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CURRENT PRACTICES IN INSULIN AND VACCINE STORAGE

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ABSTRACT

The prevalence of diabetes is increasing day by day throughout the world, and to obtain glycemic effect, people need a life saving drug called "Insulin". This article covered the current storage of Insulin and vaccines in different zones, and problems related to their handling and storage due to temperature conditions where maximum cases were seen as denaturation or loss of insulin and vaccines potency due to the improper handling or failure to maintain the cold chain, or maybe due to the absence of the proper storage facilities in rural or the semi rural parts, thus as a result, a lot many cases of hazardous insulin and vaccines were seen. This article dealt with the current storage and handling practices of insulin & vaccines. A few storage devices have been discussed in the article such as goat skin, zeer pot, and clay/mud pots. The demerits included the points that they failed to provide the required storage conditions, were unhygienic, and there were portability problems; and the merit included the point that they worked even without the electricity supply. A few newer methods included friocase, medicool, portable insulin fridge, etc; the merits were the points that they were portable, provided required temperature for longer hours; and the demerits were the points that a lot of them failed to work when the electricity was not supplied. This article was an attempt to create awareness, review, understand, and enhance the view on vaccine and insulin storage conditions and maintaining cold chain protocol, thus, ensure the highest standard of health care in this area.

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Introduction

The prevalence of diabetes is increasing day by day throughout the world. According to the International Diabetic Federation, about 425 million people in the world are suffering from diabetes, and it falls in the age group of 20-79 years. [1] And, around 2045, this will rise to 629 Million. A recent study showed that the proportion of people suffering from Type 2 diabetes is increasing in most of the countries, making it the most common non communicable disease worldwide. The disease covering such large amount of population has also been responsible for death of 4 million people. [2] Insulin therapies have been recommended for all patients suffering from diabetes. Both Type 1 and type 2 were in equal need for the glycemic control. Insulin Therapy has been required by 1% of the people. [3]

Hence, it is not surprising that the majority of people have needed insulin for the treatment of Type 2 diabetes, and to acquire significant glycemic control. [4] The importance of insulin management is to prevent the long term complications which occur due to the insufficient insulin, but; this is not an easy task as with the progression of disease, it requires follow up, leading to the majority of cases of insulin therapy. According to a survey by Centers for Disease Control and prevention (CDC), which is one of the leading national public health Institute of the United States, about 14% of people suffering from type 2 diabetes, needed insulin, 13% used insulin and oral medication which meant covering a large number of population. Out of which, the majority of people used insulin vials, and a few of them used insulin pens. [5]

But, the major problem seen in the success of Insulin and vaccines use was its storage conditions in Asian countries. Both the insulin and vaccine storage demand the appropriate temperature ranging from 2-8°C, and if they are not stored properly,

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it not only leads to the degradation but also, the desired effect of insulin cannot be seen in glycemic patients and the ones requiring vaccines.

To study the problems related to insulin storage and its effects more closely, the team of Diabport regressively conducted various health camps, and found several inappropriate & inadequate ways of handling and storing insulin devices like insulin vials and insulin pens. Insulin loses potency when stored at high temperatures in semi urban and rural areas. Various clay pots filled with water, thermocol boxes, sand, insulin pouches and other cooling devices, have been used in less-resourced places where refrigeration has not been available, or in rural or semi urban districts where there is less possibility of proper storage due to the lack of power supply, which not only causes serious health hazards but also children die due to the adverse reactions.

So, to eliminate the problems of storage and transportation for those who travel, various new innovative techniques for the storage of insulin have been found recently, like mini fridge, frio wallets and carry cases, generic cool packs, etc. They have maintained the required storage conditions, and prevented insulin and vaccines from degrading. [6]

These few current practices have shown the distinguished ways that how a few current practices have been better than the traditional ones, and insulin can be stored appropriately for a longer duration.

But, still the problem lies in the storage as well as the use of new storage devices due to electricity as well as portability.

Purpose of this Review:

The main purpose of this review was to prevent the denaturation of insulin & vaccines due to the improper storage. In this review, few traditional methods mostly used by people in rural areas or those who are unaware of the storage of insulin and vaccines have been mentioned such as pots, mud, etc. which do not provide the sufficient appropriate storage conditions. On the other hand, more convenient and recent technologies have found new methods such as friowallets, mini fridge etc. which not only have provided better storage conditions and optimum storage temperature around 2-8°C as per the requirement of the storage conditions but when compared to the traditional methods they have been much more convenient.

The merits and demerits of the equipment used for the storage of insulin & vaccines have been mentioned, where one of the main problem acknowledged was the improper electricity supply in the rural and semi urban areas, which showed that if the insulin was not given a proper storage condition, it will lead to the denaturation, and hence, the people suffering from diabetes will not get the required glycemic effect.

The team of Diabport was initiated for the welfare of diabetes, in which several studies were done to check various medical stores, and it was found that they were selling the denatured insulin as the cold chain couldn't be maintained, or due to the improper storage conditions or also due to the lack of proper electricity supply, in which the people suffering from diabetes had to suffer a lot, and they couldn't get the required effect of insulin.

Role of temperature in storage:

The improper storage of in use insulin could directly affect its potency. Insulin has been seen to be directly affected by the temperature at which it is stored. 25-30°C has been recommended as the appropriate temperature, which is also the optimum room temperature, that is recommended by the manufacturers for the storage. Through various sources, it was found that the room temperature in tropical countries generally has been much higher. So, the role of temperature in storage condition of vaccines and insulin, and also in maintaining the cold chain supply from manufacturers to the consumers has been found very important.

Insulin storage is a challenge in many resource-challenged remote areas, where adequate refrigeration may not always be available due to the lack of electricity and literacy rate which plays a major role. Thus, this review has presented the various innovations and new techniques available which can be considered for enhancing storage methods. However, the main focus has been on hot climates, where it is difficult to keep insulin cool enough.

Material and Methods

Equipment used for the storage of insulin:

There are several insulin delivery systems available for the administration of insulin; a few of the techniques which have been currently in use and available in market included insulin syringes, insulin infusion pumps, jet injectors, insulin pens, etc.

The methods used for the administration of insulin can be briefed as:

Insulin syringes:

The traditional Insulin syringes which were first brought to the market were generally bulky and heavy; they came with reusable glass plungers and also a large needle. These insulin syringes were difficult to use because of their bulky size, but then, these syringes underwent significant changes over the years. Recently, the insulin injection syringes that have been used and available in the market have been obtained from plastics because of their properties including light weight, disposable that they can be used for one time administration and then disposed off and versatile in use as they can use a variety of micro fine needles. [7] They have increased patient comfort because of their light weight, making them convenient for patients. [8]

Insulin syringes, based on their type have been mainly characterized by three main factors, which include gauge of the needle, length of the needle and capacity of the syringe. The manufacturers have offered a lot of styles and sizes as per the requirement. Almost all syringes available today include the property of being disposable that they can be disposed off after use, and they also contain micro fine needles which are very convenient. [9] Selecting a syringe, which is appropriate for use generally includes a few parameters namely, its chemical composition that means the material which has been used in making the syringe; and the capacity of the syringe [9] that is how easily the air bubbles can be removed out of the syringe, how readable has been the marking of the syringe and how easily the syringe can be disposed off after the use, and how well the patient handles the syringe safely without hurting himself.

Insulin infusion pumps:

There is generally a method known as continuous subcutaneous insulin infusion (CSII), which is used to simulate the secretion of insulin daily. [10] The structure of an insulin pump comprises of a reservoir which is filled with insulin, also consists of an operated pump which works with the battery and an automated computer chip that allows the patient to control the insulin administration to the patients with diabetes. Technically, the role of pump is supplying insulin in an automated and continuous way. Infusion can be adjusted as per the specific needs of the patient. Infusion set is the device through which the insulin is delivered into the body using the pump. Variability of subcutaneous injections has been observed generally by few factors namely, injection depth and injection site change, and all these factors have been tried to be avoided by the use of infusion pumps.

Insulin pens:

Pen devices are unique and different as single modular units that are offered including a combination of the insulin container and a syringe in one pack. And they have made carrying insulin while travelling or storing much more convenient. The first insulin pen (NovoPen) was bought up by Novo Nordisk in 1987. Numerous types and shapes in different brands of insulin pens are available in the market which provide varieties to the consumers. Reusable and prefilled are two main types of pens available. Both, reusable and prefilled pens contain cartridges containing 1.5 ml to 3 ml of U100/ml insulin. Prefilled devices have been suggested during the bedtime insulin for patients with type 2 diabetes mellitus. [11] Merits seen with prefilled pens, such as their longer durability, no need for cartridge refrigeration, and flexibility for much longer dose than expected have been the main key points as the advantages of insulin pens. Insulin pens seem to resemble fountain pens in their structure and appearance. These pens are smaller in size and lighter in weight which can be filled again. Minimal pain while injecting due to having the finest and shortest disposable needles is the main reason for their being preferred. Insulin pens can be used frequently, they are convenient to administer. Being different and unique are the two main features of insulin pens.

Insulin storage:

The upcoming science of the storage practices of insulin is much more advanced and sophisticated than the traditional or conventional methods that were available 30 years ago. However, even after the precautions, it is possible to get “bad insulin”, the insulin which gets deteriorated and decomposed due to the irrational storage conditions.

Since, insulin is a lifesaving medication for both type 1 and type 2 patients, it is important to know all the storage and necessary precautions to store it in case if the bad insulin is suspected.

Insulin should always be protected from two things, extreme hot conditions and extreme cold conditions. FDA always warns that if insulin is frozen or exposed to extreme hot, it should be thrown out. But throwing out doesn’t simply fix the problem. [12]

Although, alternatives and vaccinations have increased, the problem still lies with the handling and storage of vaccines.

In several parts of the world, awareness programs along with the complete management guide to the diabetics have provided the awareness and practice to the diabetes patients for the self-administration of insulin therapy without having any side effects. A few studies conducted had dealt with the problems including complications, patient compliance and vigilance about the dose and self medication. But these studies of compliance have not been enough, more awareness is still needed. The main motive of this study was to make the patients who administer insulin themselves, more aware, and make them understand and use the knowledge to be socially aware of the practices, and also the inappropriate storage of insulin causing degradation of it. [13]

Improper Insulin Storage: [14]

There have been specific storage recommendations, which have been provided by insulin manufacturers that should be strictly followed both by the manufacturers as well as the customers. Insulin pens, unused cartridges and vials should be refrigerated at the prescribed temperature. If the insulin is kept between 2°C and 8°C, that is the appropriate temperature for storing insulin, the consumers are expected to stick to the conditions mentioned by the manufacturers. Insulin should always be used at room temperature, and it should be prevented from being frozen.

Insulin should be kept in a refrigerator but it should be kept away from the deep freezer. The results have generally demonstrated that insulin loses its bioavailability when it is stored in the top compartments or where the temperature is too low for the storage, both causing degradation or lose of potency of it. (Figure 1).

Another case related to the storage of the pens, is that the storage with the needles should be avoided. As several reported cases have been of the air clogging, avoiding storage with needles is done to stop any leakage which might occur in thermo insulation.

It has been observed that a large group of population suffering from diabetes mellitus in the developing world lives in rural areas or those remote areas which have not been developed yet, and they do not have the access to a refrigerator, and also the lack of electricity makes it difficult to use the electronic appliances. The expiry date of insulin is about 28 days if stored properly at <30°C.If there is no refrigerator, It is advised that insulin should be kept in a place with no moisture, humidity in a dark place where there is a very small probability of being exposed to the sun rays or direct heat source. The unused vials can be kept in clean plastic bags or pouches, and stored in a container which has a wider mouth or in pots made of mud filled with water. The newer version of the "Zeer pot" filled with water or wet sands for the purpose of evaporation has helped in the storage of insulin to the patients. (Figure 2) [15]

Figure 1: The refrigerator door is broken, the insulin vials are stored in the top most compartment of the freezer.

Figure 2: A Zeer pot for insulin storage in which there are two chambers; one comprising the outer chamber containing water for cooling purpose, and the other including the inner chamber for storing insulin.

Limitations of zeer pot:

Beyond the limitations of the required climatic conditions for the pot-in-pot refrigerator or the zeer pot, there has also been a need for a continuous supply of water for the appropriate storage conditions. For many regions, water may be prioritized for other purposes which makes it difficult for communities to adopt this technology. The device also has no proper seal for the storage chamber, which reduces its overall effectiveness since warm ambient air can seep into this chamber and increase the temperature of the chilled zone. (However, warm air will rise and chilled air which is heavier, drops, so the temperature will always be the coldest in the bottom).

Apart from these, goat skin pots filled with water and mud pots have been other few traditional methods opted for the storage in rural areas, where there is no refrigerator, or there are a few available (See fig 3). [16]

Figure 3. Cooling devices studied. (a) Cooling wallets. (b) The goat skin freshly filled with water. (c) The goat skin in use.

Disadvantages:

This method provides more chances of deterioration of insulin due to the improper storage and the lack of proper temperature maintenance.

The temperature of water used for storage may vary depending on the climatic conditions during summers, which leads to the evaporation of water due to heat; and, therefore, the temperature required cannot be maintained.

Current storage techniques for better Insulin & Vaccine storage: [16]

At a temperature, which is more than the required temperature for the storage of insulin, denatures have been found which tend to lose its potency. At remote or rural/semi urban places where there is no refrigerator for storage, people have to compromise with clay pots or various cooling devices based on the principle of evaporation.

Insulin can be stored in several handy, convenient and easily available devices where it gets the appropriate storage conditions and is prevented from the chances of being denatured. These devices can be good alternatives for the people who use clay pots, bags or any other methods which are not suitable for the storage.

A few newer techniques for the storage have been listed as follows: [17]

Medicool: A PenPlus range:

Medicool has several cooling bags such as the PenPlus which works using insulation technology. Anyone suffering from diabetes can use the device regardless of age or gender. A belt is kept inside the briefcase and then, it is attached or held using a strap which can be removed easily.

It is applicable for the use of insulin pens or even insulin vials. This device maintains temperature for several hours because of the presence of the freezable gel packs present in the device. Four vials of insulin and two insulin pens can be stored in the device case and kept cool for hours (Figure 4).

Figure 4: Medi cool for insulin storage

Frio Wallets and Carry Cases:

Frio wallets and cases are very light, occupy very small space, and they are handy for diabetic patients. They are usually recommended for storing insulin for moving purposes when the climate is not very favorable as per the recommended conditions or there is no electricity (Figure 5).

Figure 5: frio case

Medi Fridge:

It is a type of cooler fridge, used by diabetic patients for storing insulin, and mainly for the travelers where they can store their vials or syringes at the desired temperature without any risk of spoilage.

Most travelers used to carry ice packs while travelling; then later, this insulin portable fridge was introduced (Figure 6, 7, 8, 9).

Figure 6: Medi fridge

Figure 7: portable insulin refrigerator

Figure 8: travel insulin with ice pack for diabetic organize

Figure 9: premium insulin cool kits

Disadvantages of the recent techniques:

The newer techniques may be much efficient as compared to the traditional ones, but they too have some demerits such as they require electricity supply as they work using batteries, and some devices have problems associated with portability, and another problem which arises is the problem where, in rural areas there is unavailability of these insulin storage devices.

Vaccine Storage: [18]

The storage conditions of vaccines depends on the maintenance in which the vaccines are not thermally damaged (by heat or freezing) during transport and storage.

The transportation and storage of vaccines should be within the recommended temperature range of 2°C to 8°C from the place of being manufactured to the point of vaccine administration which should be under the 'cold chain'.

The phenomenon of the cold chain depends on the factors such as the equipment used, and the people involved and the practices they undertake.

The following stages of cold chain has been illustrated by the flow diagram in the following figure:

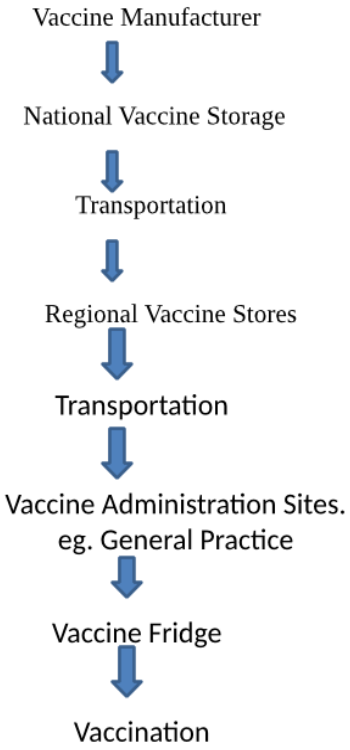

Figure 10: Flow of cold chain which represents handling of vaccines at various stages, and everyone is responsible for maintaining the cold chain.

Followings are the cases in which the vaccines can be denatured or degraded:

1. If they are frozen.
2. If they are stored inappropriately.
3. If they are heated or exposed to a direct sunlight

The impact of the inappropriate storage i.e. due to the thermal damage (heat or freezing) on vaccine potency is complex. The impact may vary for different vaccines. Once a vaccine that has been thermally damaged due to the exposure to the sun or direct heat, the loss of potency cannot be reversed.

Clinical management: [19]

Vaccines should be stored properly in the refrigerators. Anything other than vaccines including the lunches and specimens can be stored elsewhere. Using a maximum–minimum thermometer which identifies the sensitive temperature range is the only way to know if the fridge is maintaining the right temperature range, between 2°C and 8°C or not. These sensitive thermometers which are available in two forms including digital and mercury — have been designed to indicate the minimum and maximum temperatures inside the fridge with much accuracy. These temperatures should be monitored and reset almost daily.

For the storage of vaccines in refrigerators, they should never be stored on refrigerator-door shelves, where they have chances of being exposed to warm air every time the door opens. Vaccines should always be stored on the middle shelves of the fridge, and there should be sufficient space for air to circulate. Water bottles can be placed on the bottom, top and door shelves maintaining temperature consistency. There should be an inexpensive latch installation in the fridge ensuring the fridge door closes properly each time. The vaccines should be transferred to an insulated vaccine carry bag or another fridge set at the optimum temperature range, and the temperature should be checked regularly. It should be mandatory that the vaccines must be returned to the fridge immediately after the administration. It should be considered that only the required amount of dose should be ordered that can be used in 1- to 3-month periods of the vaccine to avoid the chances of wastage. The vaccines of the same type should be placed together. The vaccines whose shelf life is near to expire can be placed in front shelves of the fridge to avoid their wastage. The date when the first dose was withdrawn on all multi-dose vials should be marked properly, and discarded when the vials were opened within 30 days, or the time specified by the manufacturer.

Prevention: To avoid the vaccine degradation, regular onsite inspections of the cold-chain should be maintained by the management staff.

Safe handling of vaccines should be ensured by the management at clinics and health care facilities to ensure the safety of vaccines. A vaccine-preventable disease team is available now in most of the local public health units to assist when problems with temperature maintenance, power loss and possible spoilage arise. They together work by preventing the spoilage and wastage of vaccines making sure that the vaccines are stored correctly.

Current Storage Scenario for Insulin: [14]

It was seen in a study, that more than half of the patients keep their insulin medication in sand soaked with water, while there were also many patients who preferred using boxes and other places which were inappropriate for the storage (As shown in the figure 11).

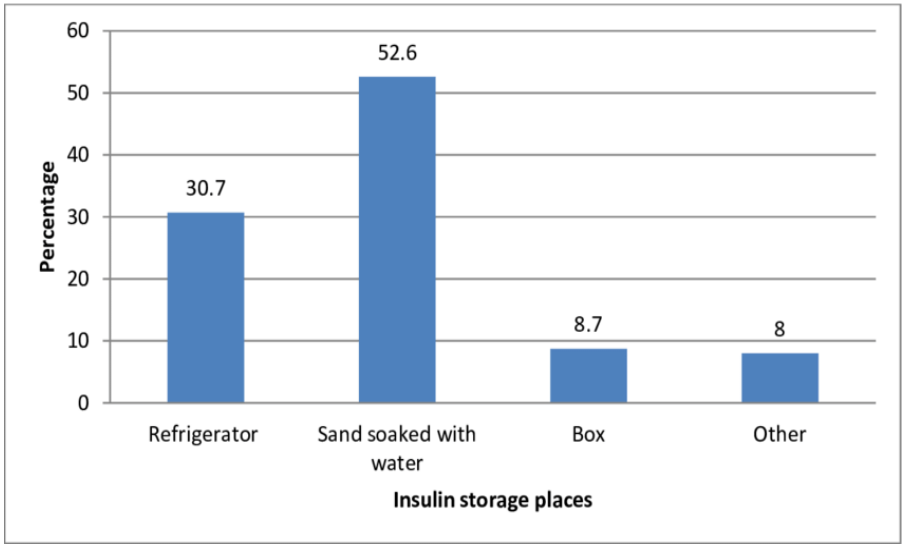

Figure 11: The storage places people prefer for storing insulin which cause loss of insulin potency and degradation.

Topics to be considered for vaccine storage: [20]

The following table indicates the topics to be considered foe vaccine storage.

Table 1. Topics to be considered for vaccine storage

Topic	Action	Comment
Staff involved	All staff must be present, but at least two trained people – one should be from the nursing team and the other one from the administration or management who should be responsible for taking care of vaccines.	Delegated persons should be named according to the rules.
Vaccine ordering	Vaccines should be stored more than 2-4 weeks. Small quantities should be ordered and regularly monitored.	Regular checks during holiday periods. Central stock should be planned.
Vaccine delivery	Vaccines should be checked correctly, and at the time of accepting and signing for them, there should be no damage or leakage. Vaccines that have recently been added, should be put immediately into the validated vaccine fridge to ensure the cold chain has been maintained.	The delivery should be well managed, and the receipt should be there at the time of delivery.
Equipment	A validated fridge should be used for the storage of vaccines at around +2°C and +8°C. Aiming for +5°C is the optimum temperature. Domestic fridge is not appropriate for the storage. A validated cool box or carrier, such as a portable vaccine fridge or a mini fridge can be used. Two Maximum/minimum thermometers should be available for checking the temperature of the fridge.	Investing on a portable fridge can be of great use.
Stock rotation and storage	Stock should be properly stored and kept in rotation with the shortest shelf life expiry first. Continuous exposure to Ultraviolet light would cause the loss of potency of the vaccines.	Marking system can be used on the vaccine packaging for the identification of 'first-markers'

Routine maintenance	The fridge should be regularly checked so as to ensure it is clean, and its gauge and instruments are calibrated. Cold chain maintenance is important.	Calibration certification record should be kept.
Audit	Daily temperature recoding duty must be the minimum duty allocated to the staff members. Vaccine fridge content should be checked weekly. Review of the vaccine stock should be done at the end of the month.	The audit of the stock as well as the temperature management must be shared with the clinical commissioning group every three months.

Case Studies Involved In Insulin & vaccine Storage:

1) **13 kids fell sick after the vaccinatio**n:

This news was recorded in the city of Kanpur, Nov 27, 2018, 14:22 IST in Unnao District, when the vaccine for Rubella (measles) was administered to children on Monday. Severe symptoms were seen in children, like high fever, flu, headache, nausea and stomachache. And as soon as the vaccination was administered, the children were rushed to the district hospital.
Several health officers visited the St. Peter's school and asked to take control of the situation.
This was the one case study seen due to the improper vaccine storage. And, it led to serious health issues for the children of Unnao District. [21]

2) 24 students of two schools fell ill after the vaccination:

There was the news in which 24 students of two different schools were again hospitalized due to the serious health problems after the vaccination.
The students reported were from Sanatan Dharm Balika Inter College and Raghunath Prasad Mishra Inter College, Kanpur. It was observed that just after the vaccination; these students fell ill on Thursday, November 30, 2018.
They were administered vaccine for measles rubella, and the symptoms of nausea, fever, rashes, and dizziness were seen in the students. They were hospitalized for 24 hours, and given proper treatment. [22]

3) Defrosting insulin: a case report:

Insulin has been recommended to be stored in a refrigerator, although problems tended to arise when it is stored at a temperature, which is out of the recommended storage condition by the manufacturer. The protein preparations stored were frozen; in contrast, rapid response for the emergency situations might be achieved by the controlled microwave thawing. The issues that have come up showed that the use of microwave radiation can lead to a reduction of functional plasma proteins due to overheating. A case was reported, where a patient used microwave radiation to thaw his frozen insulin.
A 28 year old man, who was previously well-controlled with insulin - dependent diabetes, was seen in the clinic with a recent decline in his glycemic control. The chart of his recorded history showed that his usual good control over diabetes had quite abruptly become erratic. The patient stated that, during the cold period of weather, his insulin had become frozen. He subsequently thawed both vials of frozen insulin on the 'defrost' mode by using a domestic 600 W microwave oven, and continued to use insulin.
So, at last it was concluded that due to the sudden temperature change, his insulin was denatured, hence, it showed no effect. [23]

4) Storage of insulin in rural areas:

It has been known that the vaccines are temperature sensitive. Insulin is the drug which temperature conditions needs to be adhered.
So as having some effects on the people with diabetes, insulin has been used as the drug of choice, but the underlying factor is its storage condition which should not exceed temperature range that is nearly, 2-8°C, kept far away from any heat source like sun rays. When it comes to the storage of pens or vials, they should be kept at normal ambient room temperature, around 25-28°C but not exceeding that. Data analysis was done in the city of Pondicherry, India; and the collection showed the storage of regular and biphasic insulin at around the temperature range of 32°C and 37°C, respectively that is the temperature exceeding normal storage conditions decreased the potency of insulin by 14 to 18%.
This means that people with diabetes need to be educated and well versed about the temperature and duration of the storage of insulin for maintaining the adequate glycemic control. [24]

5) Vaccine storage too often fails to meet standards:

Carmen Heredia Rodriguez, Kaiser Health News has reported that The Ventura County Health Care Agency in California made an error by giving vaccines to several people.
In October 2017, county health officials were worried that vaccines were getting too warm while being transported to clinics. So, they changed their protocol. But a routine audit that was conducted in the month of November found that the ice packs they were using might have frozen some of the medicines and lowered their effectiveness. The agency then offered to reimmunize everyone who had received a vaccine that was delivered in faulty packaging, but it was ineffective. The number of patients affected was 23,000.
Only in the past 13 months, 117 children received possibly compromised vaccines against polio,
Meningococcal disease and the human papillomavirus at an Indian Health Service clinic in

Oklahoma City because of the improper refrigeration. [25]

6) Bad Batches: The Effect of Temperature Fluctuations in Vaccines:

In private physician offices in Georgia, a systemic study was conducted for the suboptimal vaccine storage and handling practices. CDC's National Immunization Program was drafted and manually focused on the adequate vaccine storage developed in 1997.

The study was conducted amongst 263 private physician solo providers, group providers and community health centers and hospital-affiliated practices which were divided into two groups. It was observed that approximately one half of the offices received the draft manual (intervention group), while the other half did not.

After two months, graduate students conducted visits to measure refrigerator and freezer temperatures and interview the office workers about different aspects of vaccine management, such as handling of vaccine deliveries, vaccine storage and management of the problems.

The results obtained showed that there were no significant differences in vaccine storage practices between the intervention and control offices. Only 26% of the offices had written instructions for handling vaccines in preparation for immunization. Approximately, only Five percent had a written plan in the event of power outages. Seventy-three percent of the office employees knew offhand the correct temperature ranges for vaccine storage, but several were unable to read the mercury thermometer. In fact, some wrongly kept their refrigerator controls lower because they thought colder temperatures were safer for vaccines, thus increasing the risk for freezing vaccines.

Further, 20% of freezers and 7% of refrigerators had missing thermometers. More than 60% of the offices kept up-to-date temperature logs for all the compartments. Among the logs that were kept, several indicated that the vaccines had been kept outside of the recommended ranges for weeks. The site visits observed a number of vaccines stored incorrectly and out of their temperature ranges, as well as the expired vaccines. [26]

Conclusion:

The team of diabport after all the studies and surveys, concluded that there was a need for a much better evolution for the storage and handling practices of insulin and vaccines. The storage devices which have been available have been limited and restricted due to electricity and transportation constraints, and when insulin is not stored properly, it denatures. And hence, the diabetics do not get proper glycemic effect, the sufferance continues.

So, the overall solution to the problem can be drawn out by bringing new and better technology involved for the storage and handling of insulin and vaccines. Thus, new storage devices which ease the storage of insulin and vaccines in respect to transportation, and electricity supply especially for the rural areas or mobile areas must be promoted.

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