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PERSONALIZED INTERVENTIONS FOR MANAGING DIABETES DISTRESS AND IMPROVING GLYCEMIC CONTROL: A COMPREHENSIVE REVIEW

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ABSTRACT

The effectiveness of tailored therapies in reducing diabetes-related discomfort and enhancing glycemic control is examined in this review. The goals of the review are outlined in the introduction, which also defines the global significance of diabetes. The epidemiology and psychosocial factors that contribute to diabetic distress are discussed in the article, along with the therapeutic significance of achieving ideal glycemic control. Individualized food programmes, exercise routines, and psychological support are some of the components of personalised interventions that are examined, along with their applicability. Based on an extensive analysis of research, the paper offers strong proof of the efficiency of tailored therapies in reducing diabetes-related misery and enhancing glycemic management. Action mechanisms that include both psychological and physiological elements are examined. Taking into account study limitations and real-world obstacles, the review talks about implementation barriers. Potential ramifications for clinical practise, patient outcomes, and healthcare policies are taken into account in insights into the future of diabetes care. The article's conclusion highlights the critical role that tailored therapies play in alleviating diabetes-related distress and achieving optimal glycemic control. For healthcare professionals, legislators, and academics who are interested in enhancing diabetes care through customised techniques, this succinct review provides useful insights.

KEYWORDS: Personalized interventions, Diabetes distress, Glycemic control, Diabetes management, Psychosocial factors, Study Limitations.

I. INTRODUCTION

One major worldwide health concern is diabetes mellitus, a common metabolic illness that requires careful and extensive therapy.[1] Diabetes is becoming a major global health concern that affects millions of people due to its alarming rise in prevalence.[2] The World Health Organization estimates that 422 million people worldwide suffer from diabetes, underscoring the critical need for efficient management techniques.[3],[4]

Beyond the physiological factors, the management of diabetes involves a complex panorama of issues beyond glucose control. People who have diabetes have many challenges, from the difficult responsibility of taking their medications as prescribed to the ongoing attention to detail needed for blood glucose monitoring. But one thing that is frequently missed in conversations is the severe emotional burden that diabetes puts on people. This is known as diabetes-related distress.[5]

Good diabetes management is a complex process that involves more than just monitoring blood sugar levels and insulin dosages. It is essential for averting complications, enhancing quality of life, and resolving the many difficulties that people with diabetes encounter. The complex relationship between physical and mental health emphasises the value of comprehensive diabetes management.[6]

An ubiquitous and sometimes overlooked phenomena, diabetes-related distress refers to the emotional, behavioural, and interpersonal difficulties that people with diabetes face on a daily basis. Elevated degrees of distress can arise due to the condition's unrelenting nature and the ongoing requirement for monitoring. Acknowledging and comprehending this psychological load is crucial for delivering patient-focused care and advocating for a comprehensive strategy for managing diabetes.[5]

II. Diabetes Distress: An Overview

Type 2 diabetes and depression have a complicated association that takes into account a number of variables, including biological, behavioural, and psychological effects on diabetes patients. In a 1995 literature analysis, a team of psychologists and psychiatrists from the Joslin Diabetic Centre first introduced the idea of diabetes distress. Diabetes distress, which is common in people with both Type 1 and Type 2 diabetes, is the term used to describe the unpleasant emotional experiences brought on by the difficulties of having diabetes. Poorer metabolic results and a decrease in self-care have been associated with these distress levels. It's critical to distinguish between depression and diabetes distress.[7]

Stress, inflammation, and shared genetic predispositions may contribute to the two-way association between depression and diabetes. Ongoing research is exploring these connections to gain a better understanding.[8] Factors that contribute to diabetes distress include the constant management of blood sugar levels to handle stress and glucose[9], anxiety[10] stemming from the fear of complications, adjustments to exercise and dietary habits[11], financial concerns related to healthcare access and costs[12], misconceptions and judgments associated with the social stigma of diabetes distress, as well as the emotional impact of managing diabetes.[13] A thorough analysis provides a valuable approach to assessing the psychometric validity of scales like the Diabetes Distress Scale and the Problem Areas in Diabetes Scale, contributing to a more comprehensive understanding of their effectiveness in measuring diabetes distress (n=675 type 1 diabetes).[14]

III. Glycemic Control in Diabetes

Type 2 diabetes is a condition that requires careful management, starting with an early diagnosis.[15] For type 2 diabetes mellitus, glucose monitoring is essential and useful. Compared to episodic monitoring using a blood glucose metre, real-time continuous glucose monitoring (CGM) offers more possibilities for diabetes management decision-making (BGM).[16]

Table 1: Explains the difference between Blood Glucose monitoring and continuous blood monitoring (Author Source)

ASPECT	**Blood Glucose Monitoring**	**Continuous Glucose Monitoring**
Frequency of measurement	periodic, usually several times daily	Continuous 24|7 monitoring
Method Of Measurement	Fingerstick or blood Draw for a sample	Sensor continuously measuring beneath the skin
Real time Data Availability	Provides snapshot readings at the time of testing	continually delivers real-time data
Data Storage And Retrieval	Stored in a glucose meter or logbook	constant archiving and retrieval of data
Alerts for immediate action	Notifications are delayed, manual verification is needed	Able to provide high- and low-level alerts and alarms
User Engagement	demands active involvement during designated times	monitoring continuously without user interaction
Insulin Dosage Adjustment	manual modifications based on recurring measurements	Better decisions based on ongoing patterns

Cost	less expensive initial and ongoing expenses for test strips	Higher initial expenditures that might be reimbursed by insurance, less need for test strips
Comfort and Convenience	numerous fingersticks are needed, and there may be discomfort	ongoing observation, less intrusive after installation
Application In Specific Cases	Typical for diabetic regular management	Particularly helpful for people who use insulin pumps, are pregnant, or have fluctuating blood sugar
Integration With devices	Integrate with additional health gadgets or not	combining smartphone and insulin pump integration for data analysis
Accuracy	Precise throughout testing, but prone to missing variations	Constant observation offers a more thorough understanding of trends.

Exercise is the optimal strategy for improving the lipid and inflammatory profile in individuals with type 2 diabetes mellitus. It yields more benefits in inflammatory and lipid markers for patients with type 2 diabetes mellitus. The combination of aerobic and resistance training exercises provides numerous health advantages for patients with type 2 diabetes mellitus, including enhanced body composition, insulin sensitivity, lipid profile, and reduced low-grade systemic inflammation.[17]

Treadmill aerobic exercise training sessions have a more significant impact on acute glycemic control compared to rest sessions (CON). Treadmill walking with high-intensity interval training (HIIT) is a recently recognized and more effective method for immediate glucose control in middle-aged and older patients with type 2 diabetes mellitus who are receiving pharmacological therapy with metformin and/or gliptins.[18]

Glycemic control in type 2 diabetes mellitus reduces microvascular complications such as retinopathy, neuropathy, and nephropathy. Obesity and a sedentary lifestyle have higher prevalence rates among patients with type 2 diabetes mellitus. Exercise, diet, and weight loss are primarily beneficial in reducing glucose levels in type 2 diabetes mellitus. Metformin, a biguanide, can lower HbA1c levels by approximately 1.5% in diabetic patients, with the advantage of a very low risk of hypoglycemia when used as monotherapy. Metformin is more effective in glucose control compared to sulfonylureas.[15]

One of the primary obstacles to achieving glycemic control is diabetes distress. Diabetes distress is strongly linked to an individual's capacity to regulate their emotions and is also the fourth leading cause of death in the United States. Treatment options for diabetes distress encompass diabetes education and psychological interventions based on cognitive-behavioral therapy, with a primary focus on addressing symptoms of depression. Furthermore, diabetes-related distress directly correlates with a diminished ability to regulate negative emotions.[19]

Approximately 80% of individuals living with diabetes reside in low- and middle-income countries, where there is a higher prevalence of diabetes and its associated complications among minority populations and those with limited resources. Achieving improved glycemic control is complicated by factors such as poverty, limited literacy, limited access to medication, and limited access to healthcare. Additionally, inadequate training and support for community health workers pose an additional challenge. Telehealth has emerged as a crucial means of supporting both community health workers and participants in combating these factors.[20]

In interventions aimed at promoting long-term maintenance of behavioral changes, enhancing psychological well-being and quality of life are pivotal outcomes. Counseling interventions have proven effective in increasing physical activity, reducing sedentary behavior, improving psychological well-being, and enhancing health-related quality of life.[21]

The prevalence and incidence of both type 1 diabetes mellitus and type 2 diabetes mellitus are rising among younger populations. Measuring levels of glycated hemoglobin (HbA1c) aids in mitigating the risk of long-term complications in both types of diabetes. The processes and structures of care that optimize access to diabetes care and healthcare coverage for young adults with diabetes have a significant impact on reducing HbA1c levels and enhancing health outcomes within this high-risk group. It is crucial to provide education on optimizing diabetes care, along with developing additional strategies to improve outcomes specifically for patients with type 2 diabetes mellitus.[22]

Diets that are abundant in whole grains have been shown to reduce the incidence of type 2 diabetes, coronary heart disease, and colorectal cancer. Increased consumption of whole grains helps improve glycemic control, body weight, lipid profile, and other cardiometabolic risk factors in adults with type 2 diabetes mellitus.[22] However, it is important to note that the current definition of whole grains includes highly processed and reconstituted fractions. Research indicates that consuming less processed whole grains over a period of two weeks results in improved glycemic control compared to consuming whole grain foods that have been finely milled to reduce particle size.

More than 84 million adults in the United States are diagnosed with type 2 diabetes mellitus, as determined by fasting blood sugar (FBS) or HbA1c levels. Individuals with high-risk type 2 diabetes mellitus, who are overweight or obese, can slow down the progression of the disease through lifestyle modifications. A study examining the effects of vitamin D3 supplementation at a dosage of 4000 IU per day found no significant reduction in the risk of developing diabetes when compared to a placebo. The World Health Organization has expressed concern over the rising prevalence of diabetes, with an estimated 422 million individuals worldwide affected by the disease. Numerous studies have investigated the potential benefits of various supplements, such as vitamin D, vitamin C, and dietary fibers, for improving glycemic control. Magnesium supplements are recommended as supplementary therapy for the prevention and management of type 2 diabetes mellitus (T2DM). Oral magnesium supplementation has been shown to improve HbA1c levels, C-peptide levels, and reduce fasting blood sugar (FBS). By using oral magnesium supplements, individuals with T2DM can better maintain glycemic control and reduce insulin resistance.[23,24]

Exercise is highly recommended for both the prevention and treatment of T2DM. High-intensity interval training (HIIT) conducted in the afternoon has been found to be more effective than morning HIIT in lowering blood glucose levels in men with T2DM. HIIT has been shown to have a preferential effect on carbohydrate oxidation when compared to moderate-intensity exercise. It is important to note that the timing of exercise can elicit various physiological responses.[25]

The introduction of flash glucose monitoring, also known as intermittently scanned continuous glucose monitoring, allows for continuous monitoring of interstitial glucose levels using a sensor attached to the upper arm. Compared to self-monitoring blood glucose, flash glucose monitoring has been proven to reduce the duration and frequency of hypoglycemia as well as HbA1c levels in individuals with T2DM.[26]

A six-month health coaching program and a healthy diet have been shown to improve glycemic control in individuals with T2DM. HbA1c levels are assessed at the three-month and six-month marks during the coaching program. The diet involved in the program includes a decreased consumption of whole grains, fruits, meat, proteins, fats, and oils, while encouraging increased intake of vegetables. Health coaching has proven to be an effective strategy for improving HbA1c levels and dietary habits. As such, further research into health coaching is necessary to enhance glycemic control.[27]

Consuming foods high in fiber and increasing intake of green leafy vegetables has been associated with a lower risk of developing T2DM and improved glycemic control. The Nurses' Health Study demonstrated that adding one serving of green leafy vegetables per day can significantly reduce the risk of developing diabetes.[28] Very low-calorie diets (VLCDs) have been reported to effectively control glucose levels within 1 to 2 weeks. Intermittent VLCDs have been proposed as a weight loss strategy for obese patients. Studies have shown that intermittent calorie restriction for 2 days/week and 4 days/week is highly effective in glycemic control without causing any serious adverse effects. The improvements in glucose control are attributed to reductions in insulin resistance, insulin secretion, body weight, BMI, body composition, cardiovascular risk factors, and improvements in quality of life.[29]

Hyperhomocysteinemia is associated with insulin resistance in patients with T2 DM, worsening the condition by inducing reversible beta islet cell dysfunction and inhibiting insulin secretion. Folic acid is known to be the main factor determining plasma HCY concentration. Supplementation with folic acid reduces HCY concentration levels by increasing the intracellular pool of 5 methyl tetra folate, thus managing diabetes and reducing cardiovascular events.[30]

T2 DM patients using insulin degludec, an ultra-long-acting basal insulin analogue, have shown significant benefits in glycemic control. Comparisons with insulin glargine U100 or U300 have shown that insulin degludec is more effective in controlling glucose levels. Patients treated with degludec have demonstrated significantly improved glycemic control compared to those treated with other basal insulin options.[31]

Regular physical activity plays a crucial role in achieving good glycemic control in T2 DM patients. Physical activity involves body movement generated by skeletal muscles, leading to energy expenditure. Engaging in regular physical activity has been shown to improve weight management and metabolic balance, while also reducing complications in patients with T2 diabetes.[32]

IV. Personalized Interventions in Diabetes Care

In the context of diabetes care, personalised interventions refer to a focused and customised strategy that adjusts therapeutic modalities and medical tactics to the unique requirements, characteristics, and reactions of each patient. To maximise treatment success, this strategy takes into account the patient's lifestyle, psychological characteristics, and genetic composition.[33]

The increasing awareness of inter-individual differences in disease manifestation, course, and response to treatment is what makes personalised interventions relevant in today's healthcare system. Growing knowledge of molecular pathways and advances in genomic medicine have made it clear how important it is to tailor interventions to maximise benefits, reduce side effects, and support patient-centered care.[33]

Justification for Personalized Diabetes Care Methods

a. **Genetic Variability:** The variability of diabetes phenotypes is largely influenced by genetic predispositions. Genetic differences that affect drug metabolism, treatment responses, and susceptibility to problems are taken into consideration in personalised therapies.[34]
b. **Lifestyle Factors:** It's critical to acknowledge the variety of lives that people lead. Personalization ensures that interventions are in line with the patient's daily routine by taking into account variables including dietary choices, cultural influences, and physical activity levels.[35,36]
c. **Psychosocial Determinants:** Psychosocial and mental health issues have a significant influence on the management of diabetes. Personalized treatments incorporate psychological assistance that is customised to meet the needs of each patient, addressing their mental health and encouraging compliance with treatment regimens.[37]

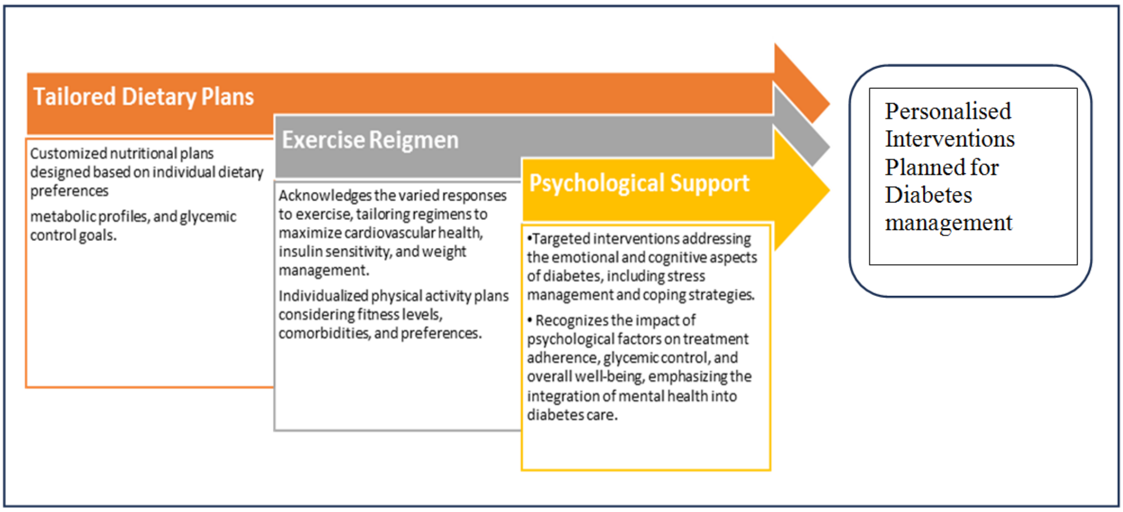

Fig 1: Components of Personalized Interventions(Author Source).

VII. Challenges and Limitations

A promising area of healthcare is personalised interventions in diabetes care, which aims to customise therapy for specific patients. However, there are a number of obstacles and restrictions that come with transferring these therapies from study environments to actual clinical settings. This scientific investigation examines potential shortcomings in the body of current research and explores the complications involved in implementing individualised solutions.

Implementing Personalized Interventions Presents Some Challenges

1. Data Accessibility and Integration

The availability and integration of a variety of patient data, like as genetic information, lifestyle characteristics, and real-time health data, is critical to the efficacy of individualised interventions. Harmonizing these diverse datasets, resolving interoperability problems amongst different EHR systems, and protecting sensitive patient data from prying eyes present challenges.[38]

2. Restricted Guidelines Based on Evidence

One significant obstacle to delivering tailored interventions is the lack of strong evidence-based guidelines. Even while studies show that certain tailored strategies work, the general implementation of these interventions is hampered by the absence of defined procedures. To effectively guide healthcare practitioners in customising interventions, evidence-based recommendations must be established.[39,40]

3. Resource Constraints

Personalized therapies may require more technological and human resources to implement. This entails educating medical staff members on the subtleties of individualised treatment, obtaining cutting-edge tools for data analytics and genetic testing, and making sure these initiatives have enough funding. The widespread adoption of individualised treatments may be impeded by resource constraints, especially in healthcare settings where resources are scarce.[41]

4. Patient Adherence and Engagement

Tailored treatment plans and active patient engagement are frequently necessary for personalised therapies. Maintaining patient motivation, encouraging behavioural adjustments, and addressing socioeconomic concerns that could affect a patient's adherence to individualised recommendations are all difficult tasks. It's a fine balance to design interventions that support long-term engagement while appealing to individual preferences.[42]

Constraints on Reviewed Research

1. **Selection Bias:** Because of participant self-selection or non-randomized study designs, many studies assessing tailored therapies may show selection bias. Participants opting for personalized interventions might differ systematically from those who do not, leading to potential confounding effects. This limitation calls for caution in generalizing findings to broader populations.[43]
2. **Variations in Intervention Design:** It can be difficult to synthesise results when there is heterogeneity in the individualised intervention designs across research. Direct comparisons are difficult because to differences in the length, intensity, and particulars of individualised care of each intervention. A more thorough assessment of the efficacy of interventions would be made possible by standardising reporting formats and intervention designs.[44]
3. **Lack of Long-Term Follow-Up:** A dearth of prolonged follow-up periods may constrain many research, making it more difficult to evaluate the long-term viability and efficacy of tailored interventions. Because diabetes is a chronic condition, it is necessary to gain understanding of how long-lasting the advantages are—a topic that is frequently overlooked in the body of current research.[45]

4. **Ethnic and Cultural Considerations:** It's possible that ethnic and cultural differences in how people react to tailored interventions have not been sufficiently addressed in most studies. The extent to which genetic and cultural factors impact health outcomes may not be sufficiently taken into consideration restricts the applicability of research findings to a variety of patient populations.[46]

VIII. Future Directions and Implications

Researchers, medical professionals, and legislators must work together to find solutions to these problems and constraints. To build a solid evidence base for tailored interventions, future research should give priority to rigorous study designs, such as randomised controlled trials with long-term follow-up. The external validity of study findings will be improved by efforts to standardise intervention designs, include a variety of patient populations, and take practical implementation considerations into account.

Given the complexity and heterogeneity of diabetes, tailored therapies are necessary to maximise patient outcomes. Precision medicine advances are expected to bring about a significant revolution in the treatment of diabetes in the future. In order to fully realise the potential of personalised treatments, this investigation explores the possible effects of tailored interventions on clinical practise, healthcare policies, and patient outcomes. It also provides insights into future directions and mitigation strategies.

Tailored Strategies: An Overview of the Future

1. Customizing Care Based on Genetic Profiles

Future diabetes care will likely involve personalised treatment plans based on each patient's unique genetic profile, thanks to advancements in genomics. Pharmacogenomic insights help doctors choose pharmaceuticals that maximise effectiveness while minimising side effects by helping them predict how patients may react to certain ones. With its potential to transform diabetic medication management and provide a more accurate and patient-centered therapeutic approach, this tailored method has great promise.[47,48]

2. Making the most of artificial intelligence and big data

Artificial intelligence and big data have a significant impact on the treatment of diabetes in the future. Machine learning algorithms have the potential to reveal complex patterns in diabetes treatment since they are powered by large datasets that include genetic data, lifestyle factors, and real-time health measurements. We are on the verge of a proactive and personalised healthcare future thanks to predictive analytics, which may detect minor trends and enhance the ability to foresee difficulties and enable prompt interventions.[41,49]

3. Utilizing Wearable Technologies to Empower Patients

With wearable technology providing patients and healthcare practitioners with real-time insights into glucose levels, physical activity, and other pertinent indicators, wearables are quickly becoming a crucial component of tailored interventions. Smart insulin pumps and continuous glucose monitoring enable people to take an active role in managing their diseases. These technologies create a collaborative approach that goes beyond traditional healthcare borders by enabling remote monitoring by healthcare experts in addition to improving self-management.[50]

4. Interventions for Holistic Lifestyles

Holistic lifestyle treatments catered to each patient's needs will be the norm in diabetes care in the future. Individualized food programmes, exercise routines, and psychological support consider the patient's preferences, cultural background, and psychosocial considerations in addition to clinical characteristics. This all-encompassing strategy recognises that managing diabetes involves more than just taking medication; it places a strong emphasis on long-term lifestyle changes that are relevant to the particular circumstances of each individual.[35]

Implications for Healthcare Policies

1. Shift towards Value-Based Care

Value-based care is about to become the norm in healthcare policy. Value-based care is consistent with personalised therapies since they have the potential to enhance both patient outcomes and cost-effectiveness. Policies may change from conventional fee-for-service models to reward clinicians according to the efficacy and quality of individualised diabetes care.[51]

2. Integration of Personalized Medicine into Guidelines

National and international diabetes care recommendations are anticipated to change as evidence for tailored therapies grows. These guidelines will probably include personalised pharmaceutical suggestions as well, giving medical professionals a road map for navigating the subtleties of customised care. Throughout order to guarantee consistent and research-based procedures in a variety of healthcare settings, this integration is essential.[52]

3. Data Governance and Privacy Regulations

The exponential rise of data connected to health necessitates strong privacy legislation and governance systems. Future health care regulations will have to carefully balance protecting patient privacy with promoting data-driven, tailored interventions. Gaining the trust of stakeholders and patients will require establishing clear policies about data ownership, sharing, and utilization.[53]

CONCLUSION

Shaping an Inclusive and Cost-Effective Future for Diabetes Management

The promise of tailored therapies defines the diabetic care landscape going forward, bringing in a time when the subtleties of individual health are carefully taken into account. This trend goes beyond precision medicine and state-of-the-art technologies; it also includes a concerted effort to make diabetes management accessible, affordable, and intimately linked to patient education.

One promising aspect of this future is the possibility of empowering rural healthcare. In remote areas where access to healthcare has historically been difficult, inclusivity takes on a critical role. Personalized interventions close the healthcare gap by utilising telemedicine, mobile health units, and community outreach initiatives to provide individualised care to even individuals living in rural places. Wearable technology emerges as an useful tool that enables healthcare providers to monitor and guide patients from a distance by giving them real-time insights.

The future of diabetes care is centred on cost-effectiveness. Although there is no denying the attraction of cutting-edge technology, their scalability and sustainability become crucial for their widespread adoption. Artificial intelligence plays a crucial role in both the interpretation of intricate datasets and the optimization of treatment plans to coincide with economically viable interventions. Customized meal plans, utilising reasonably priced and readily available food sources in the area, together with low-resource exercise regimens, all contribute to a paradigm that may be widely adopted.

In this new environment, patient awareness becomes essential to the management of diabetes. It goes beyond a basic comprehension of prescription drugs, exploring a thorough comprehension of their effects, possible substitutes, and the complex relationship between lifestyle and health. Community-driven awareness programmes enable people to identify symptoms, comprehend the effects of their drugs, and actively engage in joint health decision-making. They are supported by digital platforms and local efforts.

Future diabetes care has a more comprehensive strategy that goes beyond the narrow focus of blood glucose monitoring. People not only learn about the symptoms of diabetes but also acquire the tools necessary to fully control them. In order to treat the emotional toll of diabetes, psychological help becomes essential. Routine educational modules on coping mechanisms, mental health awareness, and stress management promote resilience and emotional health, which are crucial aspects of diabetes care.

In the future, diabetes care will be distinguished by its recognition of the rich legacy of traditional medicine. Treatment plans are more likely to be accepted when traditional traditions are incorporated into tailored interventions, which guarantees cultural relevance. In addition to contemporary medical treatments, traditional herbal cures, dietary regimens, and holistic wellness techniques coexist, providing a complex and culturally aware care.

In summary, the treatment of diabetes will be woven into a tapestry of inclusivity, economy, patient empowerment, and overall well-being in the future. It reaches into all facets of society, extending beyond the fields of technology and precision medicine, to guarantee that tailored interventions are a right rather than a privilege. This future is not just a theoretical concept; rather, it is a shared commitment to creating a society in which diabetes care is not only efficient but also takes into account the various needs of every person, regardless of where they live or how well they are doing financially.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this manuscript. All financial and non-financial interests that could be perceived as influencing the research have been disclosed in this statement. We affirm our commitment to maintaining objectivity and transparency in presenting the findings.

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Figure Legend Statement

Figure legends provide essential context for understanding visual representations. In this context:

Figure 1: Illustrates about the components

REFERENCES

1. Kaul K, Tarr JM, Ahmad SI, Kohner EM, Chibber R. Introduction to Diabetes Mellitus. In: Ahmad SI, editor. Diabetes: An Old Disease, a New Insight [Internet]. New York, NY: Springer, 2013 [cited 2023 Dec 22]. 1–11. (Advances in Experimental Medicine and Biology). Available from: https://doi.org/10.1007/978-1-4614-5441-0_1
2. Swathi nl, Hari. V1*, Kavitha. S2*, M.S. Riyazullah3, NL. Swathi4, C. Charan Kumar Reddy4, Harijana Valluru Narasimhulu5, S. Haneesh4, P. Shiva Datta sai4, E. Govardhan5, M.Deva darshini4, Dweepika4, Sherinprasad4, P.Sirisha4, M.Monasree4, M.Gayathri4, Preethi. S4, S. Bhavani4,. REVIEW OF PANCREATIC CELLS TRANS DIFFERENTIATION IN DIABETES TREATMENT [Internet]. 2022 [cited 2023 Dec 24]. Available from: https://www.lcebyhkzz.cn//article/view/856/328.php
3. Prasad DD, Swathi NL, Sree MM. DIABETIC KETOACIDOSIS: A REVIEW OF CURRENT TREATMENT OPTIONS. 2022.
4. Diabetes [Internet]. [cited 2023 Dec 22]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes
5. Dennick K, Sturt J, Speight J. What is diabetes distress and how can we measure it? A narrative review and conceptual model. J Diabetes Complications, May. 1, 2017; 31(5): 898–911.
6. Xu Y, Toobert D, Savage C, Pan W, Whitmer K. Factors influencing diabetes self-management in Chinese people with type 2 diabetes. Res Nurs Health, 2008; 31(6): 613–25.
7. Skinner TC, Joensen L, Parkin T. Twenty-five years of diabetes distress research. Diabet Med J Br Diabet Assoc, Mar., 2020; 37(3): 393–400.
8. Snoek FJ, Bremmer MA, Hermanns N. Constructs of depression and distress in diabetes: time for an appraisal. Lancet Diabetes Endocrinol, Jun., 2015; 3(6): 450–60.

9. Fisher L, Hessler D, Glasgow RE, Arean PA, Masharani U, Naranjo D, et al. REDEEM: a pragmatic trial to reduce diabetes distress. Diabetes Care, Sep., 2013; 36(9): 2551–8.
10. Serlachius AS, Scratch SE, Northam EA, Frydenberg E, Lee KJ, Cameron FJ. A randomized controlled trial of cognitive behaviour therapy to improve glycaemic control and psychosocial wellbeing in adolescents with type 1 diabetes. J Health Psychol, Jun., 2016; 21(6): 1157–69.
11. Sysko R, Devlin MJ, Hildebrandt TB, Brewer SK, Zitsman JL, Walsh BT. Psychological outcomes and predictors of initial weight loss outcomes among severely obese adolescents receiving laparoscopic adjustable gastric banding. J Clin Psychiatry, Oct., 2012; 73(10): 1351–7.
12. Loeppke R, Haufle V, Jinnett K, Parry T, Zhu J, Hymel P, et al. Medication adherence, comorbidities, and health risk impacts on workforce absence and job performance. J Occup Environ Med, Jun., 2011; 53(6): 595–604.
13. Gonzalez JS, Peyrot M, McCarl LA, Collins EM, Serpa L, Mimiaga MJ, et al. Depression and diabetes treatment nonadherence: a meta-analysis. Diabetes Care, Dec., 2008; 31(12): 2398–403.
14. Fenwick EK, Rees G, Holmes-Truscott E, Browne JL, Pouwer F, Speight J. What is the best measure for assessing diabetes distress? A comparison of the Problem Areas in Diabetes and Diabetes Distress Scale: results from Diabetes MILES-Australia. J Health Psychol, Apr., 2018; 23(5): 667–80.
15. Kheirandish M, Mahboobi H, Yazdanparast M, Kamal M. Challenges Related to Glycemic Control in Type 2 Diabetes Mellitus Patients. Curr Drug Metab, Mar. 21, 2017; 18(2): 157–62.
16. Martens T, Beck RW, Bailey R, Ruedy KJ, Calhoun P, Peters AL, et al. Effect of Continuous Glucose Monitoring on Glycemic Control in Patients With Type 2 Diabetes Treated With Basal Insulin: A Randomized Clinical Trial. JAMA, Jun. 8, 2021; 325(22): 2262–72.
17. Desjardins P, Berthiaume R, Couture C, Le-Bel G, Roy V, Gros-Louis F, et al. Impact of Exosomes Released by Different Corneal Cell Types on the Wound Healing Properties of Human Corneal Epithelial Cells. Int J Mol Sci., Oct. 13, 2022; 23(20): 12201.
18. Mendes R, Sousa N, Themudo-Barata JL, Reis VM. High-Intensity Interval Training Versus Moderate-Intensity Continuous Training in Middle-Aged and Older Patients with Type 2 Diabetes: A Randomized Controlled Crossover Trial of the Acute Effects of

Treadmill Walking on Glycemic Control. Int J Environ Res Public Health, Oct. 28, 2019; 16(21): 4163.

19. Coccaro EF, Drossos T, Kline D, Lazarus S, Joseph JJ, de Groot M. Diabetes distress, emotional regulation, HbA1c in people with diabetes and A controlled pilot study of an emotion-focused behavioral therapy intervention in adults with type 2 diabetes. Prim Care Diabetes, Jun., 2022; 16(3): 381–6.
20. Vaughan EM, Hyman DJ, Naik AD, Samson SL, Razjouyan J, Foreyt JP. A Telehealth-supported, Integrated care with CHWs, and MEdication-access (TIME) Program for Diabetes Improves HbA1c: a Randomized Clinical Trial. J Gen Intern Med., Feb., 2021; 36(2): 455–63.
21. Nicolucci A, Haxhi J, D'Errico V, Sacchetti M, Orlando G, Cardelli P, et al. Effect of a Behavioural Intervention for Adoption and Maintenance of a Physically Active Lifestyle on Psychological Well-Being and Quality of Life in Patients with Type 2 Diabetes: The IDES_2 Randomized Clinical Trial. Sports Med Auckl NZ, Mar., 2022; 52(3): 643–54.
22. Pihoker C, Braffett BH, Songer TJ, Herman WH, Tung M, Kuo S, et al. Diabetes Care Barriers, Use, and Health Outcomes in Younger Adults With Type 1 and Type 2 Diabetes. JAMA Netw Open, May. 1, 2023; 6(5): e2312147.
23. Pittas AG, Dawson-Hughes B, Sheehan P, Ware JH, Knowler WC, Aroda VR, et al. Vitamin D Supplementation and Prevention of Type 2 Diabetes. N Engl J Med., Aug. 8, 2019; 381(6): 520–30.
24. ELDerawi WA, Naser IA, Taleb MH, Abutair AS. The Effects of Oral Magnesium Supplementation on Glycemic Response among Type 2 Diabetes Patients. Nutrients, Dec. 26, 2018; 11(1): 44.
25. Savikj M, Gabriel BM, Alm PS, Smith J, Caidahl K, Björnholm M, et al. Afternoon exercise is more efficacious than morning exercise at improving blood glucose levels in individuals with type 2 diabetes: a randomised crossover trial. Diabetologia, Feb., 2019; 62(2): 233–7.
26. Wada E, Onoue T, Kobayashi T, Handa T, Hayase A, Ito M, et al. Flash glucose monitoring helps achieve better glycemic control than conventional self-monitoring of blood glucose in non-insulin-treated type 2 diabetes: a randomized controlled trial. BMJ Open Diabetes Res Care, Jun., 2020; 8(1): e001115.
27. Lin CL, Huang LC, Chang YT, Chen RY, Yang SH. Effectiveness of Health Coaching in Diabetes Control and Lifestyle Improvement: A Randomized-Controlled Trial. Nutrients, Oct. 29, 2021; 13(11): 3878.

28. Yen TS, Htet MK, Lukito W, Bardosono S, Setiabudy R, Basuki ES, et al. Increased vegetable intake improves glycaemic control in adults with type 2 diabetes mellitus: a clustered randomised clinical trial among Indonesian white-collar workers. J Nutr Sci., 2022; 11: e49.
29. Umphonsathien M, Rattanasian P, Lokattachariya S, Suansawang W, Boonyasuppayakorn K, Khovidhunkit W. Effects of intermittent very-low calorie diet on glycemic control and cardiovascular risk factors in obese patients with type 2 diabetes mellitus: A randomized controlled trial. J Diabetes Investig, Jan., 2022; 13(1): 156–66.
30. El-Khodary NM, Dabees H, Werida RH. Folic acid effect on homocysteine, sortilin levels and glycemic control in type 2 diabetes mellitus patients. Nutr Diabetes, Jun. 22, 2022; 12(1): 33.
31. AlMalki MH, Aldesokey H, Alkhafaji D, Alsheikh A, Braae UC, Lehrskov LL, et al. Glycaemic Control in People with Type 2 Diabetes Treated with Insulin Degludec: A Real-World, Prospective Non-interventional Study-UPDATES Saudi Arabia. Adv Ther., Feb. 2023; 40(2): 568–84.
32. Yao WY, Han MG, De Vito G, Fang H, Xia Q, Chen Y, et al. Physical Activity and Glycemic Control Status in Chinese Patients with Type 2 Diabetes: A Secondary Analysis of a Randomized Controlled Trial. Int J Environ Res Public Health, Apr. 18, 2021; 18(8): 4292.
33. Sugandh F, Chandio M, Raveena F, Kumar L, Karishma F, Khuwaja S, et al. Advances in the Management of Diabetes Mellitus: A Focus on Personalized Medicine. Cureus, 15(8): e43697.
34. Venkatachalapathy P, Padhilahouse S, Sellappan M, Subramanian T, Kurian SJ, Miraj SS, et al. Pharmacogenomics and Personalized Medicine in Type 2 Diabetes Mellitus: Potential Implications for Clinical Practice. Pharmacogenomics Pers Med., Nov. 13, 2021; 14: 1441–55.
35. Galaviz KI, Narayan KMV, Lobelo F, Weber MB. Lifestyle and the Prevention of Type 2 Diabetes: A Status Report. Am J Lifestyle Med., Nov. 24, 2015; 12(1): 4–20.
36. Aas AM, Axelsen M, Churuangsuk C, Hermansen K, Kendall CWC, Kahleova H, et al. Evidence-based European recommendations for the dietary management of diabetes. Diabetologia, Jun. 1, 2023; 66(6): 965–85.
37. Kalra S, Jena BN, Yeravdekar R. Emotional and Psychological Needs of People with Diabetes. Indian J Endocrinol Metab, 2018; 22(5): 696–704.

38. Ehrenstein V, Kharrazi H, Lehmann H, Taylor CO. Obtaining Data From Electronic Health Records. In: Tools and Technologies for Registry Interoperability, Registries for Evaluating Patient Outcomes: A User's Guide, 3rd Edition, Addendum 2 [Internet] [Internet]. Agency for Healthcare Research and Quality (US); 2019 [cited 2023 Dec 24]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551878/
39. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation—A Scoping Review. Healthcare, Jun. 29, 2016; 4(3): 36.
40. Pitsillidou M, Roupa Z, Farmakas A, Noula M. Factors Affecting the Application and Implementation of Evidence-based Practice in Nursing. Acta Inform Medica, Dec., 2021; 29(4): 281–7.
41. Hassan M, Awan FM, Naz A, deAndrés-Galiana EJ, Alvarez O, Cernea A, et al. Innovations in Genomics and Big Data Analytics for Personalized Medicine and Health Care: A Review. Int J Mol Sci., Apr. 22, 2022; 23(9): 4645.
42. Qoronfleh MW, Chouchane L, Mifsud B, Al Emadi M, Ismail S. THE FUTURE OF MEDICINE, healthcare innovation through precision medicine: policy case study of Qatar. Life Sci Soc Policy, Nov. 1, 2020; 16: 12.
43. Briel M, Elger BS, McLennan S, Schandelmaier S, von Elm E, Satalkar P. Exploring reasons for recruitment failure in clinical trials: a qualitative study with clinical trial stakeholders in Switzerland, Germany, and Canada. Trials, Nov., 25, 2021; 22(1): 844.
44. Haidich AB. Meta-analysis in medical research. Hippokratia, Dec., 2010; 14(1): 29–37.
45. Hill KG, Woodward D, Woelfel T, Hawkins JD, Green S. Planning for Long-Term Follow-up: Strategies Learned from Longitudinal Studies. Prev Sci Off J Soc Prev Res., Oct., 2016; 17(7): 806–18.
46. Zhong A, Darren B, Loiseau B, He LQB, Chang T, Hill J, et al. Ethical, social, and cultural issues related to clinical genetic testing and counseling in low- and middle-income countries: a systematic review. Genet Med., Dec., 1, 2021; 23(12): 2270–80.
47. Al Aboud NM, Tupper C, Jialal I. Genetics, Epigenetic Mechanism. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, 2023. [cited 2023 Sep 12]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK532999/
48. Committee on Human Gene Editing: Scientific, Medical, and Ethical Considerations, National Academy of Sciences, National Academy of Medicine, National Academies of Sciences, Engineering, and Medicine. Human Genome Editing: Science, Ethics, and Governance [Internet]. Washington, D.C.: National Academies Press, 2017. [cited 2023 Dec 6]. Available from: https://www.nap.edu/catalog/24623

49. Harrer S, Shah P, Antony B, Hu J. Artificial Intelligence for Clinical Trial Design. Trends Pharmacol Sci., Aug., 2019; 40(8): 577–91.
50. Steinhubl SR, Muse ED, Topol EJ. Can Mobile Health Technologies Transform Health Care? JAMA, Dec. 11, 2013; 310(22): 2395.
51. Bieber K, Kridin K, Emtenani S, Boch K, Schmidt E, Ludwig RJ. Milestones in Personalized Medicine in Pemphigus and Pemphigoid. Front Immunol, 2020; 11: 591971.
52. Goetz LH, Schork NJ. Personalized Medicine: Motivation, Challenges and Progress. Fertil Steril, Jun., 2018; 109(6): 952–63.
53. Nishimura A, Carey J, Erwin PJ, Tilburt JC, Murad MH, McCormick JB. Improving understanding in the research informed consent process: a systematic review of 54 interventions tested in randomized control trials. BMC Med Ethics, Jul. 23, 2013; 14(1): 28.