INSULIN HANDBOOK

Ebook for Health Care Professionals (HCPs)

Dr Raka Sheohare

Insulin Handbook

Ebook for Health Care Professionals (HCPs)

Chief Editor

Dr. Raka Sheohare
MBBS MD FNIC FDI
Madhumeet Diabetes Hospital , Raipur
rakashikha@gmail.com

Contributors

Dr. Rohini Rokkam
MBBS MD CCDFM FICCMD
AIIMS Raipur
rohinirokkam@aiimsraipur.edu.in

Dr. Ghazala Siddiqui
MBBS MD MNAMS
Suyash Hospital Raipur
drghazala88@gmail.com

Dr. Chander Bafna
MBBS MD,DFID,DAA
Bafna Health Care
Durg
chander.bafna@gmail.com

Dr. Aashutosh kori
MBBS MD
Associate professor CIMS bilaspur
Dr.Aashu.Kori@gmail.com
CIMS Bilaspur

Dr. Vanaja Thakur
MBBS MD
Lt BRKMMC Jagdalpur
vanajathakur@gmail.com

Scientific Team

Dr. Sabah Siddiqui
MD Medicine
AIIMS Raipur

Dr. Shikha Jaiswal
MD Pharmacology
Associate Professor Ptjnmc Raipur

छत्तीसगढ़ की पावन माटी को नमन।

छत्तीसगढ़ की जनता को जय जोहार।

आज हमारा प्रदेश दिनों दिन प्रगति की ओर अग्रसर है।

किसी भी प्रदेश की निरंतर प्रगति के लिए वहां की जनता का स्वास्थ्य एक आधारभूत स्तंभ होता है।

हमारे प्रदेश ने भी इस क्षेत्र में बहुत प्रगति की है और आज देश के लगभग सभी बड़े स्वास्थ्य संस्थान जैसे AIIIMS आदि हमारे प्रदेश में सफलता पूर्वक संचालित हो रहे है और लगभग हर विभाग के विशेषज्ञ चिकित्सक हमारे प्रदेश में सेवारत है।

पर ऐसे बहुत सारे रोग है जिसमें जनता की भागीदारी और उनका चिकित्सकों के साथ सामंजस्य बहुत आवश्यक है ।

मधुमेह डायबिटीज एक ऐसा ही रोग है। अच्छी जीवन शैली ,संयम और समय पर सही उपचार ही इसके मुख्य घटक है।

और इस उपचार की कड़ी में जीवनदायनी इंसुलिन आज लगभग सौ वर्षों से ज्यादा समय से इस बीमारी के उपचार में सबसे अहम कड़ी है।

इंसुलिन को सरलता से समझाने और इसके ज्ञान को सहजता से समझाने के लिए किए गए प्रयास के लिए पूरी छत्तीसगढ़ RSSDI की डॉ राका शिवहरे की टीम भी बधाई की पात्र है ।

सभी सहयोगी चिकित्सकों को बधाई। इस इंसुलिन ebook से समाज का कल्याण हो।

इसी भावना के साथ ।
धन्यवाद।।

माननीय विष्णु देव साय
मुख्यमंत्री
छत्तीसगढ़ शासन
११ अक्टूबर २०२५

सर्वप्रथम छत्तीसगढ़ की स्वास्थ्य प्रेमी जनता को जय जोहार।

आपके स्वास्थ्य के हितों को सदैव सर्वोपरी रखना ही हमारा परम कर्तव्य है।
मधुमेह की विकराल होते हुए स्वरूप से हमारा प्रदेश भी अछूता नहीं रहा है।

हर्ष की बात यह है कि हम इसके इलाज में हर संभव प्रयास कर रहे है और हमारे प्रदेश में इसके इलाज हेतु पर्याप्त अनुभव चिकित्सक और संसाधन मौजूद हैं।

विगत सौ वर्षों से इस व्याधि के उपचार में इंसुलिन एक महत्वपूर्ण कड़ी रही है और जो रामबाण रूपी कारगर है पर इंसुलिन के इस्तेमाल में बहुत सारी जटिलता देखी गई है और जरूरत है इसके प्रति कारगर वैज्ञानिक ज्ञान और दृष्टिकोण का ,जो कि इंसुलिन की व्यापक कार्यशाला या फिर सहजता से समझाने वाली किताबों या ebook के जरिए किया जा सकता है।

इस तरह के नवाचार की जानकारी मुझे रिसर्च सोसायटी फॉर स्टडी ऑफ डायबिटीज इन इंडिया की छत्तीसगढ़ ईकाई के चेयरमैन डॉ राका शिवहरे ने जब दी तो हमने उनके इस विचार को मुक्त हस्त से संबल प्रदान करते हुए कहा कि वो RSSDI सोसायटी के इस कार्य को मूर्त रूप दें।

हमारे प्रदेश और सुदूर अंचल के चिकित्सक बंधुओं को इंसुलिन के प्रभावी विज्ञान से अवगत कराने और इसकी जटिलताओं से निकालकर सहज बनाने के लिए इस इंसुलिन ebook का कार्य स्वागत योग्य कार्य है।

मैं RSSDI की राष्ट्रीय कार्यकारिणी , राष्ट्रीय अध्यक्ष डॉ विजय विश्वनाथन ,सचिव डॉ संजय अग्रवाल को भी बधाई देता हूं।
छत्तीसगढ़ ईकाई के अध्यक्ष डा राका शिवहरे एवं इनकी पूरी टीम और इस ebook के सारे रचनाकारों को विशेष बधाईयां।

संभवतः इस तरह का प्रयास और प्रयोग करने वाला हमारा राज्य प्रथम राज्य होगा।
मैं पुनः छत्तीसगढ़ के सभी संवेदनशील चिकित्सक बंधुओं को बधाई देता हूं।

श्याम बिहारी जायसवाल
स्वास्थ्य मंत्री
छत्तीसगढ़ शासन
११ अक्टूबर २०२५

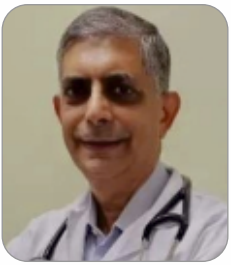
Message from President, RSSDI

It's a great pleasure that CGRSSDI is releasing an eBook on insulin therapy, which will be of great support for the healthcare professionals in the management of diabetes. Insulin remains a cornerstone of treatment. I hope this resource will offer concise, evidence-based guidance to aid its proper, effective and safe use in regular practice.

The contributors efforts in preparing this valuable reference guide is commendable and I trust it will enhance the clinical expertise and improve patient outcomes in Chattisgarh and all over India.

Dr. Vijay Viswanathan
National President,
Research Society for the Study of Diabetes in India

Preface



Insulin remains one of the most powerful, effective, and life-saving therapies in the management of diabetes. Over the past century, it has not only transformed outcomes for millions of people worldwide but has also challenged generations of healthcare professionals (HCPs) to use it judiciously, safely, and with compassion. Despite its central role, insulin therapy continues to be underutilized, delayed, or misunderstood in clinical practice—often at the expense of optimal patient outcomes.

It is with this conviction that the Chhattisgarh Chapter of RSSDI has brought forth this "Handbook on Insulin designed for Healthcare Professionals". This effort is designed to provide clinicians with concise, practical, and evidence-based insights into the rational use of insulin in diverse clinical situations.

My own academic and professional journey has been deeply intertwined with the subject of insulin. Having served as part of the RSSDI Guidelines on Management of Insulin Therapy, and as the Editor of two editions of the RSSDI Insulin Monograph, I have witnessed the evolving science, clinical challenges, and opportunities that insulin therapy presents in India. Each edition has underscored the urgent need for simple, implementable, and patient-centric resources—tailored not just for tertiary care centres but also for primary care physicians, who are often the first point of contact for people living with diabetes.

This handbook reflects the same vision: to equip HCPs with clarity, confidence, and competence in initiating and intensifying insulin therapy, overcoming barriers, and individualizing care. The chapters have been structured to blend scientific rigor with practical wisdom, ensuring that this book serves as both a quick reference and a thoughtful guide in day-to-day practice.

I commend the Chhattisgarh Chapter of RSSDI for this initiative, which will undoubtedly strengthen our collective mission of improving diabetes care in India. I also extend my gratitude to all contributors and colleagues who have devoted their knowledge and experience to this handbook.

It is my hope that this resource will empower every healthcare professional to view insulin not as a last resort, but as a trusted ally in the pursuit of better outcomes and healthier lives for our patients.

Dr. Sanjay Agarwal
MD, FACE, FACP
Secretary-General, RSSDI
Director, Dept. of Diabetes, Obesity & Metabolic Diseases, Ruby Hall Clinic, Pune
Head, Dept. of Diabetes & Obesity, Sahyadri Hospitals, Pune

From the editors pen

Warm Greetings to all.

As a practicing physician I know and correlate it well that management of diabetes is a disciplined team effort and need perfect support from everyone.
Moreover use of insulin adds complexity and responsibilities in management to both parties ie to user and to care giver.
Hence it's hightime to make our HCP scientificaly sound to update there knowledge for insulin for better adaptation and propagation of right knowledge to end user.

We at CGRSSDI had tried to address this need and has planned this E book on insulin to guide our Health care Professionals scientificaly and easily.

I am grateful to all sincere efforts of compilation from my coauthors .
I am thankful for all support from my seniors and mentors

Dr Raka Sheohare
Chief Editor
Chairman CGRSSDI 2025-2026

CONTENTS

Chapter 1

INSULIN DISCOVERY-Dr. Rohini Rokkam

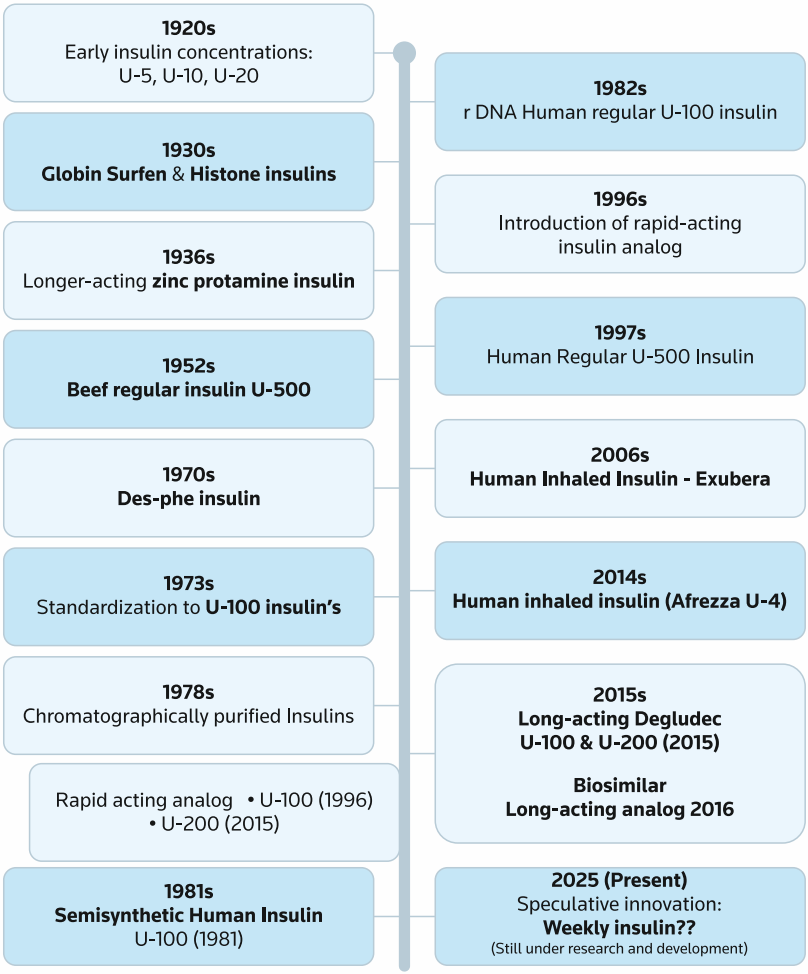
The Miracle of Insulin

Patient J.L., December 15, 1922

February 15, 1923

Banting and Best isolated insulin from dog's pancreas which could lower blood sugar of dogs. Leonard Thompson was the first child to receive insulin at the age of 14 years. He lived for another 13 years after the discovery of insulin. Prior to this diagnosis of type 1 diabetes was a death sentence.

INSULIN TIMELINES



References

- Sims, E.K., Carr, A.L.J., Oram, R.A. et al. 100 years of insulin: celebrating the past, present and future of diabetes therapy. Nat Med 27, 1154–1164 (2021).
- Irl B Hirsch, Rattan Juneja, John M Beals, Caryl J Antalis, Eugene E Wright, Jr., The Evolution of Insulin and How it Informs Therapy and Treatment Choices, Endocrine Reviews, Volume 41, Issue 5, October 2020, Pages 733–755

Chapter 2

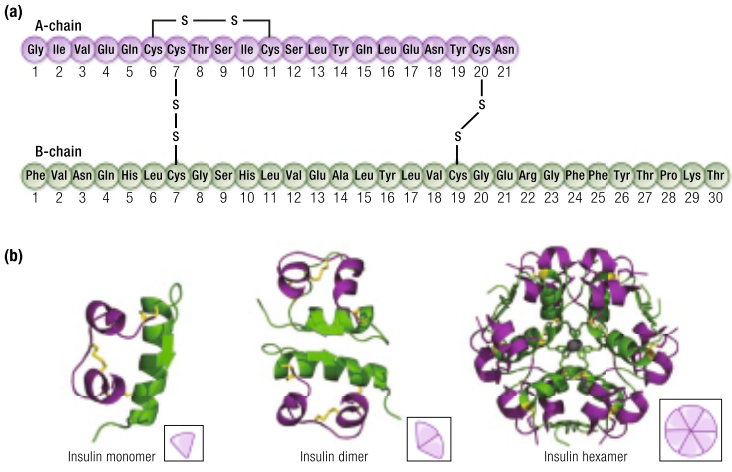
PHARMACOLOGY -

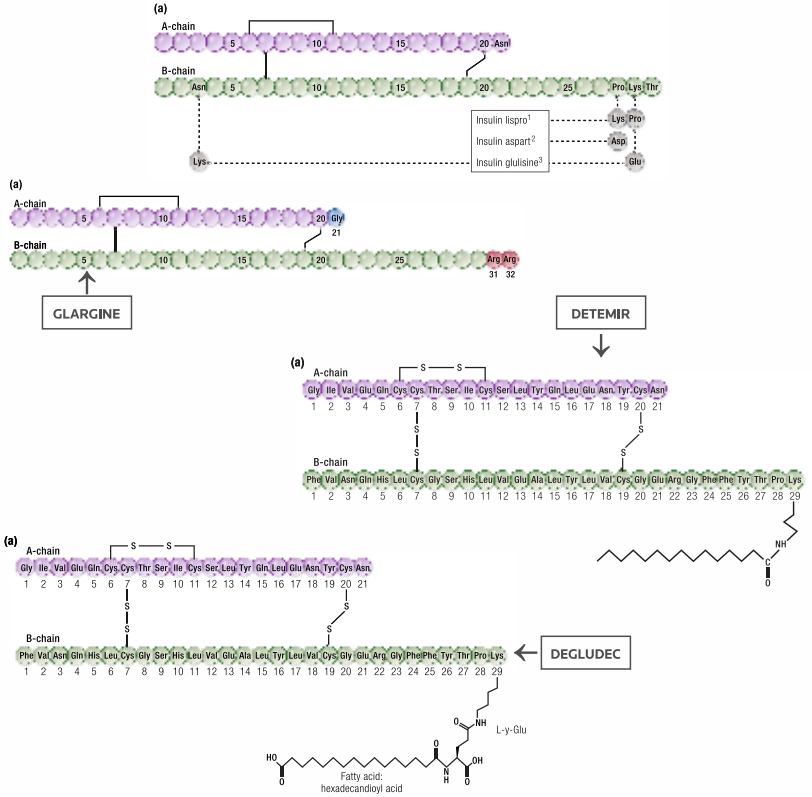
Dr. Chander Bafna, Dr. Rohini Rokkam

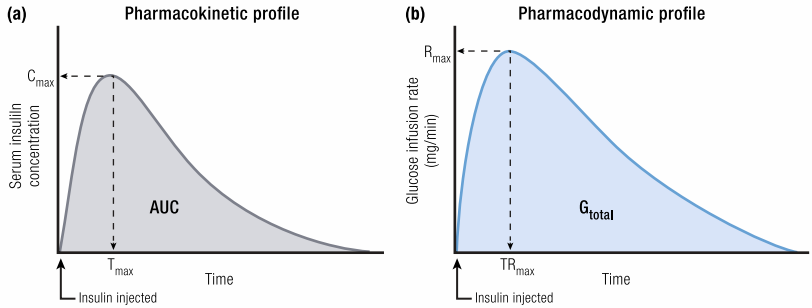
Structure of Insulin

Human insulin is a heterodimer of two polypeptides- α chain (21 amino acids) and β chain (30 amino acids). All commercially available insulins are produced by slightly modifying the composition of the chains or adding certain components to improve its stability or modify its release.

Normal human Insulin







Pharmacokinetics and PD profiles, explained. A: Pharmacokinetics profile: insulin concentration versus time after injection. B: Pharmacodynamics profile: GIR versus time after insulin injection. Abbreviations: AUC, area under the curve; C_{max}, maximum concentration reached; G_{total}, total amount of glucose infused; R_{max}, maximum rate of glucose infusion; T_{max}, time to reach C_{max}; TR_{max}, time to reach R_{max}.

Pharmacokinetics-Basics

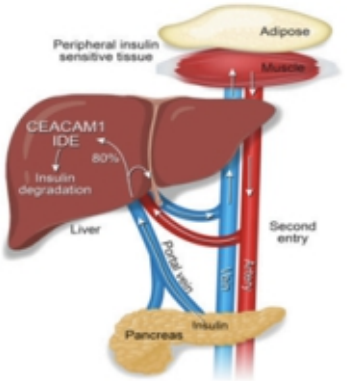
- SC insulin absorption is variable (~15% intra-individual, 30% inter-patient).
- Site matters: abdomen absorbs >2× faster than thigh.
- Patients should use consistent injection sites.
- Abdomen preferred (least variable).
- Rapid-acting analogs & glargine show less variability across sites.

Factors affecting absorption

INCREASED ABSORPTION ↑↑	DECREASED ABSORPTION ↑↑	CLINICAL COMMENTS
Exercise of injected limb	Lipohypertrophy	Exercise soon after injection can cause rapid glucose fall; lipohypertrophy leads to erratic insulin effect → rotate sites
Local massage	Cold Exposure	Massage accelerates insulin entry; cold slows absorption and may cause delayed action
Heat (sauna, hot bath, shower)	Larger insulin dose	Heat increases hypoglycemia risk; large doses prolong action and delay onset
Jet injectors	–	Jet injectors accelerate absorption compared to standard needles
Inhaled Insulin	–	Very rapid onset; useful for mealtime glucose control

Pharmacokinetics of elimination

- Insulin is degraded mainly by liver and kidneys.
- Normally: liver clears 50–60%, kidneys 35–45%.
- SC insulin shifts burden of excretion: kidneys 60%, liver 30–40%.
- Renal dysfunction → clearance → prolongs insulin effect.
- Clinically → lower insulin needs and hypoglycemia risk in CKD.



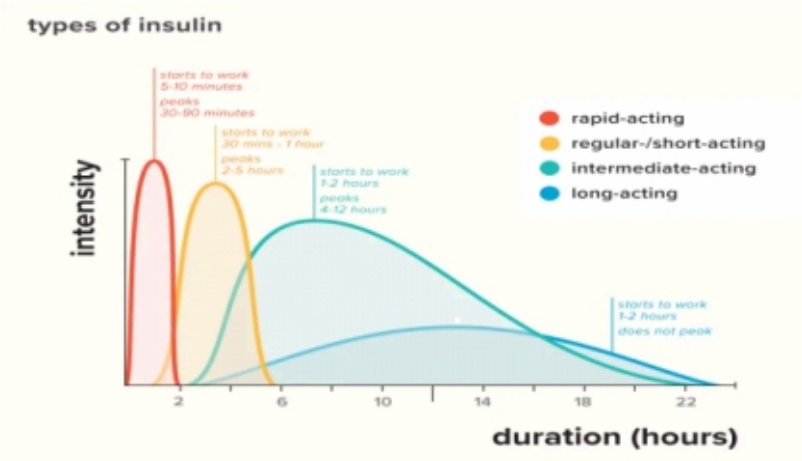
ROLE OF LIVER IN INSULIN DEGRADATION

CEACAM1- CarcinoEmbryonic cell Antigen related Cell Adhesion Molecule 1,IDE insulin degrading Enzyme

Important points relevant to renal clearance of insulin

1. Renal role in insulin clearance – Insulin is filtered by the glomeruli and reabsorbed in the proximal tubule.
2. Clearance rate – Normal renal clearance of insulin ≈ 200 mL/min, which is higher than GFR → indicates additional peritubular uptake.
3. Contribution to insulin metabolism – Kidneys remove ~6–8 units of endogenous insulin daily, accounting for 25–40% of total insulin clearance.
4. Effect of declining kidney function – With GFR <40mL/min, insulin clearance decreases; with GFR<20mL/min, insulin half life is significantly prolonged.
5. Dialysis effect – Dialysis increases insulin clearance, likely by shifting removal toward the liver and muscle.
6. CKD implications – Reduced renal and extrarenal clearance causes fasting hyperinsulinemia and lower insulin requirements in diabetics with CKD.

Pharmacodynamics



- Onset, peak, and duration vary by insulin preparation.
- Types: rapid-acting, short-acting, intermediate, long-acting.
- Patient variability requires frequent glucose monitoring.

References

• Sims, E.K., Carr, A.L.J., Oram, R.A. et al. 100 years of insulin: celebrating the past, present and future of diabetes therapy. Nat Med 27, 1154–1164 (2021).

• Irl B Hirsch, Rattan Juneja, John M Beals, Caryl J Antalis, Eugene E Wright, Jr., The Evolution of Insulin and How it Informs Therapy and Treatment Choices, Endocrine Reviews, Volume 41, Issue 5, October 2020, Pages 733–755

• Donnor T, Sarkar S. Insulin- Pharmacology, Therapeutic Regimens and Principles of Intensive Insulin Therapy. [Updated 2023 Feb 15]. In: Feingold KR, Ahmed SF, Anawalt B, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-.

Chapter 3

TYPES OF INSULIN & THEIR PROPERTIES

Dr. Vanaja Thakur

Insulin Classification Overview

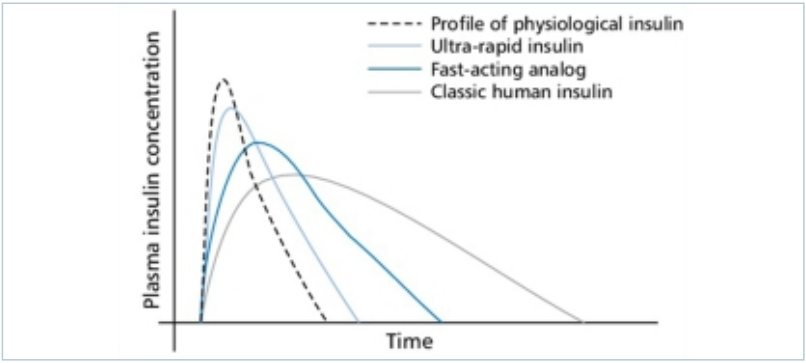
- Rapid-Acting Insulins (10-15 min onset)
- Short-Acting Regular Insulin (30-60 min onset)
- Intermediate-Acting NPH/Lente (1-3 hr onset)
- Long-Acting Insulins (1-4 hr onset)
- Ultra-Long Acting (6+ hr onset)
- Premixed Combinations (30/70, 50/50, 25/75)

International Insulin Color Coding System

Insulin Type	Color Code
Short-ActingRegular	Yellow
Intermediate NPH	Light Green
Long-Acting Lente	Turquoise
Premixed 30/70	Brown
Rapid-Acting Aspart	Orange/Blue
Rapid-Acting Lispro	Maroon/Red
Long-Acting Glargine	Purple/Gray
Long-Acting Detemir	Green

Rapid-Acting Insulins

Type	Onset	Peak	Duration	Color Code
Insulin Aspart	10-15 min	1-3 hours	3-5 hours	Orange/ Blue
Insulin Lispro	15-30 min	0.5-2.5 hours	3-6 hours	Maroon/ Red
Insulin Glulisine	10-15 min	1-1.5 hours	3-5 hours	Blue/Gray

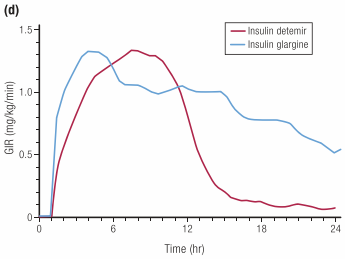


Pharmacodynamics of Short Acting Insulins

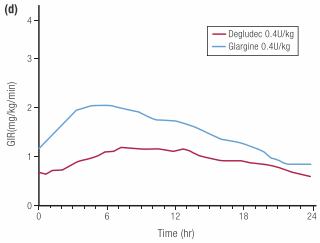
Long & Ultra-Long Acting Insulins

Type	Onset	Peak	Duration	Color Code
Insulin Glargine	1-4 hours	No peak	20-24 hours	Purple/ Gray
Insulin Detemir	1-2 hours	6-8 hours	12-20 hours	Green
Insulin Degludec	1-2 hours	No peak	42 hours	Blue/ Green
Glargine U300	6 hours	No peak	36+ hours	Gray/Silver

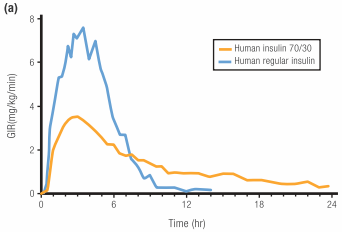
International Insulin Color Coding System



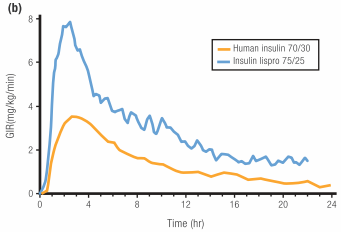
Pharmacodynamics of insulin detemir compared to glagine



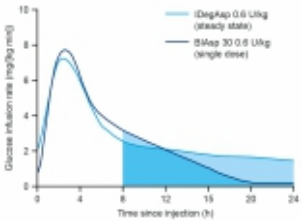
Pharmacodynamics of insulin degludec compared to glargine



Pharmacodynamics of Human Insulin 30/70



Pharmacodynamics of insulin degludec compared to Insulin Lispro 75/25

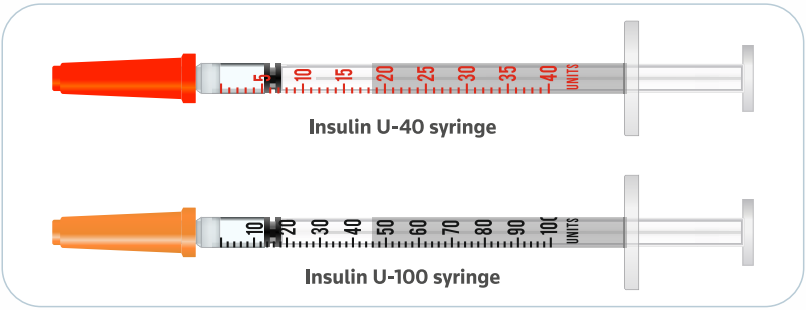


Pharmacodynamics of IDegAsp (RyzoDeg)

Insulin Concentrations & Syringe Color Coding

Concentration	Units/mL	Syringe Color	Common Use	Vial Sizes
U-40	40	Red	Traditional insulin	10ml
U-100	100	Orange	Most common	10ml, 3ml cartridge
U-200	200	Yellow	Concentrated insulin	3ml cartridge
U-300	300	Blue	Toujeo only	1.5ml cartridge
U-500	500	Purple	Very high dose	20ml

CRITICAL: Always match insulin concentration with correct syringe markings to prevent 2.5x dosing errors



Types of Insulin Pens Available in India

Pen Type	Units/mL	Advantages
Disposable Prefilled	Pre-filled, discard after use	Convenient, no loading
Reusable Cartridge	Replaceable 3ml cartridges	Cost-effective eco-friendly
Smart Connected	Digital tracking, dose memory	Dose tracking, reminders
Junior Pen	0.5-unit increments	Precise pediatric dosing

Pen Needle Specifications & Color Coding

Gauge	Diameter	Lengths	Color Code	Pain Level	Flow Rate
29G	0.33mm	12.7mm	Red	Higher	Fast
30G	0.30mm	8, 10mm	Yellow	Moderate	Good
31G	0.25mm	5, 6, 8mm	Blue	Low	Moderate
32G	0.23mm	4, 5mm	Green	Minimal	Slower

Recommendation: 31G or 32G needles preferred for patient comfort. Always use new needle for each injection.

Insulin Vials vs Cartridges Comparison

Insulin Vials	Insulin Cartridges
10ml standard size for most insulins	3ml standard for pen systems (1.5ml for U300)
Lower cost per unit but higher wastage	10x less wastage compared to vials
Requires separate syringes	Integrated with pen delivery systems
28-day room temperature stability after opening	Better patient compliance and convenience

Safety Considerations & Error Prevention

Critical Safety Measures

- ALWAYS match insulin concentration with syringe markings
- Use color coding for quick insulin identification
- Replace pen needles after each injection
- Maintain proper storage: 2-8°C unopened, 28 days at room temperature
- Check expiry dates and insulin appearance before use

Error Prevention Benefits

- Color coding reduces medication errors by 83%
- Smart pens prevent missed doses and track compliance
- Proper training reduces adverse events significantly

Chapter 4

INITIATION & TITRATION OF INSULIN

Dr. Rohini Rokkam, Dr. Ghazala Siddiqui, Dr. Ashutosh Kori

When to start insulin

- Type 1 diabetes mellitus (T1D)
- Type 2 diabetes mellitus (T2D) with HbA1c>10% with osmotic or catabolic symptoms
- T2D patients on optimal doses of oral antidiabetic drugs (OADs) but failure to achieve glycemic targets
- Acutely ill T2D patients including hospitalised patients and patients with DKA, HHS
- Steroid induced diabetes, new onset diabetes post-transplant
- Pregnancy or those planning pregnancy
- Secondary diabetes including diabetes due to chronic pancreatitis

Which insulin regimen is better?

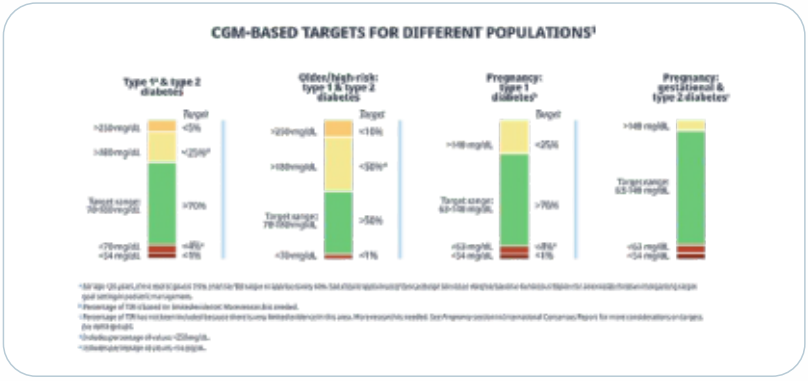
Types of insulin regimen	Advantages	Disadvantages
Basal Insulin	• Effective, safe, simple, easy • Less weight gain • Less hypoglycaemia	• Poor control of postprandial glucose (PPG) • Difficult to achieve glycaemic targets
Premix co-formulations	• Better PPG control • Better HbA1c control compared to basal insulin alone • Simpler to understand than basal bolus regimen	• Less flexibility • Difficult to titrate
Basal plus regimen	• Better flexibility • Personalisation of regimen	• Careful patient selection
Basal Bolus regimen	• Best metabolic control and most physiological • Flexible lifestyle	• Multiple daily injections • Carbohydrate counting • Weight gain • Risk of hypoglycemia

Before you start ensure!!

- Readiness of the patient to start insulin therapy.
- Discuss the best possible regimen. Take into account the patient's understanding, affordability and willingness to continue on long-term.
- Ensure the willingness to frequently check blood sugar, either by using point of care (POC) glucometers or continuous glucose monitoring systems (CGMS).
- Set attainable targets. Most accepted targets:-

  → Fasting sugar- 80-130mg/dL

  → Post prandial sugar- 140-180mg/dL
- Target needs to be individualised as per patient's status.



%TIR- Time in Range

Insulin Myth Vs Facts

Myth	Fact
Using insulin means failure.	As diabetes evolves, insulin becomes a necessary and effective therapy not a sign of defeat.
Insulin is only a last resort.	Doctors often recommend insulin earlier to prevent complications.

Myth	Fact
Insulin always causes weight gain.	Weight changes are minimal and Uncontrolled diabetes manageable with healthy habits.
Insulin damages the eyes or kidneys.	Uncontrolled diabetes causes damage; insulin helps prevent it.
Injections are painful and complicated.	Modern pens are simple and nearly painless to use.
Insulin is addictive or ineffective.	Insulin is a natural, effective hormone therapy.
People with type 2 diabetes never need insulin.	Type 2 diabetes can progress, requiring insulin later.
Once insulin is started, it must be taken for a lifetime.	Some people may reduce or stop insulin if their condition improves under medical guidance.

Do's	Don't's
Rotate injection sites to prevent lipohypertrophy.	Don't inject into sore, bruised, or lipohypertrophic areas.
Monitor blood glucose regularly (FPG, PPG, SMBG).	Don't skip doses or adjust doses without guidance.
Store insulin properly (cool, away from sunlight).	Don't freeze insulin or expose it to high heat.
Carry fast-acting carbs for hypoglycaemia.	Don't ignore hypoglycaemia or hyperglycaemia symptoms.
Follow your HCP's dose adjustments.	

Basal Insulin - Principles

Initiation

- Initiate at 6–8 units/day or 0.1 to 0.2 units/kg body weight/day if HbA1c is ≤ 8%
- Initiate at 8–10 units/day or 0.2 to 0.3 units/kg body weight/day if HbA1c is > 8%

Titration

- Based on fasting blood sugar (FBS)
- Titrated once weekly or earlier if feasible
- Should be titrated based on the lowest FBS or the mean FBS of past three values.

  - FBS 41–70 mg/dL: reduce dose by 20%
  - FBS < 40 mg/dL: reduce dose by 40%
  - FBS 80–130 mg/dL: no adjustments
  - FBS 131–160 mg/dL: increase by 2 units
  - FBS 161–200 mg/dL: increase by 4 units
  - FBS >201 mg/dL: increase by 6 units

OADs can be continued at usual doses

- Increased risk of hypoglycemia when used in combination especially with sulphonylureas.
- Increased weight gain and fluid retention with pioglitazone

Options

- U-100 glargine- most widely used, cheaper, small peak.
- NPH- acts as basal only when given at night. Significant peak (risk of hypoglycemia)
- U-300 glargine- costlier, flatter curve, less risk of hypoglycemia
- Degludec- longest acting, flat curve, less risk of hypoglycemia

Pre-mix insulin coformulations- Principles

Can be given as once daily (OD), twice daily (BD) or thrice daily (TID).

- **Initiation**

  If HbA1c<8%, Premix insulin can be started OD with the largest meal of the day.

- **Titration**

  Titration will depend on the pre-meal blood sugar of the next meal. For e.g. pre-breakfast doses are adjusted based on pre-dinner values.

  Principles of titration are same as for basal insulin.

Pre-mix insulin coformulations- Principles

BD Dose

Initiation

- In insulin naïve patients start at 12-16 units/day
- Divide the total daily dose (TDD) as 60% before breakfast and 40% before dinner.
- When switching from OD to BD dosing, increase the TDD by 10% and follow the 60-40 rule as described above

Titration

- Pre-breakfast dose is adjusted based on pre-dinner blood sugar and pre-dinner insulin is titrated based on fasting blood sugar.

- FBS 41–70 mg/dL: reduce pre dinner dose by 20%
- FBS < 40 mg/dL: reduce pre dinner dose by 40%
- FBS 80–130 mg/dL: no adjustments
- FBS 131–160 mg/dL: increase pre dinner by 2 units
- FBS 161–200 mg/dL: increase pre dinner by 4 units
- FBS >201 mg/dL: increase pre dinner by 6 units

- Pre dinner BS 41–80 mg/dL: reduce pre breakfast dose by 20%
- Pre dinner BS < 40 mg/dL: reduce pre dinner dose by 40%
- Pre dinner BS 80–140 mg/dL: no adjustments
- Pre dinner BS 141–180 mg/dL: increase pre dinner by 2 units
- Pre dinner BS 181–220 mg/dL: increase pre dinner by 4 units
- Pre dinner BS >221 mg/dL: increase pre dinner by 6 units

Pre-mix insulin coformulations- Principles

TID Dose

Initiation

- When glycemic targets are not achieved with BD dose, consider adding pre-lunch dose of premix insulin.
- Reduce the dose of pre-breakfast insulin by 10%, add 4-6 units before lunch.
- Switch to 50-50 insulin when starting TID dose.

Titration

- Pre-breakfast insulin dose is adjusted based on pre-lunch BS, pre-lunch insulin based on pre-dinner BS and pre-dinner insulin based on FBS.
- Targets are same as for BD dosing.

Basal Plus Regimen- Principles

Initiation

- Single short-acting insulin is added before the meal with largest? post prandial glucose (PPG) surge in a patient already on basal insulin.
- Dose- 4 units or 0.1U/kg.

Titration

PPG (mg/dL)	Insulin dose adjustment
≤180	0
180-200	+1 to 2
201-220	+2 to 3
≥221	+3 to 4

Basal Bolus Regimen- Principles

- Most closely resembles physiological insulin secretion.

Initiation

- For insulin naïve patients, TDD is calculated as:
- In T1D- 0.5U/kg body weight
- In T2D- 0.2-0.3U/kg body weight
- Split the TDD as 40% basal dose; 60% divided as prandial insulins divided into three doses with each meal.
- When switching from other insulin regimens, increase the TDD by 10% and then use the same 40-60 division

Titration

- "Fix Fasting First"- target FBS first and titrate the basal insulin first.

- FBS 41–70 mg/dL: reduce basal dose by 20%
- FBS < 40 mg/dL: reduce basal dose by 40%
- FBS 80–130 mg/dL: no adjustments
- FBS 131–160 mg/dL: increase basal by 2 units
- FBS 161–200 mg/dL: increase basal by 4 units
- FBS >201 mg/dL: increase basal by 6 units

Basal dose titration

- PPG 41–80 mg/dL: reduce pre meal dose by 20%
- PPG < 40 mg/dL: reduce pre meal dose by 40%
- PPG 80–140 mg/dL: no adjustments
- PPG 141–180 mg/dL: increase pre meal dose by 2 units
- PPG 181–220 mg/dL: increase pre meal dose by 4 units
- PPG>221 mg/dL: increase pre meal dose by 6 units

Prandial dose titration

Hypoglycemia

Classification:

Level 1: BS ≥54mg/dL-70mg/dL

Level 2: BS <54mg/dL

Level 3: Any BS requiring assistance from another person for treatment

Treatment:

- Self treated with orally consumed simple carbohydrate
- 15-20g glucose, juices, candies etc.
- Can be repeated every 15-20 minutes
- Consume a larger snack or meal soon.

One-off episode of hypoglycemia- for e.g. due to missing a meal or acute illness, no permanent insulin dose adjustment needed.

Dose titration to be done as described in previous pages.

A Few Case Studies

Case 1

Newly Diagnosed Type 2 Diabetes with High HbA1c

Patient: 52-year-old male, HbA1c 10.2%, symptomatic with polyuria and weight loss. Already on metformin. Approach:

Why insulin? Oral agents unlikely to bring HbA1c down quickly enough, symptomatic hyperglycemia.

Choice: Basal insulin (e.g., insulin glargine, detemir, or degludec).

Starting dose: 10 units once daily or 0.2 units/kg. Along with GLP1RAs with or without SGLT2i. Optimise the dose of metformin.

Titration: Increase by 2 units every 3 days until fasting plasma glucose is 80–130 mg/dL.

Reduce by 10–20% if hypoglycemia occurs.

Case 2

Patient: 60-year-old female, T2DM x 12 years, on metformin + SGLT2i + sulfonylurea, HbA1c 9.4%. FPG 140–160 mg/dL, but PPBG >250 mg/dL. Approach:

Problem: Fasting sugars near target, but postprandials high → basal not enough.

Choice: Basal + rapid-acting mealtime insulin "Basal-plus".

Starting dose:

Basal: continue (e.g., 20 units glargine at bedtime).
Add rapid-acting: 4 units with largest meal or 0.1 U/kg.

Titration: Increase by 1–2 units every 3 days based on postprandial readings.

Expand to multiple meals if needed.

Case 3

Patient: 22-year-old male, T1DM, no ketosis. Approach:

Why insulin? Lifelong need.

Choice: Basal-bolus regimen with rapid-acting before meals + long-acting basal.

Starting dose: Total daily insulin (TDI) = 0.4–0.5 U/kg/day.

40% basal + 60% bolus, divided across 3 meals.

Titration: Adjust based on SMBG or CGM trends.

Correct hypoglycemia promptly.

Teach carb counting & insulin-to-carb ratio
(e.g.1 unit per 15g carbs).

References

1. Erukulapati RS, M. MR, Jakkidi LR et al. A Practical Approach to the Initiation, Titration and Intensification of Insulin Therapy in Adults with Diabetes in the Indian Context: Recommendations by Association of Clinical Endocrinologists Consensus Group. Clinical Diabetology. 2024;13(1):6–42. doi:10.5603/cd.98136.

2. https://diabetesed.net/wp-content/uploads/2024/12/ADA-2025-Instensifying Injectable-Therapy_v2.pdf

3. Kalra S, Kalra P, Gangopadhyay KK, et al. Expert Opinion on Optimizing Suboptimal Basal Insulin Titration in India: Addressing Challenges and Leveraging Digital Solutions. Diabetes Ther. 2025 Jul;16(7):1327-1339.

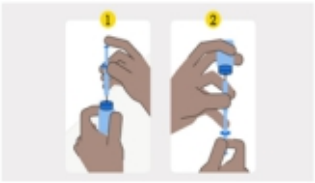
4. American Diabetes Association Professional Practice Committee; 9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes—2025. Diabetes Care 1 January 2025; 48 (Supplement_1): S181–S206

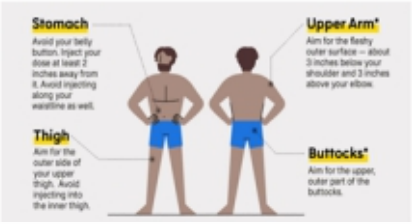
Chapter 5

INSULIN INJECTION TECHNIQUES

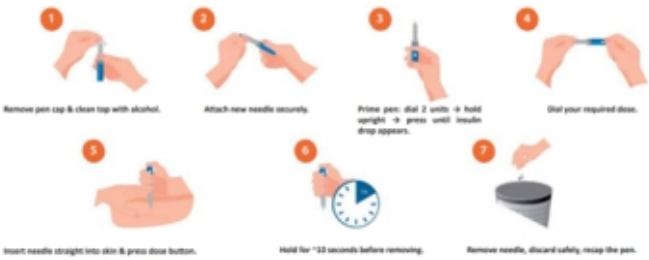
Dr. Ghazala Siddiqui

How & Where to Inject Insulin with a Syringe

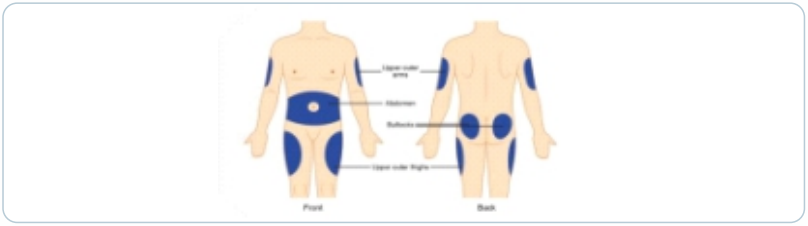




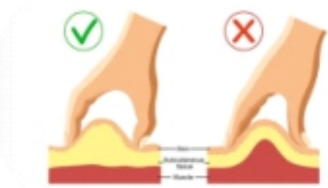
Correct injection technique with an insulin pen



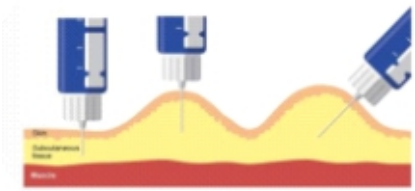
1. Choosing the Injection Site It is important to choose the right injection site. Typically, the abdomen, thighs, and buttocks are the most common sites due to their consistent absorption rates. It is not advisable to utilize the upper arm and lower leg regions as access to the correct zone may be limited and the lower thickness of subcutaneous fat in these areas may increase the risk of IM injection.



2. Folding the Skin If required, it is essential to lift a fold of skin. This involves gently lifting the skin while ensuring the subcutaneous tissue, or fatty layer between the thumb and index finger, while leaving the muscle untouched.



3. Needle Insertion Insert the needle at a 90° angle into the skin. For patients with a lean build, combined use of lifted skin fold and angled insertion may be required. Avoid indenting the skin while trying to prevent the needle from penetrating the muscle.



4. Injecting the Medication Inject insulin gradually and withdraw the syringe needle at the same angle. Keep the needle under the skin for at least 10 seconds after the injection to ensure full dose delivery.

5. Disposing of the Needle Once done discard the used needle safely.

Insulin Injection Sites & Administration

Common Injection Sites

- Abdomen, thighs, buttocks.
- Rotate sites to avoid lipodystrophy.

Injection Technique

- Insert insulin subcutaneously (SC).
- After injection, count to 10 seconds before withdrawing the needle.

Other Routes

- IV infusion: Only in emergencies (DKA, HHS, NBM, ICU).
- IM injection: Rarely used; risk of erratic absorption and hypoglycemia.

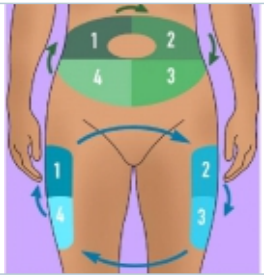
Injection Site Rotation

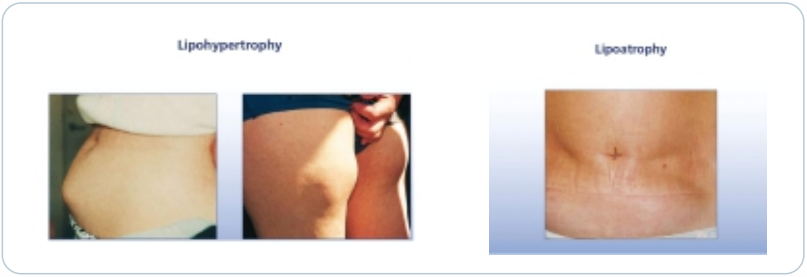
Reasons to Rotate Injection Sites:

- Prevent lipohypertrophy (LH) – fatty lumps from repeated injections.
- Improves insulin absorption.
- Reduces glycaemic variability and unexplained hypoglycaemia.

How to Rotate

- Divide site into quadrants (abdomen) or halves (thighs/buttocks).
- Use one quadrant/half per week, then rotate clockwise or anticlockwise.
- Keep ≥1 cm distance from previous injection.
- Avoid areas with lipohypertrophy (LH), infection, or edema.
- Adolescents: prefer abdominal area.





Lipodystrophy

Insulin Storage

- Keep insulin in a cool (<30°C) dark place
- Refrigerate unopened vials/cartridges between 2-8°C if possible
- Avoid direct sunlight and high temperatures
- Roll gently before use. Avoid excessive shaking to prevent clumping
- Shelf life after opening a vial is 28 days. Discard after that.
- Do not freeze insulin.

Travelling with Insulin

- Keep insulin cool during travel
- If refrigeration not available use:
  → Earthenware pot with water (ziplock inside)
  → Thermos flasks or ice packs
- Do not keep insulin in glove compartment of car
- Do not keep insulin in check-in baggage in flight.
- Regular insulin: do not use if hazy
- Cloudy insulin: must be re-suspended before use
- Allow insulin to reach room temperature before injection

Guidance on managing basal insulin for patients travelling Internationally or Across time zones

Type of Trip	What to Do with Basal Insulin
Short trips (few hours difference)	- Long-acting insulin (like degludec):Take at usual time. - Short-acting basal (like detemir): may need small timing adjustment. - Twice-daily basal: usually no change.
Medium/long trips	- Plan for changes in day length and meal times.
Traveling East (shorter day)	- Take morning dose as usual. - Take evening dose earlier during travel. - After arrival you may need to skip or reduce next morning dose depending on glucose.
Traveling West (longer day)	- May take a slightly higher evening dose on travel day. - Do not take extra insulin on arrival. - Check blood sugar before bed and next morning. - Resume usual schedule.

References

- https://endocrinologistinahmedabad.com/Insulin-facts-and-myths/
- Annual medicine update2021 Dec;53(1):998-1009
- Clinical Diabetology 2024, Vol.13
- Diabetes ther 14, 1785-1799(2023)
- Joslin's Diabetes Mellitus, 14th Edition

Notes


Eris
POWER OF EMPATHY
TRUTH OF SCIENCE