for the uncontrolled sugar levels to subside can be detrimental to both the patient and reputation of the doctor.

The way to prevent major infections is via immunisation.

There is sufficient awareness about diabetes in the community, but not sufficient enough about how pernicious it can be if not controlled. Apprehension of such an ailment should be spread by the health sector as well as the media. Medical camps and general hospitals should ensure the illiterate patients are educated to understand the basic knowledge of health-related issues such as diabetes, and that thorough follow-up with the medication is necessary to sustain a healthy lifestyle.

4. Infection in diabetes

The incidence of infections is increased in patients with diabetes mellitus (DM) [1]. Some of these infections are also more likely to have a complicated course in diabetic than in non-diabetic patients [1]. Diabetic ketoacidosis, for example, is precipitated or complicated by an infection in 75% of the cases. The mortality rate of patients with an infection and ketoacidosis is 43% [1]. In a prospective study of 101,293 adult hospitalised patients, 1640 episodes of bacteraemia were diagnosed. Of 1000 hospitalised patients studied, 2/3 of the bacteraemia were found in patients with DM compared to 1/3 in patients without DM ($P < 0.001$) [2].

5. Defects in innate immunity and relation to humoral innate immunity

The immune system can be divided into innate and adaptive-humoral or cellular immune systems. Concerning the humoral adaptive immunity, serum antibody concentrations in patients with DM are normal and they respond to vaccination with pneumococcal vaccine as well as non-diabetic controls [3, 4]. Furthermore, no differences have been shown in the immune response to intramuscular hepatitis B vaccine between children with DM type 1 and controls [5]. Concerning the adaptive cellular immunity, inhibition of the proliferative response to different stimuli has been observed in the lymphocytes of diabetics with poorly controlled disease [6]. An abnormal delayed-type hypersensitivity reaction (cell-mediated immunity) has also been described in DM type 1 and type 2 patients [7–9].

6. Complement function

In a study of 86 DM type 1 patients, 22 (26%) had a serum complement factor 4 concentration (C4) below the normal range [10]. The low C4 values did not appear to be the result of consumption. Since non-diabetic identical twins also had a C4 concentration below normal, and the genes encoding C4 are linked with the antigens DR3 and DR4 (which are expressed in 95% of the Caucasian diabetic patients in contrast to 40% of the general population [6]), the authors suggest that the reduced C4 level may be an inherited phenomenon [10].

7. Cytokines

Studies with whole blood, peripheral blood mononuclear cells (PBMCs), and isolated monocytes of diabetics have to be divided into studies with and without stimulation. Without stimulation, tumour necrosis factor alpha (TNF-α) concentrations in patients with DM type 1 [11], interleukin (IL) 6 concentrations in patients with DM type 2 [12] and IL-8 concentrations in DM type 1 and 2 patients [13] have been studied. Elevated resting values of TNF-α, IL-6 and IL-8 were found in diabetic patients compared to non-diabetic controls.

Studies with PBMCs and isolated monocytes of diabetic patients after stimulation show the following results: in one study [14] the IL-1 secretion of PBMCs in response to lipopolysaccharide (LPS) was reduced in diabetic (type 1 and 2) PBMCs, while the TNF-α response was the same as in the control cells. In another study, monocytes of DM type 1 patients showed a significantly lower production of IL-1 and IL-6, but again no differences in TNF-α concentrations were measured, after stimulation with LPS, compared with monocytes of DM type 2 patients and non-diabetic controls [15]. Possibly most of the TNF-α already disappeared after the incubation period of 24 h [15]. Neither glucose nor insulin showed any effect on the production of IL-1 or IL-6 in isolated monocytes, so the decreased production after stimulation with LPS seemed an intrinsic cellular defect of diabetic cells. It is possible that the elevated resting value of diabetic cells leads to the induction of tolerance to stimulation, which results in lower cytokine secretions after stimulation. This phenomenon has already been described in non-diabetic cells [16].

Studies of cytokine excretion by PBMCs of non-diabetic patients after the addition of different glucose concentrations have shown comparable results as studies with diabetic cells. One study [17] showed that after the addition of different glucose concentrations, unstimulated monocytes of non-diabetics showed an increased TNF-α and IL-6 response. Another study [18] showed that after pokeweed mitogen stimulation, lower IL-2, IL-6 and IL-10 concentrations were found after the addition of glucose (with a dose-response effect). Possibly, the induction of tolerance, described above, can also explain these results. In other words, the presence of glucose leads to a higher resting cytokine production; after stimulation, however, this cytokine production is impaired compared to the situation without glucose. Another substance which may play a role in the increased basal cytokine secretion is the advanced glycation end products (AGEs, which are products of glucose and lysine or arginine residues). An increased formation of AGEs takes place in poorly regulated diabetic patients [19]. Different studies have shown that binding of these AGEs to non-diabetic cells, without stimulation, leads to an increased cytokine production [17, 20, 21]; so, it seemed that the increased formation of these AGEs in diabetics may be responsible for the increased basal cytokine secretion.

8. Hyperglycaemia/glucosuria

Following the 1985 WHO criteria, DM is defined as a fasting glucose concentration of at least 7.8 mmol l^{-1} or a 2-h glucose concentration of 11.1 mmol l^{-1} or higher [22]. As a result of

this, patients with DM (also with medication) very often have hyperglycaemia. This hyperglycaemic environment can enhance the virulence of certain microorganisms. An example is *Candida albicans*, which expresses a surface protein that has great homology with the receptor for complement factor 3b (CR3). Normally, opsonisation of microorganisms takes place by attachment of complement factor 3b (C3b). Receptors on phagocytising cells recognise this bound C3b and attach, thereby initiating ingestion and killing. In a hyperglycaemic environment, the expression of the receptor-like protein of *C. albicans* is increased, which results in competitive binding and inhibition of the complement-mediated phagocytosis [23]. Another example is the presence of glucosuria, as found in poorly regulated patients. We showed [24] that glucosuria enhances bacterial growth of different *Escherichia coli* strains, which probably plays a role in the increased incidence of urinary tract infections in diabetic patients.

9. Other serum factors

In vitro tests analysing the functions of non-diabetic polymorphonuclear cells (PMNs) are carried out by incubating these cells with plasma derived from patients with DM. These defects are not correlated with the amount of glucose present in plasma [6, 25, 26]. An example is the increased adherence of PMNs of non-diabetic patients to bovine aortic endothelium in the presence of diabetic plasma [27]. This increased adherence probably leads to a decrease in diapedesis and exudate formation of PMNs [27]. The question arises which factor in diabetic serum is responsible for the difference mentioned above. It has been suggested [28] that AGEs play a role. Since the formation of AGEs is increased in poorly regulated patients, it seemed that an optimal diabetes regulation possibly can improve the host response.

Another frequently mentioned substance in the pathogenesis of infections in diabetic patients is zinc. Low plasma zinc levels have been reported in DM type 1 and type 2 patients [6]. Nevertheless, in another study, no differences in zinc levels between diabetic and non-diabetic subjects were found [29]. In vitro studies described a disturbed lymphocyte response and depression of chemotaxis in diabetic PMNs when zinc deficiency was present [1, 6, 28]. Other in vitro studies with PBMCs of non-diabetic patients showed an enhanced LPS-induced excretion of pro-inflammatory cytokines after the addition of zinc [30]. Considering the contradictory epidemiological data about zinc deficiency in DM patients, the clinical relevance of the above-mentioned in vitro results in the pathogenesis of infections in diabetic patients remains unclear.

In conclusion, some innate (cytokines, complement) humoral immune functions are decreased and some remain the same in patients with DM compared to those without DM.

10. Cellular innate immunity: PMNs and chemotaxis

A significantly lower chemotaxis has been found in PMNs of diabetic patients (type 1 and type 2) than in those of controls [25, 31, 32]. However, it could not be demonstrated in the study in which (we studied) the PMN function in women with DM having asymptomatic bacteriuria were

compared to non-bacteriuric diabetic women (healthy controls) were studied [33]. All studies used serum from healthy controls. It is possible that the different stimuli (zymosan, complement) of the PMNs and the differences in patient characteristics (duration, regulation and complications of DM, DM type 1 or DM type 2) in the above-mentioned studies may explain these contradictory results. No correlation was found between glucose concentration [25, 32] or haemoglobin A1c (HbA1c, which is a serum marker for the regulation of the DM) level and the chemotactic responses, although one study showed a further reduction in chemotaxis in patients with hyperglycaemia [31]. Interestingly, one of the other studies showed that the chemotactic responses of the PMNs did not alter after the incubation of either glucose or insulin, but returned to normal values after the incubation with glucose and insulin together [32]. Since most PMN functions are energy-dependent processes [34], an adequate energy production is necessary for an optimal PMN function. Glucose needs insulin to enter the PMNs to generate this energy, which may explain the improvement of the chemotactic response after the addition of these two substances.

11. In vitro adherence of diabetic PMNs

Conflicting data have been reported about the in vitro adherence of diabetic PMNs without stimulation [25, 27, 31, 34, 35]. In contrast, no differences have been found between diabetic and control PMNs after stimulation [27, 31]. No correlation was found between plasma glucose or HbA1c and adherence [25, 27, 31]. However, in a small number of DM type 1 and DM type 2 patients with untreated hyperglycaemia, the decreased adherence of PMNs to nylon fibre columns increased after the hyperglycaemia was corrected [34, 35]. Of course, adherence to nylon fibre columns is not the same as to endothelial cells as a first step in the inflammation reaction. However, again a better regulation of the DM seemed to increase the host response.

12. Phagocytosis

PMNs of diabetic patients have shown the same [25, 33] and a lower [31, 36] phagocytotic capacity compared to PMNs of controls. The mean HbA1c concentration was lower (better regulation) in patients without impaired phagocytosis [33] than in those with impaired phagocytosis [31, 36]. One study [36] showed an inverse relationship between the HbA1c levels and the phagocytotic rate. Another study [37] showed that the decreased phagocytosis improved, but did not become normal after 36 h of normoglycaemia. Therefore, it seems that impairment of phagocytosis is found in PMNs isolated from poorly regulated patients and that better regulation of the DM leads to an improved phagocytotic function.

13. Oxidative burst

Chemiluminescence (CL) corresponds to the emission of light directly or indirectly produced in the course of a chemical reaction. This phenomenon is often used to evaluate the oxidative potential of PMNs, a process during which free radicals are synthesised early in the phagocytotic

process [31, 38]. CL correlates well with antimicrobial activity [39] and may be used as a measure of phagocytotic capacity [38]. Compared to controls, CL at baseline was higher [31] or the same [36, 39] in PMNs of diabetic patients. These studies [31, 36, 39] also showed that, after stimulation, the CL of diabetic PMNs was lower than that of control PMNs. It is possible that the reaction of diabetic PMNs to stimuli is quenched as a result of the higher resting CL.

14. Killing

Data about the bactericidal activity of diabetic PMNs have yielded conflicting results [25, 26, 33, 37]. An impaired killing function of diabetic PMNs was found in all studies using *Staphylococcus aureus* as the microorganism [25, 26, 37], but not in the studies in which the killing of *C. albicans* [33] was used as the measure. Killing was impaired in one study that used non-diabetic serum for opsonisation [37], but not in another [33]. Thus, based on these studies, any conclusions about the effect of non-diabetic serum on the killing of diabetic cells cannot be drawn. No correlation was found with glycaemic level [25, 26, 37], although some studies have shown that bactericidal activity improved, but did not normalise after achieving normoglycaemia [6, 37].

15. Cellular innate immunity: monocytes/macrophages

Both impaired chemotaxis and phagocytosis of the monocytes of diabetic patients have been described [1, 40]. Since plasma from healthy controls does not cause any significant change in the phagocytotic capacity of diabetic monocytes [40], it seems that this impaired function is caused by an intrinsic defect in the monocytes themselves.

A lower immune response in children with DM type 1 compared to controls was found after intradermal (instead of intramuscular) administration of the hepatitis B vaccine [5]. It has been suggested that this lower response is probably partly the result of an impaired macrophage function in this patient group [5].

In combination with the earlier mentioned decreased production of pro-inflammatory cytokines after LPS stimulation in DM type 1 patients, it seemed that monocyte/macrophage functions are impaired in DM type 1 patients.

16. Adherence

Adherence of a microorganism to mucosal or epithelial cells is an important step in the pathogenesis of infections. Host-related factors may influence this adherence. For example, women with recurrent urinary tract infections have a greater adherence of *E. coli* to their vaginal and buccal cells compared to controls [41].

C. albicans infection is frequently found in diabetic patients. Since infection mostly is preceded by colonisation, Aly et al. investigated which risk factors increased the risk of *Candida* carriage in diabetic patients [42]. Risk factors for oral *Candida* carriage in patients with DM type 1 were a

lower age and a higher HbA1c level (poor regulation of DM). Continuous wearing of dentures and the presence of glucosuria (also an indication of a poor DM regulation) increased the risk of *Candida* carriage in DM type 2 patients, the mean number of cigarettes smoked per day was correlated with *Candida* carriage in DM type 1 and type 2 grouped together [42]. Cameron et al. extracted lipids from human buccal epithelial cells and found, using chromatogram overlay assays, that some *C. albicans* strains bind to fucose-containing and other *C. albicans* strains to *N*-acetylgalactosamine-containing lipids extracted from human buccal cells. The authors conclude that the existence of several adhesin-receptor systems contributes to the virulence of *C. albicans* [43]. The carbohydrate composition of receptors probably plays an important role in the susceptibility to infections. It has been shown that severely ill patients have a decreased amount of galactose and sialic acid on their buccal cells, compared with minimally ill patients and healthy controls. The investigators mentioned that these receptor changes possibly lead to an increased adherence of microorganisms and play a role in the high prevalence of Gram-negative bacterial colonisation in the respiratory tract of these patients [44]. This mechanism of increased adherence, due to an altered receptor carbohydrate composition, is possibly also present in diabetic patients. Buccal cells from 50 diabetic patients (DM type 1 and type 2) showed an increased in vitro adherence of *C. albicans* compared to buccal cells from controls [45]. A significantly higher incidence of *Candida* infection, but not *Candida* carriage, was also found in this patient group (12% versus 0%) [45]. No relationships, however, were found between the frequency or quantity of *Candida* and age, duration, regulation or type of DM [45]. This increased adherence to diabetic cells might also play a role for other microorganisms, for example the adherence of *E. coli* to uroepithelial cells, which would explain the increased prevalence of infections in patients with DM.

In conclusion, disturbances in cellular innate immunity play a role in the pathogenesis of the increased prevalence of infections in DM patients. In general, a better regulation of the DM leads to an improvement of cellular function. A second important mechanism is the increased adherence of the microorganism to diabetic cells. Furthermore, some microorganisms become more virulent in a high-glucose environment.

17. Types of infections from diabetes

Diabetes could cause the following infections:

- Bladder infections
- Skin infections
- Foot infections
- Oral infections

17.1. Bladder infections

People with diabetes are more likely to get these infections than those without diabetes. It involves the kidney, ureter, bladder and urethra. Major complaint from such infection includes:

- Burning micturition
- Urinary urgency (a sudden compelling urge to urinate)
- Polyuria (producing abnormally large volumes of dilute urine)
- Nocturia (waking up at night for voiding urine)
- Urinary incontinence(uncontrolled leakage of urine)
- Blood in the urine
- Cloudy appearance of urine
- Strong smelly urine

Additionally, if it is an infection in the kidney:

- Upper back and side (flank) pain
- High fever
- Shaking and chills
- Nausea
- Vomiting

If it is an infection in the bladder:

- Pelvic pressure
- Lower abdomen discomfort
- Frequent, painful urination
- Blood in urine

If it is an infection in the urethra:

- Burning on urination
- Discharge

17.2. Skin infections

There is increased risk of bacterial and fungal infections. The best way to avoid this is to take care of skin and look out for early symptoms.

For bacterial infections,

you have to look out for:

- Stye (infection of the glands of the eyelid)
- Boils folliculitis (infections of the hair follicles)

http://dx.doi.org/10.5772/intechopen.81346

- Carbuncles (deep infections of the skin and the tissue underneath)
- Infections around the nails

For fungal infections it may be:

- Ringworm
- Vaginal yeast infection
- Athlete's foot

Diabetics are more likely to develop overgrowth of yeast-like-fungus, *Candida albicans*. The patient comes with complaints of itchy rashes, moist red areas, surrounded by tiny blisters and scales. Common sights are areas of warm, moist folds of skin. Identifying in the early stages is the key for successful treatment.

17.3. Foot infections

Like already mentioned, foot infections occur due to reduced blood supply to the extremities. Proper care of feet must be done by methods that will be later mentioned.

17.4. Oral infections

Elevated blood sugar leads to elevated sugar levels in the saliva, leading to increased growth of bacteria in the mouth. This predisposes to:

- Plaque on the teeth
- Gum disease
- Breath odour

17.4.1. Gingivitis

Here, the gums are unhealthy, swollen, bleed easily and appear red.

17.4.2. Periodontitis

This is a mild to severe gum disease. Symptoms are:

- Red and swollen bleeding gums
- Gums pulled away from the teeth
- Long-lasting infection between teeth and gums
- Presence of pus between teeth and gums

- Persistent bad breath
- Loose teeth

17.4.3. Thrush

This occurs due to candidiasis, that is, overgrowth of candida yeast as white or red patches in the mouth. This can be treated by fungal medications.

17.4.4. Dry mouth

Here, there is not enough saliva in the mouth. This poses a high risk for gum diseases and cavities. The patient complains of trouble in talking and difficulty in swallowing. The treatment for this is occasionally drinking sips of water and avoiding tobacco, alcohol and caffeine.

17.4.5. Oral burning

This is a sensation of burning in the mouth, dry mouth and bitter taste. Oral care must be followed, which will be mentioned later.

17.5. Prevention

"I may have diabetes, but diabetes does not have me."

The first and foremost way is to control the sugar levels in the blood.

Second most important measure is undergoing immunization which will be taken in detail in the later pages.

Prevention or early diagnosis is mostly done for foot infections and oral infections.

17.5.1. Foot infections

The following should be done, in case of foot infections:

- Wash your feet everyday
- Keep the skin soft and smooth
- Smoothen corns and calluses gently
- Trim your toenails regularly
- Wear shoes and socks at all times
- Ensure that minor cuts do not turn into ulcerated infections which migrate to the bloodstream

http://dx.doi.org/10.5772/intechopen.81346

17.5.2. Oral infections

The following should be done in case of an oral infection:

- Use a soft bristle toothbrush
- Angle the toothbrush towards your gum line
- Use a gentle scrubbing motion
- Brush your tongue and gums
- Replace toothbrush every 3–4 months
- Floss once a day, using a clean section of floss per tooth
- When flossing, scrub up and down, each side of your tooth
- See your dentist regularly for check-ups and cleanings

17.5.3. Urinary infections

This has to be done mostly for women and children. In cases of urinary tract infection (UTI), the following has to be checked for:

- Toilet hygiene
- Regular emptying of bladder
- Prompt urination after sexual intercourse
- Ample fluid intake

17.5.4. Vaginal infections

Yeast infections can be avoided by the following:

- Eating foods with active culture (yoghurt with acidophilus)
- Avoidance of spermicides and douches

17.5.5. Common symptoms of all infections

- Alert for:
  - An increased body temperature
  - Change in blood sugars
  - Foul-smelling vaginal discharge
  - Pain while urination

- Cloudy and bloody appearance of urine
- Painful swallowing
- Irregular bowel movement

18. What are the other consequences of a high sugar level in the blood?

"Sometimes I pretend I'm not diabetic, but that's a dangerous game."
– Unknown

Interestingly, sometimes an infection can lead to diabetes and not the other way round which we encounter usually.

An infection can cause our body to produce higher levels of certain hormones like adrenaline or cortisol. These hormones counter the effect of insulin, thus increasing the levels of sugar in the blood which may trigger an episode of diabetic ketoacidosis.

19. Immunisation

As spoken above about the seriousness of diabetics and insulin and infection, why is not the prevention of that infection not spoken much about? Is it that we always wait for the seriousness of a situation to escalate to maximum to actually take it into consideration and look for cure even after reaching a stage of no cure? Are people only preaching prevention is better than cure but not actually practicing it? Well, fellow humans! We have reached an era of high prevalence in vaccine-preventable diseases and it is time we prevent them for good.

We all know why diabetics are more prone to infections by this point. The science keeps the mind going but what keeps the heart going? Probably a big size chocolate bar for a diabetic with a blood sugar of. But no! Resistance is key. If we are not going to resist that candy bar nor are the bacteria or other organisms causing infection going to. There is not a lot we can do after this point, but there is quite a lot that could be done before—immunisation.

As spoken about already, it is estimated that 415 million people are living with diabetes around the world. That makes it 1 in every 11 people in the world's population. At this rate, it is estimated to reach a dramatic 642 million by the year 2040. Diabetes being non-communicable, hence, increased dramatically over the past few years and according to the statistical staircase imagine how many people will be suffering in the future! If such a non-communicable disease has such an increase, imagine how fast the other infections as spoken above will become more and more common? As if that question did not scare you enough, imagine how many infections will mess with diabetics in the coming future? We have already gone through some very notorious infections that play around with the life of diabetics and surprisingly looking at the bright side, most of them are vaccine preventable.

Influenza, pneumococcal and hepatitis stand as the most important vaccine-preventable infections in diabetics along with many others. Additionally, we need to take care of diphtheria, typhoid, pertussis, tetanus and shingles. These viruses as we have come across already have a high tendency to cause infection in people with weak immune systems, which is important to note among diabetics.

The influenza virus is famous for causing infection in the elderly usually at the age of around 65. People who have weak immune systems with underlying ailments are more prone to such infections. Diabetics are at a risk of more severe form of the disease. Vaccination is available against the flu whose compliance against the disease can be found to be effective seasonally.

Coming to pneumococcal vaccination, there are two types of vaccines for this infection, the pneumococcal conjugate vaccine (PCV13) which protects against 13 types of pneumococcal bacteria and the pneumococcal polysaccharide vaccine (PPSV23) which protects against 23 types of pneumococcal bacteria.

As in the case of typhoid, this vaccine works by exposing you to a small amount of the bacteria, which causes your body to develop immunity to the disease. **Typhoid vaccine will not treat an active infection that has already developed in the body**, and will not prevent any disease caused by bacteria other than *Salmonella typhi*.

As for diphtheria, pertussis and tetanus, the potent Tdap vaccine protects patients against tetanus, diphtheria, and pertussis. Tetanus can lead to tightening of the muscles of the head and neck and kills 1 in 10 people with the infection, while diphtheria can cause breathing problems, heart failure, paralysis and death, according to the centers for disease control and prevention (CDC). Pertussis causes serious coughing fits that can strain breathing, cause vomiting and disturb sleep.

As for shingles, the zoster vaccine protects individuals against shingles, which is the reactivation of the chicken pox virus. Shingles presents as a painful rash, with pain that can persist even after the rash clears up.

We all know by this point that people with diabetes are more prone to infection. So, it is not surprising to note that people with diabetes are prone to hepatitis B infection more than nondiabetics. Hence, hepatitis B vaccination is recommended for everyone. It is a series of three vaccine shots. The second shot is taken 1 month after the first and the third dose is taken 6 months after the first.

The centre for disease control and prevention had recommended several other vaccines for diabetic patients. Various vaccines are provided against measles, mumps, rubella, chicken pox, herpes, diphtheria, tetanus and many others.

It is always recommended to be aware of the vaccinations taken in the past and to enquire with a doctor to know more information on your status and keep a record hence forth.

No matter how much we keep speaking about these great vaccines which have always given us a second chance, it is important to seek its help before it is too late. That is where the importance of early immunisation comes in. Immunisation is a simple way of protecting against so many harmful diseases. But many times, it is neglected and it is not surprising to know that it is not hard for diabetics to neglect vaccination either. Many infectious diseases are rare or eradicated

now as a result of our immunisation programmes that have been ongoing from the past, but new infectious diseases are appearing around the world which increases the need to promote the importance of early immunisation. Immunising yourself not only means protection to yourself but also protection to the future generations against these deadly diseases. It is a crucial step in eradication of some of the most deadly diseases. It protects and continues to protect you and everyone around you from easily preventable disease. There are people in the community who take this matter into utmost importance and take their vaccines when required and make sure people around them do so too. But quite a few do not do so. Some may not be able to take vaccine if they might be too weak or sick as they might be vulnerable to the infection if vaccine is taken: these people are usually an acceptation but those who do not get vaccinated just because of mere carelessness or unawareness are something that can be changed. On a positive note, the importance of early immunisation can be spread around the world only when those taking it show a difference than those who do not. But, why wait for that difference? You never know when you might get infected by a needle prick. For all we know, people doing their daily duties for a living are getting infected even when they take all measures to prevent it. Except one: the person taking vaccination. It may be a simple step, but it makes all the difference.

Every country must do its part to make this world a safer and better place for us and our future generations to live in. Immunisation stands as priority not only in diabetics but also for everyone whether or not they are suffering from any diseases, because, remember, prevention is better than cure. That being said, WHO has recommended every country to have a national immunisation programme based on the country statistics on prevalent infectious diseases that are vaccine preventable. India has put to action the Universal Immunisation Programme (UIP) which was launched in 1985. The programme now consists of vaccination for 12 diseases: tuberculosis, diphtheria, pertussis (whooping cough), tetanus, polio, measles, hepatitis B, diarrhoea, Japanese encephalitis, rubella, pneumonia (Haemophilus influenza type B) and pneumococcal diseases (pneumococcal pneumonia and meningitis). Our country has come a long way in planning for the health and well-being for us and generations to come. The plan has been put to use but it is not going to be 100% effective unless everyone does their part in creating awareness and spreading the importance for early immunisation.

As we slowly approach the end of the discussion on immunisation, let us discuss the other modes of preventing infection in diabetics other than immunisation.

The most important measure to protect themselves from infection that most diabetics neglect is to maintain clean foot hygiene and always wear footwear or socks to protect the foot from minor injuries. Every now and then, the foot must be checked for any scratches or cuts or other skin problem which could give way for an infection. If any such things are present, they should be maintained clean so that the infection is not given a chance to enter the bloodstream and aggravate. Good urinary hygiene should also be maintained. In women, clean vaginal hygiene is of utmost importance as well. Eating food rich in active cultures are helpful in preventing yeast infections.

All these measures can help people suffering with diabetics protect themselves from further infections. If you are a diabetic and have not followed the above prevention methods, then, it is time to make change because it is better late than never. But if you do not have diabetes and are happy, well my friend, get yourself immunised! You do not have to be a diabetic to be susceptible

to infection. Anyone can get infected anywhere, any time. So, do not laze around or ignore the seriousness of the situation because prevention is better than cure. Spend a few rupees now getting vaccinated. It saves much more than when you have to spend to treat the disease later on.

20. Insurance

20.1. Introduction to insurance

India has an expenditure of 1.5 lakh crore on availability of insulin preparations to the general public, and yet many people are unable to afford the medication required.

Since majority of India's population is not in the upper or upper middle class, a major hurdle is faced by the health sector in order to keep the physical quality of life index (PQLI) of the population in check. To ensure that the money spent on health necessities by the country is balanced out with the rise in the demand of medication by people who cannot afford it, the government introduced health insurance into the country. Ironically, only a small portion of individuals are making use of this advantage and a majority of the population have probably never even heard of the term insurance!

Based on the age, type of diabetes and various other factors, the government targeted certain groups of people to make sure that the insurance scheme is most favourable to them.

Diabetes is an uphill battle for those that suffer from it, and their providers. Medical expenses and the complications that may occur for diabetics are far more than those for nondiabetics. It is a major struggle in the present world, but the new health insurance schemes offered by the government should ease a little bit of the pressure.

As mentioned before, awareness must be spread by the government and those employed in the health sector via medical camps. In this modern era, everyone is hooked onto at least one type of social media platform.

Therefore, spreading the word on various social media is a great step in the right direction and must be implemented more extensively.

The amount of awareness and utilisation of these insurance schemes among the population have a direct correlation to diminished expenditure from the diabetics.

This way, many lives that are taken due to the mere absence of medication can be avoided and even diabetics among the economically unstable can lead to a better life.

20.2. Insurance schemes

A few government-implemented health insurance schemes in India are:

- Central government heath scheme
- Universal health insurance scheme
- Aam Aadmi Bima Yojana, Rashtiya Swasthiya Bima Yojana

There are also several private sector insurance companies offering health insurance, such as:

- Star health insurance
- ICICI prudential
- Apollo Munich Health insurance
- National insurance
- Religare Health Insurance, etc.

which are all diabetic safe. They all offer health care insurance services to the people of our country.

21. I-I-I-I as a full unit

The above all, that is, **insulin**, **infection**, **immunisation** and **insurance,** are interrelated.

A decrease or lack of **insulin** causes diabetes, which is a great predisposing factor to make the individual more susceptible to various **infections.** The various infections can be prevented mostly by using **immunisation**. If immunisation is not done for the individual at an early age, he will be under the financial burden of the medicines, hospital visits and doctor consultations related to diabetes, in the later stages of his life, for which the government has come up with various **insurance** schemes.

Therefore, as we have seen above, **insulin is just the tip of the iceberg.** So, when we treat a case of diabetes, it is not sufficient to look at just the amount of insulin administered to the patient, but also taking care that the patient does not get any infections. Additionally, from a preventive stand point, it is important to make sure that the entire population is immunised at a very early age against the various infections that diabetes get. Lastly, it is also important to look at the various insurance schemes because diabetes as a disease is a great financial burden, not only to the family but also to the country as a whole.

As already mentioned, India is the diabetic capital of the world and hence all these issues must be taken care of as soon as possible. This is not only for the good of the people, but for the good of the country as a whole. Lastly, I would like to say **'better late than never'**.

Author details

Ashish Chauhan

Address all correspondence to: martin_ashish@yahoo.com

Apollo, Hyderabad, Andhra Pradesh, India

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