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## Review Article

# Pharmacist's Role in the Safe and Effective Use of GLP-1-Based Therapies: A Narrative Review

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## ABSTRACT

**Background:** The dual GIP/GLP-1 receptor agonist tirzepatide with glucagon-like peptide-1 receptor agonists now include not only reduction of glucose levels but have proved their worth by acting on body weight and heart/kidney benefits. These drugs have shown their efficacy in reducing body weight, heart disease risk, and kidney damage. However, medication safety continues to be an area of concern for the pharmacy because of the nature of the drug absorption through self-injection with stepwise doses increasing. It is, however, expected that in time new safety signals will emerge, and these will need to be monitored in conjunction with known adverse effects.

**Objective:** To describe the role of the pharmacist in the safe and efficient use of GLP-1-based therapeutics, with a focus on Indian practice, and to summarize the pharmacology, formulations, clinical evidence, and safety profile of these treatments.

**Results:** Tirzepatide showed better weight loss than semaglutide at up to -20.2% vs. -13.7% in SURMOUNT-5 and caused a mean weight change of -20.9% after 72 weeks in SURMOUNT-1 versus only -3.1% with placebo. While 1 mg of semaglutide significantly reduced the risk of a composite of kidney events by 24% in the FLOW study, 2.4 mg of semaglutide reduced the occurrence of adverse cardiovascular events by approximately 20% in SELECT. Among the safety issues that pharmacists should be aware of are dose-dependent gastrointestinal effects, gallbladder disease, a possible association with semaglutide and non-arteritized anterior ischemic optic neuropathy (NAION), the risk of procedural aspiration that is still unclear, and administration error with compounded vial products. Certainly pharmacists must keep in mind some major safety issues: Gastrointestinal side effects related to dosage; gallbladder disease; an alleged connection between semaglutide and anterior non-arteritic ischemic optic neuropathy (NAION); uncertainty with procedural aspirations; administration errors of compounded vial products.

**Conclusion:** Pharmacists can assist in bridging the gap between trial efficacy and real-world results by utilizing eligibility screening, titration and injection counseling, error prevention, adherence support, and pharmacovigilance. Controlled research is essential for pharmacist-led interventions especially in India.

*Keywords: GLP-1 receptor agonist; semaglutide; tirzepatide; clinical pharmacist; medication safety; pharmacovigilance; obesity; type 2 diabetes; India*

## INTRODUCTION:

GLP-1 based medicines are no longer just seen as a means of lowerin blood sugar level; they form the cornerstone of broader cardiometabolic treatment strategy. Among other sections like GLP-1 RA and GIP/GLP-1, it finds a place in the 'Pharmacologic Management' part of the Standards of Care in Diabetes 2026 published by the American Diabetes Association (ADA).

A summary of the 2026 standards written for pharmacists, explains the use of these agents as supportive to the liver, the kidneys and the heart and emphasizes losing weight as the first treatment goal,[2]. This change is supported by many pieces of evidence. For example, people with obesity who were not diabetic experienced weight reduction of 15.0-20.9 % after 72 weeks of tirzepatide injection once per week, while 2.4 mg of semaglutide and [3] led to the reduction of 15 % on average after 68 weeks. Also, semaglutide significantly reduced renal events in diabetic type 2 (CKD) individuals with chronic kidney disease, and in adults with cardiovascular disease who are overweight or obese without diabetes, a major decrease in adverse cardiovascular events was seen.[5,6] Just because a drug works well in clinical trials does not mean that it will definitely bring about real-life benefits for patients. The majority of the novel drugs in question need to be injected by patients themselves, require incremental increases of the dose over several weeks, for example, one of the drug trials (named SURMOUNT-1)[3] needed a 20-week dosage increase period, and are associated with gastrointestinal side effects during the up-titration. Also, these medications are intended for long-term therapy. Each of these features can potentially make a pharmacist identify the potential harm or therapy interruptions. India is a country that demonstrates the danger well. A countrywide study from 2008 to 2020 looked at the prevalence of diabetes among adults in 113,043 people who participated the survey. The result was that 101 million Indians are diabetic, 11.4% of the total population.[7] On March 20, 2026, the expiration of an Indian patent covering semaglutide permitted the launch of Indian generic versions of the drug accompanied by strong price competition.[8] While lowering prices should lead to increased availability of the medicine, lower pricing can also pose a higher risk in terms of patients not reporting ADEs, incorrect use of medicine, lack of understanding of the product, and introduction of new dosage forms like multi-dose vials. Patients may have to

do some research to find out about a drug and use it correctly. Objectives of this review are to:

- sum up the drug mechanism, available forms, and medical conditions for which they are prescribed (indications) of GLP-1 RAs (Glucagon-Like Peptide-1 Receptor Agonis) and DITs (Dual Incretin Therapies);
- assess the clinical evidence related to their use in type 2 diabetes, obesity, heart-related disease, and kidney disease;
- discuss potential safety issues, drug-related interactions, incorrect medication use, and drug level monitoring;
- illustrate examples of pharmacist-based services especially Indian experience.

## BACKGROUND:

**Mechanism of action:** After meals, intestinal L-cells emit the incretin GLP-1. It acts on hypothalamus and brainstem circuits to decrease hunger and food intake, increases glucose-dependent insulin production, inhibits glucagon, and slows stomach emptying through the GLP-1 receptor. Since dipeptidyl peptidase-4 breaks down native GLP-1 in a matter of minutes, therapeutic analogs are structurally altered to withstand degradation and have longer half-lives. For instance, semaglutide has a fatty-acid side chain that facilitates albumin binding and allows for once-weekly administration. Hypoglycemic episodes are uncommon, except when the drug is combined with insulin or a sulfonylurea due to the fact that insulin is released in a glucose-dependent manner.

Tirzepatide interacts simultaneously with the GIP and GLP-1 receptors which were two different molecular targets before.[9] Much greater weight loss with tirzepatide in head-to-head vs studies still has no clear underlying mechanism to blame or credit for it, as well; the question of how much does the GIP part play in reducing weight and improving glycemic control has yet to be answered. Similarly, the exact mechanisms of the beneficial effects on the kidneys and the cardiovascular system remain to be elucidated. Weight loss, lower blood pressure, improved cholesterol levels, and reduced inflammatory response may all be potential contributing factors, although it is possible and not fully tested that changes which are completely independent of weight are also responsible. There are also dosage and formulations considerations.

**Dosage and administration of drugs:** Among the current products are Daily injectable, once-weekly injectable liraglutide and dulaglutide, Daily oral, and once-weekly injectable tirzepatide. semaglutide. semaglutide was titrated from 0.25 to 2.4 mg after 16 weeks,[4] whereas tirzepatide was initiated with 2.5 mg weekly and further increased by 2.5 mg every 4 weeks to a maximum of 15 mg in these studies.[3,9] The launch of tirzepatide in India came in the form of single-dose vials in March 2025,[10] and in August 2025 the drug became available as a multi-dose pen, KwikPen, with six strengths that stores four weekly fixed dosages. According to the manufacturer, tirzepatide is a prescription-only drug that should not be used for esthetic weight loss[11]. Unlike injectors where the user has to draw up the dose, such as recently launched Indian semaglutide multidose vials for which there will be a separate discussion, the pen devices come with fixed doses which reduces the risk of dosing errors.

**Indications**: Different agents, doses, brands, and countries may vary in their approved indications. They generally refer to glycemic control in persons with type 2 diabetes, prevention of cardiovascular risks in people with type 2 diabetes and a history of cardiovascular disease, and maintenance of weight in a long period of time of adults who are obese or overweight and have a weight-related comorbidity (the approval of Indian tirzepatide refers to a body mass index (BMI) of 30 or more, or 27 or more if at least one is diagnosed with a weight-related comorbidity).[11] Semaglutide and tirzepatide are being developed for and in some areas have been approved additional conditions: obstructive sleep apnea, heart failure with preserved ejection fraction, and steatotic liver disease.

## CURRENT EVIDENCE:

Type 2 diabetes: glycemic control: Participants in SURPASS-2 that were not properly managed with metformin were given a choice of either tirzepatide 5, 10, or 15 mg or semaglutide 1 mg at random for 40 weeks. Tirzepatide was found to be non-inferior as well as better to semaglutide in the case of HbA1c levels at each dose with only 0.9 kg of weight reduction in excess of semaglutide; 1.8 kg, and 2.75 kg less weight loss of participants on tirzepatide was reported. Tirzepatide users experienced the most common adverse events of 5-7% serious adverse events while 3% serious adverse events in semaglutide users were recorded, and both tirzepatide and semaglutide users suffered frequently from the adverse effects such as nausea, diarrhea and vomiting.[9] The makers of tirzepatide supported the study whose comparison target was only a 1 mg dose of semaglutide when the higher doses are the only ones sold now.

Cardiovascular outcomes in type 2 diabetes: The study also assessed cardiac events related to type 2 diabetes.Liraglutide brought down cardiovascular death, non-fatal myocardial infrarction, or non-fatal stroke (primary composite) (14.9% vs. 13.0%; hazard ratio 0.87, 95% CI 0.78 to 0.97), and especially reduced cardiovascular mortality (hazard ratio 0.78). LEADER had the largest ever high-risk diabetes population with almost 3.8 year follow-up, including individuals (N=9,340).[12] To prove that one treatment is at least as effective as another, the SUSTAIN-6 study (3,297 patients, 104 weeks), once-weekly semaglutide led to fewer primary events (108 vs. 146). The drug-drug diabetic-retinopathy Safety signal comes out of the study, and its short time of running and small overall sample sizes of individual subgroups make for unreliable results. A 12% decline in the primary composite event (hazard ratio 0.88, 95% CI 0.79 to 0.99) was noted using REWIND, which evaluated the effects of weekly dulaglutide 1.5 mg in patients with type 2 diabetes who either had a history of cardiovascular disease or had a number of risk factors

(but only about one-third were those with prior disease).[15] The SOUL trial showed the beneficial effect of oral semaglutide in reducing the risk for major adverse cardiovascular events, i.e., 12.0 % compared to 13.8 % (hazard ratio 0.86, 95 % CI 0.77 0.96) during a mean of 47.5 months in 9,650 adults with type 2 diabetes and atherosclerotic cardiovascular disease, CKD, or both. Interestingly, the kidney and limb secondary confirmatory outcomes were not different significantly.[16] Pooled studies are generally considered reliable. No increase was found in hypoglycemia, pancreatitis, pancreatic cancer, but a 12 % reduction in major adverse cardiovascular events (hazard ratio 0.88, 95 % CI 0.82 0.94) in a meta analysis of cardiovascular outcome trials was observed.[17] No matter how close an agent is structurally to human GLP-1, an update of eight placebo-controlled trials involving 60,080 participants showed a 14% decrease (HR 0.86, 95% CI 0.80 to 0.93) for heart failure and less deterioration of renal function.[18] GLP-1 RAs significantly reduce kidney events, kidney failure, and cardiovascular events, according to the 2025 meta-analysis of randomized studies with at least 12 months follow-up on people with type 2 diabetes.[19] SURPASS-CVOT, which included 13,299 adults having type 2 diabetes and atherosclerotic disease, compared tirzepatide and dulaglutide. Tirzepatide was not inferior in terms of cardiovascular death, myocardial infarction, or stroke, which amounted to 12.2% compared to 13.1%, hazard ratio 0.92. At the same time, there were bigger decreases of HbA1c and weight with tirzepatide and more gastrointestinal side effects.The main point is this trial does not demonstrate placebo benefit since the drug used as comparator was another active GLP-1 RA.

Obesity: Semaglutide 2.4 mg led to 15.3 kg weight loss over 68 weeks as compared to 2.6 kg with a placebo in the first trial of STEP, and 86.4% versus 31.5% had lost at least 5% of their weight. Nearly 4.5% of the subjects stopped because of digestive issues with semaglutide.[4] The weight loss was 15.0 to 20.9% with the help of tirzepatide in SURMOUNT-1 after 72 weeks, and the placebo group showed weight loss of only 3.1%. The rates of discontinuation of patients due to adverse events were 4.3-7.1% in the tirzepatide group while for a placebo it was 2.6%.[3] Efficacy-estimand analysis might reflect higher results than real world because they account largely for treatment adherence. The only head-to-head trial, SURMOUNT-5, showed that 36.5 mg of tirzepatide resulted in more weight loss (20.2%) after 72 weeks compared to the best semaglutide dosage, 1.7 mg (which is 13.7%). Patients stopped semaglutide due to stomach problems more than with tirzepatide (5.6% vs. 2.7%).[21] But its open-label, US-only sites, and sponsored design limit the possibility of being a general solution. When you stop taking the medicine, people usually gain some weight. A study STEP 4, showed that those who kept on the drug lost 7.9% more weight compared to those who changed to placebo which gained 6.9% after 48 weeks.[22] According to data from STEP 1 extension, the heart-metabolism benefits went mostly away and nearly two out of three people regained the lost weight within one year of discontinuation.[23]

Cardiovascular outcomes without diabetes: Individuals having developed cardiovascular disease, overweight or obese, who weren't diabetic were the focus group. The drug semaglutide 2.4 mg caused a cardiovascular death, nonfatal myocardial infarction, nonfatal stroke composite to decrease by nearly 20% over a mean follow-up of 39.8 months; the percentage of semaglutide users who had to stop permanently because of adverse events was 16.6% as opposed to only 8.2% in the placebo group. Weight loss remained after 208 weeks.[24] These findings cannot be interpreted to individuals who solely rely on these drugs for cosmetic reasons of weight loss as no trial for primary prevention in subjects without existing disease has been carried out.[5] Kidney outcomes: 3,533 adults type 2 diabetes and chronic kidney disease (CKD) who had all undergone treatments blocking renin-angiotensin were randomly split into two groups: a group that would take 1.0 mg semaglutide a week and the control group that would be given a placebo. It was decided to stop the study ahead of time at a pre-defined point after an average of 3.4 years into it. The rate of occurrence of the primary combined (which included kidney failure, a sustained eGFR reduction of about 50%, death either from the kidney or a cardiovascular cause) was cut down by 24% by semaglutide; The kidney-related composite hazard ratio was 0.79 (95%CI 0.66 to 0.94), and the risk of cardiovascular death was estimated as 0.71 (0.56 to 0.89), whereas the eGFR decline rate was slowed down by 1.16 mL/min/1.73 $m^2$ yearly.[6] Cardiovascular results in accordance with the severity of CKD had a secondary analysis FLOW.[25] FLOW provides benefits to both the kidneys and the cardiovascular system. However, it is not a perfect marker of the actual effect since the main event involved death due to heart disease, and the trial was halted before completion, this usually leads to an overstated effect size. Patients with diabetes only participate in this trial; therefore, we cannot say whether the benefits extend to obese patients without diabetes as well.

Other emerging indications: Semaglutide at 2.4mg was the only one that made the symptoms of heart failure and the physical function of heart failure less bad and it caused even greater loss of body mass compared with the placebo, the STEP-HFpEF study shows. (the study was conducted in 529 people with heart failure related to obesity and heart failure with preserved ejection fraction).[26] Very few individuals used SGLT2 inhibitors which are now considered standard treatment, and the effect on hospitalization has not been evaluated.About its Tirzepatide, it is clear that in the two 52- -week SURMOUNT-OSA tests, it reduced the apnoea-hypopnoea Index very significantly versus, the control, that, is, people having moderate-to-severe OSA and obese who participated the study.[27] In the ESSENCE interim analysis, semaglutide 2.4 mg induced fibrosis improvement in 36.8 per cent of cases against only 22.4 per cent as baseline. Besides that, this therapy successfully resolved steatohepatitis without the development of worse fibrosis in 62.9 per cent of patients compared to 34.3 per cent of baseline patients at 72

weeks. Long-term monitoring of clinical consequences has continued.[28]

## Clinical Application:

Matching agent to patient: From the trial evidence, a basic structure can be outlined. GLP-1 receptor agonists that have shown proven outcome benefits (e.g., liraglutide, semaglutide, dulaglutide, oral semaglutide) provide the most support for patients with type 2 diabetes also having atherosclerotic cardiovascular disease;[12,13,14,16] a drug that is not worse than the other drug with regard to cardiovascular outcomes is tirzepatide compared to dulaglutide.[20]The Semaglutide 1 mg has specific evidence for kidney outcomes in those living with both type 2 diabetes and CKD.[6] In a direct competition trial, tirzepatide was shown to be ahead of semaglutide 2.4 mg in terms of inducing the greatest weight loss among the average person who is obese with or without diabetes.[21] Semaglutide 2.4mg also provides outcome data regarding obesity for patients without diabetes alongside those with an ongoing condition of heart disease.[5]In reality, such a choice as a rule is the result of patient's preference, cost issues and the availability of drugs as well as pharmacist's expertise since he/she knows which medicines are actually on shelves and their retail prices.

Eligibility: Adults with a body mass index (BMI) ≥30 kg/m² or BMI ≥27 kg/m² who also had a weight- related issue were taken part in key obesity trials; the same thresholds are reflected in the labeling of tirzepatide for India.[11] But Indian guidelines, on the other hand, classify overweight at 23.0-24.9 kg/m² and obesity as ≥25 kg/m².Waist circumference ≥80 cm in women and ≥90 cm in men define central or abdominal obesity.[30,31] This inconsistency underlines the fact that besides BMI, adiposity evaluation is also necessary as advocated by the Lancet Commission.[29] There is no evidence in favor of cosmetic purposes, therefore, pharmacists have a professional duty to challenge weight loss prescriptions not backed by medical reasons.

Initiation and titration: The starting dose is low and the medication is slowly tapered as therapy progresses. As an example, with tirzepatide, the initial dose is 2.5 mg followed by a gradual increase of 2.5 mg every 4 weeks[3,9] until reaching the target dose of 5 mg or 10 mg at week 24. An escalating dose is primarily a method to improve a drug's tolerability rather than to find the best effective dose. A patient who regularly gets upset from the medicine can either stay at the current dose level with the hope that the side effect will decrease or go down one level and stay on the lower dose. Either of the two choices requires a patient's discussion with the doctor, it is not advisable for a patient to miss doses. Missed-dose rules depend on the product and the only reliable source is the product information of the particular drug formulation administered.

Combination therapy and deintensification: Pharmacist should advise reviewing and adjusting insulin and sulfonylurea dose levels at the start and throughout the weight loss phase. The reason is that combining GLP-1-based drug with insulin or a sulfonylurea is associated with a hypoglycaemia risk. All of the volunteers in FLOW were given the blocker of renin-angiotensin system, a therapy that plays a particularly important role in the context of kidney function and volume depletion.[6] As weight drops, antihypertensive medicines may no longer be needed and doctors prescriptions adjusted accordingly. The 2026 ADA Standards have a graduated method that enables deintensification of treatment in aging people.[6]

Special Population: Along with monitoring for volume status, and identifying malnourished or sarcopenic individuals, elderly persons generally require these interventions. Kidney function monitoring throughout or after the acute illness that caused vomiting or diarrhoea seems crucial, since CKD is associated with kidney disease and other kidney disorders. For women of reproductive age, the prescription should come with recommendations on effective means of contraception, and it would be wise to look up the drug label to find out whether there are interactions between tirzepatide and oral contraceptives.

Duration: Weight regain after withdrawal[22] [23] and the long-term cardiovascular trial designs[5] both point to chronic therapy for chronic disease. Pharmacists should help patients set expectations about duration from the outset and discuss plans before cost or supply interruptions force a stop.

## Safety and Limitations:

Gastrointestinal effects: Among the common side effects of GLP-1 Receptor Antagonists are nausea, vomiting, diarrhea and constipation. Usually, these effects vary from mild to moderate but may become quite severe if the amount of medication is being increased.[3] In the SELECT trial, the rate of drug discontinuation for semaglutide due to side effects was 16.6% versus the 8.2% rate for the placebo group. Even though the data are not yet strong enough to confirm, reports of gastroparesis, pancreatitis, and bowel obstruction cases suggest that the drugs may possibly increase the risk of these conditions.[32] The chance of developing a negative side reaction can be diminished by means of smaller and frequent meals, refraining from consuming high-fat foods, drinking adequate water, and incrementally adapting one to higher dosage levels. Persistent vomiting together with very low liquid intake may lead to renal failure; thus, if this happens medical intervention immediately should be requested.

Class warning: GLP-1 RAs have a thyroid-related boxed warning. Patients with a personal or familial history of medullary thyroid cancer or MEN should not have C-cell tumors, which have been seen in rodents.2. Research on thyroid cancer in humans yields inconsistent findings and a low absolute risk. [33,34] Although trial evidence has not consistently demonstrated an elevated risk of pancreatitis, prolonged severe stomach discomfort justifies stopping medication until examination. Acute pancreatitis and gallbladder disease are labeled concerns. Rapid glucose reduction may exacerbate difficulties in people with diabetic retinopathy. [12,17] Frequent eye exams are recommended, especially after starting medication.[13]

Non-arteritic anterior ischaemic optic neuropathy: The connection causality is still unknown, however observational studies show possible association of semaglutide and non-arteritic anterior ischemic optic neuropathy (NAION).[35] The EMA identified NAION as a very rare adverse reaction of semaglutide (up to 1 in 10,000 patients) and has advised to stop the drug if the effect is proven.[36] One typical clinical feature is sudden painless loss of vision in one eye according to WHO.[37] Moreover, a pharmacovigilance study in 2026 identified reporting signals of a potential adverse effect with tirzepatide rather than causation. Pharmacist need to be alert in reporting any possible adverse drug reactions and suggest eye specialists consultation in case sight loss is sudden and unexpected. Procedural aspiration: GLP-1 RAs have reported in the literature of a few cases of pulmonary aspiration following deep sedation or general anesthesia with the occurrence of the incident despite fasting and delay of gastric emptying.[39] There is a controversy amongst observational studies; some state there is higher risk of aspiration or procedure discontinuation.[40,41] In fact, the 2023 guideline recommended deferring weekly dose for elective surgery. However, the new guidelines emphasize shared decision-making and an individualized risk assessment that are often combined with an adjusted fasting policy.[42,44] Pharmacists must advise patients not to stop or restart therapy unilaterally without consultation with a physician and inform procedural teams of the medicine and dosing regimen of the patient.

Medication errors: The FDA has reported that hospitalizations following semaglutide compound dose-related issues are largely due to wrong conversions or misunderstanding of milligrams, milliliters and the units on syringes.[45] In addition, a mix-up between daily and weekly supplies, different strengths of semaglutide (such as 1 mg vs 2.4 mg) and brand names that are either similar in pronunciation or appearance are also contributing factors to errors. When vial-and-syringe products are to be used, it is essential to provide clear, accurate dosage instructions as well as a complete check to eliminate any potential mistake.

Mental Health: Reports of suicidal thoughts prompted European regulators to review semaglutide. However, a large observational study found a lower risk of suicidal ideation with semaglutide than with non-GLP-1 weight-loss drugs.[46] Although these findings are reassuring, pharmacists should remain alert to possible mood changes and discuss them with patients during counselling.

Body composition: GLP-1-based weight loss may include 20%–30% loss of lean tissue, occasionally reaching 40%. Most studies do not distinguish muscle loss from changes in other lean tissues, and its effects on physical function remain unclear. The concern is greater in older and frail individuals, making adequate protein intake and regular resistance exercise important during treatment.[47,48]

Drug Interactions: The combination of GLP-1-based therapy with insulin or SUs may result in a higher chances of developing hypoglycaemia. The slowing down of emptying may change the way oral medicines, like warfarin and levothyroxine, work; hence, close monitoring is necessary. People taking tirzepatide should follow instructions regarding the use contraception, because of the possible decrease of the protective effect of oral contraceptives. On the other hand, oral semaglutide should be taken exactly before the meal as instructed. In addition, the use of GLP-1-based therapy together with other drugs that can induce fluid loss can potentially raise the risk of kidney damage as well.

Signals from spontaneous reports: Disproportionality analyses of the FDA Adverse Event Reporting System have flagged neurological events such as dizziness, tremor and dysgeusia with GLP-1 RAs, with a median onset of 32 days,[49] and have catalogued tens of thousands of tirzepatide reports.[50] These studies cannot establish causation or incidence because of reporting bias, stimulated reporting, missing denominators and confounding, and the authors themselves frame results as associations. They are useful for hypothesis generation, which is precisely why pharmacist-submitted reports matter.

Limitations of the safety evidence. Trials exclude people with prior pancreatitis, medullary thyroid carcinoma and many with advanced kidney or liver disease. Evidence on pregnancy outcomes, adolescents, long-term mental-health effects, bone changes and effects of treatment cycling is limited, and none was assessed in depth in this review. Table 4 lists monitoring parameters.

## Emerging Advances:

Oral small-molecule GLP-1 receptor agonists: Orforglipron is a daily oral, non-peptide GLP-1 receptor agonist. The phase of clinical studies (ATTAIN-1, 127 adults without diabetes, 72 weekly visits) revealed the weight loss in the range of 7.5 11.2% depending on the dose whereas placebo had only 2.1%. There were mainly mild-to-moderate gastrointestinal side effects. Since this was an industry-sponsored trial and small molecules can have off-target effects, there's a need for long-term safety surveillance. The status and availability of a regulatory approval need to be verified before using it as a clinical agent. If introduced in India, the possible drug interactions and potential hepatic safety should be closely monitored by pharmacists.

Triple agonist: Retatrutide has been targeted at multiple receptors that include GIP, GLP-1, and glucagon receptors. It has been revealed that Company reported top line results of its 2,339-participant TRIUMPH-1 trial which showed the mean weight loss was 28.3% over 80 weeks in efficacy estimand while weight loss was as high as 30.3% at 104 weeks. Adverse reaction based discontinuation was reported to be 4.1%, 6.9%, and 11.3% with the three doses against 4.9% in placebo.[52,53] It will be only after the complete peer-reviewed articles and corresponding regulatory decisions have been made available that we could discuss further phase 3 data and intended indications.

Heart failure with preserved ejection fraction: Heart failure with preserved ejection fraction, steatotic liver disease, sleep apnoea and osteoarthritis are active

research areas for incretin therapies. Other multi-agonist and amylin-based combinations are in development but were not reviewed.

Implications for pharmacy practice: Every product has a unique titration regime, device, interaction picture and adverse-event profile. Higher levels leading to increased drop-out rates at a top dose level for Retatrutide according to the main figure show how important tolerability talks and the ability to tailor titration according to circumstances will be in the future. The periods right after product release are when pharmacists submit reports of adverse events and such feedback is the most useful one.

## Pharmacist's role:

Pharmacists, who are professionally trained, are aware of the limitations of GLP-1-based therapy which are that the patients have to self-inject, titration is slow, frequent gastrointestinal upsets occur, it's an expensive treatment and also long-term use is required. The potential effect on outcomes is mostly a theoretical prediction based on assumptions rather than proven outcomes, similar to what was mentioned as being the case with most of the evidence provided below. The data provided by the present study is summarized below:

1. Patient assessment and eligibility screening: At first sight the pharmacist can verify if indication and BMI or comorbidity are compatible with the product prescribed, ask the patient whether either personally or one's family there has/have been medullary thyroid carcinoma or MEN2, or any history of pancreatitis, gallbladder disease, diabetic retinopathy, gastroparesis, plans of pregnancy, status of kidney function and if there would be any surgery or endoscopy coming soon. These assessments mainly highlight contraindications and precautions in the Safety section, and can be performed without any extra facility.
2. Medication review and reconciliation: In suggesting monitoring or changing doses to the prescriber, the pharmacist needs to mention the drugs associated with possible problems that include insulin and sulfonylureas as sources for hypoglycemia, diuretics, renin-angiotensin blockers, and NSAIDs for volume depletion and kidney damage, oral contraceptives, and drugs with a narrow therapeutic index like levothyroxine and warfarin. It would also be very helpful to find out whether a patient receives more than one drug of the same class, e.g., a GLP-1 receptor agonist with a DPP-4 inhibitor or a patient receiving two GLP-1 products.
3. Counselling: At initiation and again at each escalation, teach-back should cover: weekly versus daily dosing and the same day each week; injection site rotation and pen or syringe technique; storage; what to do after a missed dose according to the specific product label; small, lower-fat meals and fluid intake; early recognition of dehydration and of pancreatitis, gallbladder and visual warning symptoms; sick-day advice for patients on diuretics, ACE inhibitors or ARBs; contraception and pregnancy planning; informing procedural lists before surgery or endoscopy; and expectations for gradual weight loss, long-term use and weight regain after stopping.[22] [23] Protein intake and resistance activity can be raised as advice for preserving lean mass.[47] [48]
4. Dose administration and error prevention: For vial-and-syringe products, the pharmacist should confirm the concentration, state the dose in the units printed on the syringe, mark or provide a dose chart, and observe the patient drawing and injecting a dose. The FDA's account of compounded-semaglutide overdoses driven by milligram, millilitre and unit confusion defines the failure mode to design against.[45] Pharmacists should also reject doubled doses to catch up after missed injections, challenge any weekly drug prescribed daily, and be cautious about compounded or unregulated products whose strength and sterility cannot be assured.
5. Adherence and persistence support: Randomised-trial evidence syntheses have shown support for pharmacist-led patient education and pharmaceutical care for people with type 2 diabetes and also have demonstrated better glycaemic control as an outcome.[55,58] These results do not, however, directly apply to GLP-1-based therapy. Persistence remains a challenge. In the non-diabetic population, about 65% of patients discontinue therapy within 1 year; in patients with diabetes, the figure drops to about 47%.[59] Very little evidence of pharmacist-led GLP-1 services exists as a specific type. There was no randomised trial or meta-analysis found related to the topic. If there is to be any change in drug persistence, medication errors, patient-centered outcomes, AE reporting, and cost-effectiveness, more studies need to be set up as prospective controlled designs (i.e., comparing outcomes between groups over time or at fixed intervals).[62] Also, the pharmacists' lack of knowledge about GLP-1 therapy and their lack of regulatory know-how that have been mentioned indicate that there is a need for targeted training.[63]
6. Adverse drug reaction reporting and pharmacovigilance: Pharmacists have to report suspect drug reactions and errors to the concerned authorities, including cases of NAION, pancreatitis, procedural aspiration, severe dehydration or failure of kidneys, serious hypo glycaemia and dosing mistakes. In India, reports of adverse effects are made to the Pharmacovigilance Programme of India (PvPI), that provides a national helpline and a reporting system for healthcare professionals.[64] To do signal detection, detailed reports such as (product involved, batch number, dose, device or vial used, time line of the occurrence, other drugs, and outcome) are indispensable. The lack of these elements is a known problem with spontaneous-report analyses.[49,50]
7. Interprofessional collaboration. Useful mechanisms include collaborative protocols agreed with prescribers for titration and monitoring, a standard

communication to surgical and endoscopy teams, shared access to kidney function and HbA1c results, and dietitian referral. Because the ADA Standards of Care describe the pharmacist as part of the person-centred diabetes team,[2] these roles are consistent with current guidance, although their precise scope in Indian practice depends on local regulation.

8. Applications in Indian Health care: Four factors influence pharmacists' priorities in India.

- Affordability as well as accessibility: Pharmacists are expected to check prices regularly as it is not always a lower price that makes a medicine interchangeable. Along with verifying availability, they should also confirm approved uses, strengths of the drug, concentrations, packaging, and devices for administration.
- New formulations of dosage forms: Pharmacists must ensure that for products like vials or custom-drawn syringes, proper and well-explained instructions in the local language are available in writing and orally to patients along with a dose measure demonstration.
- Regulation and advertisement: Pharmacists have to prevent use for cosmetics purposes of the drug without supervision as well as to verify the latest laws with respect to prescriptions, dispensing and advertising, respectively.
- Pharmacovigilance: Potential adverse reactions and medication errors have to be reported via national channels, while recording data on product, dose, batch, device, time of administration etc. and concomitant medicines used and the final outcomes. Targeted pharmacist training, standard protocols and documenting tools would help community pharmacy practice to be safer.

## Research Gaps:

Key research gaps remain in GLP-1-based therapy. Randomised trials are needed to evaluate pharmacist-led services and their effects on glycaemic control, weight, adherence, safety and costs.[55,56,57] Indian-specific outcome and safety data, independent evaluations of generic semaglutide and dosing-error surveillance are lacking.[30,66] Long-term studies should clarify rare adverse effects, including ocular, pancreatic, gallbladder, thyroid and mental-health outcomes.[33,34,38] Evidence on perioperative management, aspiration risk and treatment interruption remains limited.[40,41,44] Optimal maintenance doses, tapering and switching strategies to prevent weight regain require investigation.[22,23] Blinded comparative trials and cardiovascular and kidney outcome studies of newer agents are also needed.[21] Active pharmacovigilance in India could better establish adverse-event patterns and incidence.[49,50] Finally, further research should assess effects on muscle quality and physical function, including the role of resistance exercise and protein supplementation.[47,48]

## Future Perspectives:

Models for practice: Logical next steps that can be investigated in pragmatic trials include pharmacist-led titration and monitoring clinics running under cooperative guidelines, structured follow-up at each dose level, and consistent preprocedure communication templates. The knowledge gaps observed among pharmacists in other countries support the idea of providing community and hospital pharmacists in India with a brief certification on GLP-1-based therapy that covers counseling, vial and pen technique, error prevention, and PvPI reporting, with results monitored from the outset.[63]

Safety by design: The error traps can be prevented by a proper choice of product and labeling for instance: the drug doses can be labeled together with syringe markings, dose-matched syringes can be supplied, various concentrations of a product should be avoided in the same market, and finally, the graphical instructions should be given in the local language. Pharmacists have an essential part to play in influencing these decisions by giving usability feedback and reports of errors to manufacturers and regulatory bodies.

Digital support: Dose-conversion calculators, injection-day reminders, symptoms checking and refill alerts could extend pharmacist reach, but their effect on persistence and error rates should be evaluated before wide adoption.

Evolving therapeutic landscape: If approved, oral small-molecule agents and triple agonists can cause changes in pharmacy advisory services and pharmacovigilance practices.[51,52,54] The extension of indications will involve pharmacists more widely in disease management and emphasize the importance of multidisciplinary collaboration.

Equity and stewardship:Lower prices of the drug in India may enable more people to get it. However, price cuts in such a manner may lead to the misuse of medicine by the uninitiated and cosmetic type use. Pharmacists can play a role in identifying patients most likely to benefit (those with established cardiovascular disease, CKD with diabetes, and obesity with complications) and, therefore, prioritising them, besides supervising, keeping the record, and finally making the medicine available at a reasonable price over a long period.

## Conclusion:

Studies have clearly shown that GLP-1-based therapies help people to lose weight, are good for the heart, and in diabetes with renal impairment, have even protective effect on kidneys,[3,5,6,21] but in practice their effectiveness depends a lot on proper choice of the drug, adjusting the starting dose, method of administration, dealing with side effects, and staying with the treatment. The side effects of these drugs are mostly avoidable and treatable: gastric disturbance can be reduced by slow increase in drug dosage and patient education, aspiration after taking medicine is preventable by explaining procedure before taking medicine and product design with teach-back, and for occasional events such as NAION timely reporting systems are needed along with appropriate communication.[36,45] Pharmacists are uniquely placed to carry out all the necessary functions and preliminary information show that pharmacist-led interventions can

help people to continue use the medication, control their diabetes and improve their access, but GLP-1-focused evidence is mainly based on observation and with low certainty.[60,61] In India, the introduction of cheaper alternatives and newer vial presentations has made pharmacist-led prevention of medication errors, patient education, and pharmacovigilance an urgent issue. To find out the impact of these pharmacist-led approaches, the highest priority is a well-planned experimental study.

## Tables and Figures

**Table 1: Key safety concerns and pharmaceuticals actions**

| Concern | Status of evidence | Pharmacist action |
|---|---|---|
| Nausea, vomiting, diarrhoea, constipation | Very common, mostly during escalation | Titration advice, meal and fluid counselling, escalate if persistent vomiting |
| Pancreatitis, bowel obstruction, gastroparesis | Rare; cohort data conflict with trial data | Stop and refer for severe persistent abdominal pain or vomiting |
| Dehydration and kidney injury | Standard clinical reasoning | Sick-day advice; review diuretics, ACEi/ARB, NSAIDs |
| Thyroid C-cell tumour warning; MEN2/MTC contraindication | Standard labelling; human cohort data conflict | Screen history before dispensing |
| Diabetic retinopathy | Signal in SUSTAIN-6 | Confirm eye follow-up |
| NAION | EMA: very rare, up to 1 in 10,000 | Urgent referral for sudden visual loss; report |
| Procedural aspiration | Labelled; observational data and guidance diverge | Ask about procedures; liaise with proceduralist |
| Dosing errors with vials | FDA alert for compounded semaglutide | Teach-back, syringe-specific dosing, observed first dose |
| Suicidal ideation | Observational cohort shows no excess | Ask about mood changes |
| Lean-mass loss | Common; functional impact uncertain | Protein and resistance-exercise advice, especially in older adults |
| Hypoglycaemia with insulin or sulfonylurea | Standard pharmacology | Prompt dose review at initiation |
| Oral drug absorption changes | Mechanistic; warfarin and levothyroxine commonly considered | Closer INR or TSH follow-up where relevant |

## References:


1. American Diabetes Association Professional Practice Committee for Diabetes*. 9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes-2026. Diabetes Care. 2026 Jan 1;49(Suppl 1):S183-S215. doi: 10.2337/dc26-S009. PMID: 41358900; PMCID: PMC12690185.

2. Liu QK. Mechanisms of action and therapeutic applications of GLP-1 and dual GIP/GLP-1 receptor agonists. Front Endocrinol (Lausanne). 2024;15:1431292. doi:10.3389/fendo.2024.1431292.

3. Jastreboff AM, Aronne LJ, Ahmad NN, et al. Tirzepatide once weekly for the treatment
of obesity. N Engl J Med. 2022;387(3):205-16. doi:10.1056/NEJMoa2206038

4. Wilding JPH, Batterham RL, Calanna S, et al. Once-weekly semaglutide in adults with
overweight or obesity. N Engl J Med. 2021;384(11):989-1002. doi:10.1056/NEJMoa2032183

5. Lincoff AM, Brown-Frandsen K, Colhoun HM, et al. Semaglutide and cardiovascular
outcomes in obesity without diabetes. N Engl J Med. 2023;389:2221-32. doi:10.1056/NEJMoa2307563

6. Perkovic V, Tuttle KR, Rossing P, et al. Effects of semaglutide on chronic kidney disease
in patients with type 2 diabetes. N Engl J Med. 2024;391:109-21. doi:10.1056/NEJMoa2403347

7. Anjana RM, Unnikrishnan R, et al; ICMR-INDIAB Collaborative Study Group. Metabolic
non-communicable disease health report of India: the ICMR-INDIAB national crosssectional study (ICMR-INDIAB-17). Lancet Diabetes Endocrinol. 2023;11(7):474-89. doi: 10.1016/S2213-8587(23)00119-5.

8. Myerson M, Paparodis RD. Pharmacotherapy of weight-loss and obesity with a focus on GLP-1-receptor agonists. J Clin Pharmacol. 2024;64(10):1204-1221. doi:10.1002/jcph.2487.

9. Frías JP, Davies MJ, Rosenstock J, et al. Tirzepatide versus semaglutide once weekly in
patients with type 2 diabetes. N Engl J Med. 2021;385(6):503-15. doi:10.1056/NEJMoa2107519

10. Ansari S, Khoo B, Tan T. Targeting the incretin system in obesity and type 2 diabetes mellitus. Nat Rev Endocrinol. 2024;20:447-459. doi:10.1038/s41574-024-00979-9.

11. Holst JJ. GLP-1 physiology in obesity and development of incretin-based drugs for chronic weight management. Nat Metab. 2024;6:1866-1885. doi:10.1038/s42255-024-01113-9.

12. Marso SP, Daniels GH, Brown-Frandsen K, et al. Liraglutide and cardiovascular
outcomes in type 2 diabetes. N Engl J Med. 2016;375:311-22. doi:10.1056/NEJMoa1603827

13. Marso SP, Bain SC, Consoli A, et al. Semaglutide and cardiovascular outcomes in
patients with type 2 diabetes. N Engl J Med. 2016;375:1834-44. doi:10.1056/NEJMoa1607141

14. Gerstein HC, et al; REWIND Investigators. Dulaglutide and cardiovascular outcomes in
type 2 diabetes (REWIND): a double-blind, randomised placebo-controlled trial. Lancet. 2019;394(10193):121-30. doi:10.1016/S0140-6736(19)31149-3

15. Husain M, Birkenfeld AL, Donsmark M, et al. Oral semaglutide and cardiovascular
outcomes in patients with type 2 diabetes. N Engl J Med. 2019;381(9):841-51. doi:10.1056/NEJMoa1901118

16. McGuire DK, Marx N, Mulvagh SL, et al. Oral semaglutide and cardiovascular outcomes
in high-risk type 2 diabetes. N Engl J Med. 2025 May 29;392(20):2001-2012. doi: 10.1056/NEJMoa2501006.

17. Kristensen SL, Rørth R, Jhund PS, et al. Cardiovascular, mortality, and kidney outcomes
with GLP-1 receptor agonists in patients with type 2 diabetes: a systematic review and meta-analysis of cardiovascular outcome trials. Lancet Diabetes Endocrinol. 2019;7(10):776-85. doi:10.1016/S2213-8587(19)30249-9

18. Sattar N, Lee MMY, Kristensen SL, et al. Cardiovascular, mortality, and kidney
outcomes with GLP-1 receptor agonists in patients with type 2 diabetes: a systematic review and meta-analysis of randomised trials. Lancet Diabetes Endocrinol. 2021;9(10):653-62. doi:10.1016/S2213-8587(21)00203-5

19. Badve SV, Bilal A, Lee MMY, et al. Effects of GLP-1 receptor agonists on kidney and
cardiovascular disease outcomes: a meta-analysis of randomised controlled trials. Lancet Diabetes Endocrinol. 2025;13(1):15-28. doi:10.1016/S2213-8587(24)00271-7

20. Nicholls SJ, Pavo I, Bhatt DL, et al. Cardiovascular outcomes with tirzepatide versus
dulaglutide in type 2 diabetes. N Engl J Med. 2025;393(24):2409-20. doi:10.1056/NEJMoa2505928

21. Aronne LJ, Horn DB, le Roux CW, et al. Tirzepatide as compared with semaglutide for
the treatment of obesity. N Engl J Med. 2025;393(1):26-36. doi:10.1056/NEJMoa2416394

22. Rubino D, Abrahamsson N, Davies M, et al. Effect of continued weekly subcutaneous
semaglutide vs placebo on weight loss maintenance in adults with overweight or obesity: the STEP 4 randomized clinical trial. JAMA. 2021. doi:10.1001/jama.2021.3224.

23. Wilding JPH, Batterham RL, Davies M, Van Gaal LF, Kandler K, Konakli K, et al.; STEP 1 Study Group. Weight regain and cardiometabolic effects after withdrawal of semaglutide: the STEP 1 trial extension. Diabetes Obes Metab. 2022 Aug;24(8):1553-64. doi:10.1111/dom.14725.

24. Ryan DH, Lingvay I, Deanfield J, Kahn SE, Barros E, Burguera B, et al. Long-term weight loss effects of semaglutide in obesity without diabetes in the SELECT trial. Nat Med. 2024 Jul;30(7):2049-57. doi:10.1038/s41591-024-02996-7.

25. Mahaffey KW, Tuttle KR, Arici M, Baeres FMM, Bakris G, Charytan DM, et al. Cardiovascular outcomes with semaglutide by severity of chronic kidney disease in type 2 diabetes: the FLOW trial. Eur Heart J. 2025 Mar 24;46(12):1096-1108. doi:10.1093/eurheartj/ehae613.

26. Kosiborod MN, Abildstrøm SZ, Borlaug BA, et al. Semaglutide in patients with heart
failure with preserved ejection fraction and obesity. N Engl J Med. 2023;389:1069-84. doi:10.1056/NEJMoa2306963

27. Malhotra A, Grunstein RR, Fietze I, et al. Tirzepatide for the treatment of obstructive
sleep apnea and obesity. N Engl J Med. 2024;391:1193-205. doi:10.1056/NEJMoa2404881

28. Sanyal AJ, Newsome PN, Kliers I, et al. Phase 3 trial of semaglutide in metabolic
dysfunction-associated steatohepatitis. N Engl J Med. 2025;392(21):2089-99. doi:10.1056/NEJMoa2413258

29. Rubino F, Cummings DE, Eckel RH, et al. Definition and diagnostic criteria of clinical
obesity. Lancet Diabetes Endocrinol. 2025;13:221-62. doi:10.1016/S2213-8587(24)00316-4

30. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al.; Consensus Group. Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. J Assoc Physicians India. 2009 Feb;57:163-70.

31. Behl S, Misra A. Management of obesity in adult Asian Indians. Indian Heart J. 2017. doi:10.1016/j.ihj.2017.04.015

32. Sodhi M, Rezaeianzadeh R, Kezouh A, Etminan M. Risk of gastrointestinal adverse events associated with glucagon-like peptide-1 receptor agonists for weight loss. JAMA. 2023;330(18):1795-7. doi:10.1001/jama.2023.19574

33. Bezin J, Gouverneur A, Pénichon M, et al. GLP-1 receptor agonists and the risk of
thyroid cancer. Diabetes Care. 2023;46(2):384-90. doi:10.2337/dc22-1148

34. Pasternak B, et al. Glucagon-like peptide 1 receptor agonist use and risk of thyroid cancer: Scandinavian cohort study. BMJ. 2024;385:e078225. doi:10.1136/bmj-2023078225

35. Hathaway JT, Shah MP, Hathaway DB, et al. Risk of nonarteritic anterior ischemic optic
neuropathy in patients prescribed semaglutide. JAMA Ophthalmol. 2024. doi:10.1001/jamaophthalmol.2024.2296

36. European Medicines Agency. PRAC concludes eye condition NAION is a very rare side
effect of semaglutide medicines Ozempic, Rybelsus and Wegovy. EMA/186862/2025. 2025 Jun 6. https://www.ema.europa.eu/en/news/prac-concludes-eye-condition-naionvery-rare-side-effect-semaglutide-medicines-ozempic-rybelsus-wegovy

37. Hidalgo Ramos RA, Ortiz M, Dufner Krieger S, Secades D. Semaglutide and non-arteritic anterior ischemic optic neuropathy (NAION): a systematic review. Cureus. 2025;17(8):e89656. doi:10.7759/cureus.89656.

38. Murray M, Schifano F, Chiappini S. Potential Eye Disorders in People With and Without Type 2 Diabetes Mellitus Exposed to GLP-1 Receptor Agonists: An Examination of the FAERS
(FDA Adverse Event Reporting System) DatabaseAmerican Journal of Ophthalmology, 2025; 283, 279-290

39. In brief: new FDA warning of pulmonary aspiration with GLP-1 receptor agonists. Med Lett Drugs Ther. 2024;66(1718):201-2. doi:10.58347/tml.2024.1718a

40. Alkabbani W, Suissa K, Gu KD, Cromer SJ, Paik JM, Bykov K, et al. Glucagon-like peptide-1 receptor agonists before upper gastrointestinal endoscopy and risk of pulmonary aspiration or discontinuation of procedure: cohort study. BMJ. 2024;387:e080340. doi:10.1136/bmj-2024-080340.

41. Yeo YH, Gaddam S, Ng WH, Huang PC, Mohamed G, Samaan J, et al.; Motility and Metabolic Pharmacoepidemiology Group. Increased risk of aspiration pneumonia associated with endoscopic procedures among patients with glucagon-like peptide 1 receptor agonist use. Gastroenterology. 2024 Jul;167(2):402-4.e3. doi:10.1053/j.gastro.2024.03.015.

42. Chen KY, Chan HC, Chan CM. Does semaglutide increase the risk of non-arteritic anterior ischemic optic neuropathy? A systematic review and meta-analysis of emerging evidence. Asia Pac J Ophthalmol (Phila). 2026;15(1):100245. doi:10.1016/j.apjo.2025.100245.

43. Kindel TL, Wang AY, Wadhwa A, Schulman AR, Sharaiha RZ, Kroh M, Ghanem OM, Levy S, Joshi GP, LaMasters TL; American Gastroenterological Association, American Society for Metabolic and Bariatric Surgery, American Society of Anesthesiologists, International Society of Perioperative Care of Patients with Obesity, Society of American Gastrointestinal and Endoscopic Surgeons. Multisociety clinical practice guidance for the safe use of glucagon-like peptide-1 receptor agonists in the perioperative period. Surg Obes Relat Dis. 2024 Dec;20(12):1183-6. doi:10.1016/j.soard.2024.08.033.

44. Moore T, Ramsahoye B. Perioperative management of patients taking GLP-1 receptor agonists: a comparative review of international clinical guidelines. Saudi J Anaesth. 2026. doi:10.4103/sja.sja_314_26.

45. Spitery A, Elder MJ, Farhat N, Mohammad I, Lobkovich A. Legal, safety, and practical considerations of compounded injectable semaglutide. J Am Coll Clin Pharm. 2024;7(9):941–946. doi:10.1002/jac5.1999.

46. Wang W, Volkow ND, Berger NA, Davis PB, Kaelber DC, Xu R. Association of semaglutide with risk of suicidal ideation in a real-world cohort. Nat Med. 2024;30(1):168-76. doi:10.1038/s41591-023-02672-2

47. Chrysavgis L, Mourelatou NG, Koloutsou ME, Rozani S, Cholongitas E. The influence of glucagon-like peptide-1 receptor agonists and other incretin hormone agonists on body composition. Int J Mol Sci. 2025;26(24):12130. doi:10.3390/ijms262412130.

48. Chavez AM, Carrasco Barria R, León-Sanz M. Nutrition support whilst on glucagon-like peptide-1 based therapy: is it necessary? Curr Opin Clin Nutr Metab Care. 2025;28(4):351-7. doi:10.1097/MCO.0000000000001130.

49. Chen H, Liu S, Gao S, et al. Pharmacovigilance analysis of neurological adverse events
associated with GLP-1 receptor agonists based on the FDA Adverse Event Reporting System. Sci Rep. 2025. doi:10.1038/s41598-025-01206-9.

50. Gu S. Adverse events associated with tirzepatide: updated pharmacovigilance analysis using FAERS (2022 Q1–2025 Q1) with an adapted time-to-onset method. Drug Healthc Patient Saf. 2026 Jan 8;18:556918. doi:10.2147/DHPS.S556918.

51. Wharton S, et al. Orforglipron, an oral small-molecule GLP-1 receptor agonist for
obesity treatment. N Engl J Med. 2025;393(18):1796-806. doi:10.1056/NEJMoa2511774

52. Jastreboff AM, Kaplan LM, Frias JP, et al. Triple-hormone-receptor agonist retatrutide for obesity: a phase 2 trial. N Engl J Med. 2023;389:514-526. doi:10.1056/NEJMoa2301972.

53. Phase III retatrutide study demonstrates 30% weight loss. Pharm J. 2026;319(8009).
doi:10.1211/PJ.2026.1.413195

54. Liu QK. Mechanisms of action and therapeutic applications of GLP-1 and dual GIP/GLP-1 receptor agonists. Front Endocrinol (Lausanne). 2024;15:1431292. doi:10.3389/fendo.2024.1431292.

55. Pousinho S, et al. Investigating sources of heterogeneity in randomized controlled trials
of the effects of pharmacist interventions on glycemic control in type 2 diabetic patients: a systematic review and meta-analysis. PLoS One. 2016;11(3):e0150999. doi:10.1371/journal.pone.0150999.

56. Bukhsh A, Tan XY, Chan KG, Lee LH, Goh BH, Khan TM. Effectiveness of pharmacist-led educational interventions on self-care activities and glycemic control of type 2 diabetes patients: a systematic review and meta-analysis. Patient Prefer Adherence. 2018;12:2457-74. doi:10.2147/PPA.S180256.

57. Bukhsh A, Khan TM, Lee SWH, Lee LH, Chan KG, Goh BH. Efficacy of pharmacist based
diabetes educational interventions on clinical outcomes of adults with type 2 diabetes mellitus: a network meta-analysis. Front Pharmacol. 2018;9:339. doi:10.3389/fphar.2018.00339

58. Nogueira M, Otuyama LJ, Rocha PA, Pinto VB. Pharmaceutical care-based interventions in type 2 diabetes mellitus: a systematic review and meta-analysis of randomized clinical trials. Einstein (Sao Paulo). 2020;18:eRW4686. doi:10.31744/einstein_journal/2020RW4686.

59. Rodriguez PJ, Zhang V, Gratzl S, et al. Discontinuation and reinitiation of dual-labeled
GLP-1 receptor agonists among US adults with overweight or obesity. JAMA Netw Open. 2025;8(1):e2457349. doi:10.1001/jamanetworkopen.2024.57349
60. Pousinho S, Morgado M, Falcão A, Alves G. Pharmacist interventions in the management of type 2 diabetes mellitus: a systematic review of randomized controlled trials. J Manag Care Spec Pharm. 2016;22(5):493-515. doi:10.18553/jmcp.2016.22.5.493.
61. Bukhsh A, Khan TM, Lee SWH, Lee LH, Chan KG, Goh BH. Efficacy of pharmacist-based diabetes educational interventions on clinical outcomes of adults with type 2 diabetes mellitus: a network meta-analysis. Front Pharmacol. 2018;9:339. doi:10.3389/fphar.2018.00339.
62. Revolutionizing type 2 diabetes management: the role of the pharmacist in unlocking
the potential of tirzepatide. PMC12712260. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC12712260.
63. Bayram-Ozgur D, Demirtürk E, Sar Y. Community pharmacists' knowledge and counseling competence on GLP-1 receptor agonists in obesity and type 2 diabetes care in Türkiye: a cross-sectional study. Diabetes Metab Syndr Obes. 2026;19:587750. doi:10.2147/DMSO.S587750.64. Chen H, Liu S, Gao S, et al. Pharmacovigilance analysis of neurological adverse events associated with GLP-1 receptor agonists based on the FDA Adverse Event Reporting System. Sci Rep. 2025. doi:10.1038/s41598-025-01206-9.
65. Le Roux C, Mondoh A. Treatment of obesity with medications binding the glucagon-like peptide 1 receptor: what is the current state of play? Expert Opin Pharmacother. 2024;25(2):131-138. doi:10.1080/14656566.2024.2311731.
66. Zheng Z, Zong Y, Ma Y, et al. Glucagon-like peptide-1 receptor: mechanisms and advances in therapy. Signal Transduct Target Ther. 2024;9:234. doi:10.1038/s41392-024-01931-z.
67. Espinosa De Ycaza AE, Brito JP, McCoy RG, Shao H, Singh Ospina N, Maraka S, et al. Glucagon-like peptide-1 receptor agonists and thyroid cancer: a narrative review. Thyroid. 2024;34(4):403-418. doi:10.1089/thy.2023.0530.
68. Liu QK. Mechanisms of action and therapeutic applications of GLP-1 and dual GIP/GLP-1 receptor agonists. Front Endocrinol (Lausanne). 2024;15:1431292. doi:10.3389/fendo.2024.1431292.