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Recent Trends and Emerging Approaches in the Treatment of Type 2 Diabetes: Lifestyle Modification, Pharmacotherapy, and Bariatric Surgery

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Abstract

Hyperglycemia and insulin resistance are the two major hallmarks of T2DM, a metabolic disorder that is widely spread and severely threatening global public health. Of interest, treatment options for T2DM are also under significant advancements in the recent past, including medication, bariatric surgery, and lifestyle modifications. In addition, lifestyle therapies, including changes in eating and additional physical activities, substantially improve glycemic control, while pharmacotherapy provides a large number of drugs focusing on different components of the pathophysiology of type 2 diabetes. Besides, over the past years, bariatric surgery has also been proposed as a possible alternative for intractable diabetics with extreme obesity. This paper seeks to shed some light on the changing roles in type 2 DM therapy by now revisiting the current modifications; ultimately, it is targeted at reducing the burden of the disease for improved patient outcomes and enlightening policymakers and healthcare professionals on the same.

Keywords: Bariatric Surgery, Medication, Lifestyle Changes, Type 2 Diabetes Mellitus, New Approaches

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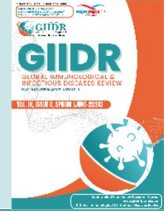


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Abstract

Hyperglycemia and insulin resistance are the two major hallmarks of T2DM, a metabolic disorder that is widely spread and severely threatening global public health. Of interest, treatment options for T2DM are also under significant advancements in the recent past, including medication, bariatric surgery, and lifestyle modifications. In addition, lifestyle therapies, including changes in eating and additional physical activities, substantially improve glycemic control, while pharmacotherapy provides a large number of drugs focusing on different components of the pathophysiology of type 2 diabetes. Besides, over the past years, bariatric surgery has also been proposed as a possible alternative for intractable diabetics with extreme obesity. This paper seeks to shed some light on the changing roles in type 2 DM therapy by now revisiting the current modifications; ultimately, it is targeted at reducing the burden of the disease for improved patient outcomes and enlightening policymakers and healthcare professionals on the same.

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Introduction

Genetic predisposition, environmental variables, and lifestyle choices are the complex interplay that transactions toward the heterogeneous disease type 2 diabetes mellitus (T2DM) (Murea & Ma, 2020). Its burden has concomitantly increased worldwide

alongside the alarming upward trend in obesity prevalence and sedentary behaviors (Lassale et al., 2017). Classical T2DM management involves metabolic control through lifestyle modification, activity, and pharmacotherapy among the three domains (American Diabetes Association, 2020). With advances in medical research and the gradual unraveling of the pathogenesis



of the disease, the situation has changed drastically regarding T2DM therapy in recent years.

Recently, there has been a huge interest in developing therapeutic treatments. Growing attention is paid to tailored therapy approaches to meet the specific needs of the patients, which may differ in many ways. Therapeutic policy in the case of type 2 diabetes should be based on the principles of lifestyle treatment. Such an intervention includes important elements of dietary, structured exercise programs, and behavioral modification, among others, as brought to the limelight by Evert et al. (2019). The role and importance of lifestyle therapies in improving insulin sensitivity initiating weight loss and reducing cardiovascular risk have been accepted in several studies, including those by Dunkley et al. (2014).

Concomitantly, drug therapy is also evolving, with numerous drug options available targeting many aspects of T2DM pathophysiology (Cosentino et al., 2019). Pharmacotherapies aim to provide optimal glycemic provisions that are best tolerated. Classic agents include metformin, belonging to the more recent classes, such as the sodium-glucose cotransporter-2 inhibitors and glucagon-like peptide-1 receptor agonists (American Diabetes Association, 2020). Subsequent novel research has shown that some of the pharmacological agents are beneficial not only for controlling glycemia but also for the kidney and heart; the treatment modality for T2DM has started to change, therefore (Cosentino et al., 2019).

For the severely obese and those with difficult-to-control type 2 diabetes, bariatric surgery has turned out to be a revolutionary procedure that provides substantial improvements in metabolic endpoints and glycemic control for a longer period of time (Adams et al., 2017). Multiple surgical modalities of bariatric surgery, such as adjustable gastric banding, sleeve gastrectomy, and Roux-en-Y gastric bypass, have been noted for their excellent effectiveness in managing type 2 diabetes (Rubino et al., 2016). Physiologically, bariatric surgery causes.

The changes in the composition of the gut microbiota and related responses in metabolic status, such as improved sensitivity to insulin and the gut hormonal environment responsive to β -cell function, would change the course of type 2 diabetes progression profoundly. In fact, such changes may result in a great decrease in or even in complete remission from the disease in their sufferers (Pories et al., 2010).

In conclusion, it can be stated that the changing face of T2D treatment is because of the research and novel therapeutics. Pharmacotherapy, bariatric surgery, and lifestyle modification are keys to the multilateral treatment for type 2 diabetes. This needs to be done so that patients will have an array of individually tailored therapeutic options. To maximize clinical outcomes in the management of this very common metabolic disorder, a comprehensive approach using evidence-based therapies, patient-centered care, and continued updates as our understanding of T2DM evolves is necessary.

Lifestyle Intervention

This essential approach is through the recommended lifestyle interventions, including dietary changes, increased levels of activity, and management of body weight, which are crucial in modern-day treatment in not only achieving good glycemic control but also decreasing the risk of complications in an individual with type 2 diabetes (American Diabetes Association, 2020). Indeed, findings from different types of research clearly show that lifestyle interventions enable positive changes in most metabolic parameters and, therefore, contribute to an overall improvement in people diagnosed with type 2 diabetes.

This assertion has further been confirmed by other studies that have sought to determine the significant influence of dietary patterns on metabolic health and the state of glycemic control. Appropriate dietary choices for effective management of type 2 diabetes involve choosing whole, nutrient-dense foods such as whole grains, lean meats, and fruits. Optimal food choices that promote weight loss and improvements in lipid profiles and insulin sensitivity are critical for the slow development of type 2 diabetes and its complications. An increase in regular physical activity is another secondary benefit to making dietary changes to optimize metabolic benefits in those with type 2 diabetes. There are numerous benefits that flow from involvement in individualized, structured activities, such as improved glucose utilization, increased cardiovascular fitness, and a reduction in insulin resistance (Evert et al., 2019). Further, exercise significantly helps in weight management and is believed to present long-term benefits for glycemic control and general health.

Behavioral interventions are paramount. This would ensure that people with type 2 diabetes have a drive to make changes in lifestyle for life. For this, setting goals,

self-monitoring, problem-solving, and similar techniques help the individual in behavior change and help to

improve ecological habits (Dunkley et al., 2014). Behavioral therapies can maximize the benefits of lifestyle intervention programs as continual reinforcement of self-efficacy and tools to establish a positive environment. All this ensures maximal clinical outcomes and significant quality of life.

In conclusion, lifestyle intervention has remained a

key component of modern T2DM care, offering a comprehensive approach to handling complex interactions between metabolic disorders and lifestyle variables. In contemporary diabetes care, healthcare practitioners can support persons with type 2 diabetes through dietary modifications, physical activity, and behavioral therapies in attaining optimal regulation of glucose, whereby the risk of developing long-term complications that compromise the quality of life is minimized.

Table I

In this study, it has been demonstrated that lifestyle changes are much more cost-effective and beneficial to type 2 diabetes patients than the control measures; they include reduced use of medications, weight reduction, and improvement in the overall quality of life.

Parameter	Before Intervention	After Intervention	Change
Mean HbA1c (mmol/mol)	56.3 ± 10.5	55.6 ± 12.8	No significant change (p = 0.43)
HbA1c ≤ 53 mmol/mol (%)	45%	53%	More responders achieved target levels
Triglyceride levels (mmol/L)	-0.34 ± 1.02	Decreased (p = 0.004)
Body weight (kg)	-7.0 ± 6.8	Decreased (p < 0.001)
Waist circumference (cm)	-7.9 ± 8.2	Decreased (p < 0.001)
Body mass index (kg/m ²)	-2.4 ± 2.3	Decreased (p < 0.001)
Total cholesterol/HDL ratio	-0.22 ± 1.24	Decreased (p = 0.044)
HDL levels (mmol/L)	+0.17 ± 0.53	Increased (p < 0.001)
LDL-cholesterol levels (mmol/L)	+0.18 ± 1.06	Slightly increased (p = 0.040)
Quality of life improvement	Significant	

Pharmacotherapy

Pharmacotherapy is an essential component of the multi-disciplinary care for T2DM, especially in those patients who are unable to achieve the glycemic targets with lifestyle intervention alone. The therapeutic armamentarium for the management of T2DM encompasses a variety of drugs with different mechanisms of action and benefits over other therapies, according to the American Diabetes Association, 2020. Metformin, as a first-line therapy in the management of type 2 diabetes, acts mainly through decreased hepatic glucose production and enhanced peripheral insulin sensitivity. Sulphonylureas

increase the release of insulin from the pancreatic β cells, thus making the use of glucose enhanced to decrease blood sugar levels. Thiazolidinediones stimulate insulin sensitivity in peripheral tissues and, consequently, glucose uptake and utilization. More recently, new agents acting on the incretin pathway to improve glycemic control include glucagon-like peptide-1 (GLP-1) receptor agonists and dipeptidyl peptidase-4 (DPP-4) inhibitors. DPP-4 inhibitors act by increasing glucose-dependent insulin secretion and decreasing glucagon secretion through prolongation of the action of endogenous GLP-1 and G. GLP-1 receptor agonists work by mimicking the action of

GLP-1 in increasing satiety, suppressing glucagon release, and stimulating insulin secretion—effects that support weight reduction.

Another novel family of drugs is represented by the SGLT2 inhibitors. They act by preventing the kidneys from reabsorbing glucose, thus causing glucosuria and dropping blood glucose levels. SGLT2 inhibitors exert beneficial actions on the kidney and cardiovascular axis by slowing the progression of DKD and the rate of cardiovascular events.

Even with the availability of many glucose-lowering agents, including insulin, therapy remains a major mainstay in the management of type 2 diabetes, especially for those patients whose disease has progressed severely or who have developed other illnesses. There are various insulin formulations that present flexible approaches to attaining glucose reduction targets effectively while minimizing the risks of hypoglycemia and weight gain. These include the rapidly acting, short, intermediate, and long analogs.

In the last couple of years, treatment for type 2 diabetes has changed dramatically with the introduction of novel pharmacological medications such as SGLT2 inhibitors and GLP1 receptor agonists. Ensuring stronger glucose control besides other extra cardiovascular and renal advantages, these drugs counteract the complexity of T2D and its related comorbidities.

One of the cornerstones in treating type 2 diabetes is pharmacotherapy, with a large array of medications available with different mechanisms of action and therapeutic effects. As such, each healthcare professional can therefore profit from it in enormous ways by achieving improvements in glycemic control, fewer complications, and improved quality of life for patients with type 2 diabetes. Such benefits can be garnered through the formulation of individual treatment plans that take into account patients' particular needs and preferences.

Table 2

When taken as prescribed these medications assist individuals with T2DM in attaining tighter glycemic control and reducing the potential for long-term complications.

Drug Class	Mechanism of Action	Efficacy and Considerations
Metformin	Reduces hepatic glucose production, improves insulin sensitivity, and decreases intestinal glucose absorption.	First-line therapy; minimal risk of hypoglycemia; weight-neutral or weight loss; may cause gastrointestinal side effects.
Sulfonylureas (SUs)	Stimulate insulin secretion from pancreatic beta cells.	Effective in lowering HbA1c; risk of hypoglycemia; weight gain.
Thiazolidinediones (TZDs)	Enhance insulin sensitivity in peripheral tissues.	Modest HbA1c reduction; risk of weight gain, fluid retention, and heart failure; limited use due to safety concerns.
Dipeptidyl Peptidase-4 (DPP-4) Inhibitors (Gliptins)	Enhance incretin hormone activity, increase insulin secretion, and decrease glucagon release.	Well-tolerated, weight-neutral, low risk of hypoglycemia, and may be used as monotherapy or in combination.
Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists	Enhance incretin hormone activity, increase insulin secretion, delay gastric emptying, and reduce appetite.	Effective in lowering HbA1c; weight loss; injectable; may cause gastrointestinal side effects.
Sodium-glucose Cotransporter-2 (SGLT2) Inhibitors (Gliflozins)	Block renal glucose reabsorption, leading to increased urinary glucose excretion.	Effective in lowering HbA1c; weight loss; reduced cardiovascular risk; risk of genital mycotic infections and euglycemic ketoacidosis.
Insulin	Replaces deficient endogenous	Used when other agents fail; various

Drug Class	Mechanism of Action	Efficacy and Considerations
	insulin.	formulations (rapid-acting, long-acting); risk of hypoglycemia; weight gain.

Bariatric Surgery

Bariatric surgery is one of the most important and new therapeutic resources available for individuals living with obesity and T2DM, which has been ill-controlled by conventional medication use. The efficacy and durability of bariatric surgery in achieving significant improvements in glycemic control and metabolic parameters have been well-documented in numerous studies (Rubino *et al.*, 2016).

The most common types of bariatric surgeries conducted include sleeve gastrectomy, adjustable gastric banding, and Roux-en-Y gastric bypass. All of these surgeries have been proven to maximize outcomes significantly for patients with Type 2 Diabetes Mellitus (T2DM). Apart from leading to massive weight loss, such surgical interventions bring about dramatic metabolic changes that eventually lead to enhanced activity of β cells, increased insulin sensitivity, and further remission from T2DM in very many individual patients.

The intricate metabolic benefits processes of bariatric surgery are directly associated with the significant alterations in gastrointestinal physiology these operations cause. Plasma levels of gut hormones secreted postbariatric surgery that have been demonstrated to contribute to improved glucose homeostasis, lowered hunger, and elevated insulin secretion include higher concentrations of peptide YY

(PYY) and glucagon-like peptide-1 (GLP-1) (Pories *et al.*, 2010).

Moreover, bariatric surgery amends the metabolism of bile acids due to variations in hepatic glucose generation and the metabolism of lipids at the liver level (Pories *et al.*, 2010). The mechanisms by which the metabolism ameliorates after bariatric surgery due to an altered population of gut microflora are not well defined (Pories *et al.*, 2010).

In fact, there is now a new consensus based on studies showing that bariatric surgery is associated with improvement in glycemic control but also, interestingly, lowers the risk of diabetic complications aside from the huge cardiovascular benefits expected from it. Long-term decreases in cardiovascular risk variables have been reported following bariatric surgery, including inflammation, dyslipidemia, and hypertension, among others.

Bariatric surgery stands out in this innovative treatment, providing very substantial and more permanent metabolic health and glycemic improvements in subjects. It has been associated with various syndromes, including type 2 diabetes and obesity. To that end, the mechanistic insight into the metabolic effects of bariatric surgery could explain why surgery would be a feasible therapeutic option for the complex pathophysiology of type 2 diabetes and its associated diseases. Therefore, it allows the possibility of personalized and truly comprehensive ways of treating the disease.

Table 3

Individuals with type 2 diabetes and severe obesity are offered wishful thinking of reducing cardiovascular risk factors and complications of the infection related to these procedures.

Surgical Procedure	Effects on Glycemic Control and Metabolic Parameters
Roux-en-Y Gastric Bypass (RYGB)	Marked and persistent improvements in glycemic control, and alterations in metabolism including bile acids, gut microbiota, and gut hormones.
Sleeve Gastrectomy	Comparable improvements in β -cell function, reduced insulin resistance, and better glycemic control.
Adjustable Gastric Banding	This is also associated with positive effects on metabolic indices and glycemic control.

Conclusion

Treatment of type 2 diabetes mellitus requires a multimodal approach with medication, lifestyle

interventions, and bariatric surgery in appropriately selected patients. Our armamentarium has expanded, tapping into new approaches and innovations in the management of type 2 diabetes, enabling an enhanced

choice of treatment options for patients that are tailored to their requirements and preferences.

For achieving optimal glycemic control, as well as other health goals, the cornerstone remains the modification of lifestyles by way of dietary adjustment, increased physical activities, and behavioral interventions.

It lowers the risk of complications. Pharmacotherapy is a useful adjunct to lifestyle interventions because different pharmaceutical classes with differential mechanisms of action target diverse aspects of type 2 diabetes pathophysiology. Bariatric surgery is also joining the armamentarium as a potentially game-changing approach for those with refractory diabetes and extreme obesity, providing dramatic improvements in metabolic parameters and

glycemic control.

It is, however, important to highlight that each patient requires specific care and follow-up to allow for the adaptation of administered treatments to meet the necessities of each patient. While recent advances in the area have dramatically improved clinical results, further study concerning comparative effectiveness and long-term safety in various treated populations is required.

In all, type 2 diabetes care is still changing with the times, due to improvements in clinical practice, technology, and research. Without a comprehensive and patient-centered approach to treatment, there will be no way that health professionals can improve treatment results, and quality of life, or lessen the long-term consequences connected with T2DM.

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