Brought to you by T1Dto100.com & the New York Diabetes Program, Inc.

Steroids in T1D

Carolyn Robertson, APRN, MSN, BC-ACNS, BC-ADM, CDCES

New York Diabetes Program, Inc./ SOIG

crobertsoncde@gmail.com

Objectives

1. Identify what is a steroid and why it can be useful.
2. Recognize potential challenges inherent to steroid therapy and strategies to offset those challenges.
3. Understand peak action and potency of different steroids and some strategies to consider when adjusting insulin.
4. Identify a daily check list to follow when taking a steroid.
5. Identify when you should get immediate help.
6. Provide time for asking questions, sharing insights and exploring the opportunities for the future.

I will make my slides available if you send me an email

crobertsoncde@gmail.com

What is a Steroid ?

- **Usually refers to a Glucocorticoid** - a man made drug that mimics the natural hormone *cortisol* produced by your adrenal glands.
- It is often prescribed to **reduce inflammation** and **suppress an overactive immune system**.
- **It can be taken as**:
  - Oral pills,
  - Injectables – IM,IV, into joint/capsules,
  - Creams for skin inflammation,
  - Eye drops, or
  - Inhalation .
- **For this lecture,** I will focus on oral and injectable steroids

Common Side Effects of Steroids

SHORT TERM (LESS THAN 21 DAYS)

- **Metabolic Effects**
  - Elevated blood sugar, DKA, Increased blood pressure,
- **Mood/Behavioral Changes:**
  - Irritability, anxiety, restlessness, euphoria, depression or insomnia.
- **Physical Changes**:
  - Increased appetite, weight gain, fluid retention leading to swelling in ankles or hands, and a "moon face" (puffy face).
- **Gastrointestinal Issues**:
  - Stomach upset, heartburn, nausea.
- **Skin Issues**:
  - Acne, thinning skin, and easy bruising.

LONG TERM (GREATER THAN 21 DAYS)

- **Endocrine and metabolic complications**
  - Hyperglycemia, DKA, Weight gain, suppression of adrenal gland
- **CV complications**
  - Hypertension, Dyslipidemia, Cardiovascular Disease, Heart Failure, Atrial fibrillation
- **Immunological complications**
  - Infections (bacterial, viral, fungal), Wound healing, Acne
- **Musculoskeletal complications**
  - Myopathy, Osteoporosis and bone fractures, Avascular necrosis
- **Ophthalmological complications**
  - Cataract, Glaucoma

How to control the side effects

- **Review your medication list to determine possible interactions.**
- Take medications with food to reduce stomach upset.
- If able take the dose in the morning. Avoid taking the last dose of the day close to bedtime to minimize insomnia.
- Modify your diet
  - Lower your sodium intake and increase your potassium intake
  - Eat small frequent meals high in protein and fiber, assure adequate carbohydrates
  - Avoid dehydration (limit alcohol and excessive caffeine consumption)
- Prevent infection
- If you are on long term steroids,
  - Increase your Calcium and Vitamin D through food or supplements
  - Do weight bearing exercises
- Never stop steroids abruptly
- If you have diabetes, anticipate a possible negative impact on your glucose levels.

Drug Interactions of Steroids

Table 3: Drug interactions of steroids

Drug groups	*Interaction*
Antivirals (e.g., ritonavir, indinavir), ciclosporin	Inhibit metabolism ↑ Systemic steroid exposure
Antifungals (e.g., ketoconazole, itraconazole)	
Macrolides (e.g., erythromycin, clarithromycin)	
Rifampicin, rifabutin, carbamazepine, phenobarbitone, phenytoin, primidone, ephedrine, and aminoglutethimide	Increased metabolism ↓ Steroid systemic exposure and effect
Anticoagulants (e.g., warfarin), aspirin, other nonsteroidal anti-inflammatory drugs	↑ Gastrointestinal bleeding
Diuretics (e.g., furosemide, hydrochlorothiazide)	↑ Hypokalemia
Methotrexate	Hematological toxicity

Journal of The Association of Physicians of India, Volume 72 Issue 7 (July 2024)

How to control the side effects?

- Review your medication list to determine possible interactions.
- Modify your diet
  - Lower your sodium intake and increase your potassium intake
  - Eat small frequent meals high in protein and fiber, assure adequate carbohydrates
  - Avoid dehydration (limit alcohol and excessive caffeine consumption)
- Prevent infection – frequent hand washing, avoid crowds
- If you are on long term steroids to minimize bone loss
  - Increase your Calcium and Vitamin D through food or supplements
  - Do weight bearing exercises
- Determine best time to take the steroid
  - In the morning
  - With or immediately after food to reduce stomach upset..
  - When possible, avoid taking the last dose of the day close to bedtime to minimize insomnia
- Never stop steroids abruptly
- Anticipate a possible negative impact on your glucose levels.

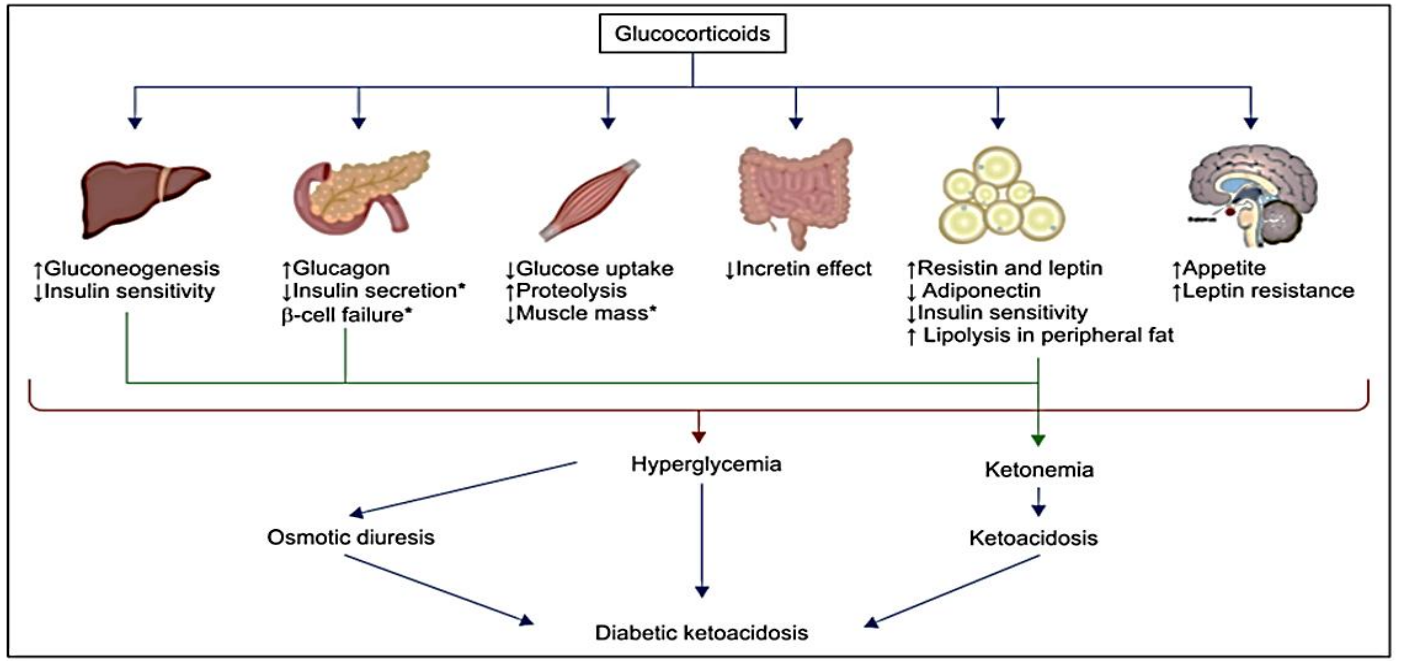
Why does blood sugar levels rise with steroid use?

The impact of steroids is systemic. It affects :

- † Liver
- † Pancreas
- † Muscle
- † Gut
- † Fat
- † Brain

- **Hyperglycemia is caused by several mechanisms**, including increased production of glucose by the liver, decreased glucose uptake in the other cells, and reduced insulin sensitivity
- **Agents differ in pharmacokinetic and pharmacodynamic properties**, which influences when and how high the blood sugar might rise
  - Impact depends on the formulation, dose, route and duration of therapy
  - Can lead to glycemic fluctuations and necessitates tailored insulin dose adjustments to the specific steroid regime selected..

The hyperglycemia, insulin deficiency, osmotic diuresis, and increased catabolism may precipitate diabetic ketoacidosis (DKA) in vulnerable patients.



Responsible Use of Oral Corticosteroids in People with Comorbid Diabetes: An Expert Consensus *Journal of The Association of Physicians of India* (2024): 10.59556/japi.72.0573

How to handle the expected glucose changes?

Expert opinions and …

- **Researchers and clinicians agree that a steroid will impact glucose control in T1D and insulin changes are needed.**
  - **There are no universal recommendations for altering the insulin.**
- **Learn what steroid will be used**
- **Plan to alter the Insulin proactively rather than reactively.** The plan must address:
  - The duration of steroid,
  - The dose of the steroid,
  - The frequency over the course of the day.
- **Maintain close BG and Ketone surveillance**

Waiting for BG to rise exposes the person with T1D to prolonged hyperglycemia and a higher risk of DKA.

Diabetes Obes Metab. A systematic review of glucocorticoid use in type 1 diabetes :Glycaemic effects and clinical management strategies 2026;28:2594–2614

Step 1. Learn the duration of steroid activity

- **Short-acting agents** (e.g., *hydrocortisone*) tend to produce rapid but short-lived hyperglycemia.
- **Intermediate-acting agents** (e.g., *prednisone, prednisolone, budesonide*) are associated with more sustained rises, particularly affecting the post-prandial period, and often persisting for many hours up to a day or more.
  - Careful attention should be paid to the early morning BG values post dose.
    - Experts in the field suggest that BG values *may decline to hypoglycemic levels* following attenuation of steroid activity.
- **Long-acting formulations** (e.g., *dexamethasone, betamethasone*) exert prolonged effects on hepatic glucose output and peripheral insulin sensitivity, resulting in *multi-day disturbances*.
- **Local injectable agents** (e.g., *triamcinolone acetonide, methylprednisolone acetate*) can cause delayed (6-8 hrs. later) and extended hyperglycemia lasting several days to weeks. Impact vary dose to dose and type of steroid.

Katz A, Shulkin A, Housni A, et al. A systematic review of glucocorticoid use in type 1 diabetes:

Step 2. Predict the glucose response based on peak effect

Steroid	Potency* (Equivalent Doses, mg)	Duration of Action (anti-inflammatory)	Relative Anti-inflammatory Activity*	Hyperglycemic Effects (hours)		
				Onset	Peak	Resolution
Short Acting						
Hydrocortisone (cortisol)	20	8-12	1	1	3	6
Cortisone acetate	25	8-12	0.8	n/a	n/a	n/a
Intermediate Acting						
Prednisone	5	12-36	4	n/a	n/a	n/a
Prednisolone	5	12-36	4	4	8	12-16
Methylprednisolone	4	12-36	5	4	8	12-16
Long Acting						
Dexamethasone	0.75	36-72	30	8	variable	24-36
Betamethasone	0.6	36-72	30	12	variable	Up to 72

*N.B. steroid doses are often expressed as prednisone equivalent doses & potency relates to anti-inflammatory action, relative to hydrocortisone, which may not equate to hyperglycemic effect

Long acting extended release injectable : Triamcinolone (Zilretta)) slow onset with lower and later peak.

- May cause less hyperglycemia.

Non steroid factors influencing dosing !

- Weight and BMI
- Age
- Concurrent Infection/inflammation
- Stress

Steroid	Potency* (Equivalent Doses, mg)	Duration of Action (anti-inflammatory)	Relative Anti-inflammatory Activity*	Hyperglycemic Effects (hours)		
				Onset	Peak	Resolution
Short Acting						
Hydrocortisone (cortisol)	20	8-12	1	1	3	6
Cortisone acetate	25	8-12	0.8	n/a	n/a	n/a
Intermediate Acting						
Prednisone	5	12-36	4	n/a	n/a	n/a
Prednisolone	5	12-36	4	4	8	12-16
Methylprednisolone	4	12-36	5	4	8	12-16
Long Acting						
Dexamethasone	0.75	36-72	30	8	variable	24-36
Betamethasone	0.6	36-72	30	12	variable	Up to 72

How many PE's in the prescribed steroid? i.e. Dexamethasone 8mg

- Dexamethasone 8mg/0.75mg =10.6 or 11x the PE

Calculate the dose potency 11 x (1 PE of Prednisolone 5mg) = 55mg

Predict the dose adjustment based on Prednisolone Equivalence

PE	Adjustment initial	Final * alter daily if BS>180mg
5 to 20mg	10% increase in TDD	~ 30% increase in TDD
20 to 40mg	20% increase in TDD	~ 50% increase in TDD
40 to 60mg	30% increase in TDD	~ 70% increase in TDD

Select the recommended adjustment 30-70% increase

Step 3. Predict the % of insulin change needed per steroid dose

*** Monitor and adjust daily**

Katz A, Shulkin A, Housni A, et al. A systematic review of glucocorticoid use in type 1 diabetes:
Glycaemic effects and clinical management strategies. Diabetes Obes Metab. 2026;28(4):2594-2614. doi:10.1111/dom.70465
Data adapted from Buttgereit et al, 2002.17 https://doi.org/10.2147/DMSO.S330253
Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 2022:15

If on Injection Therapy (MDI)

Step 4a Create the dosing schedule for injection therapy

- **Short Acting Steroid** – Use short acting insulin with steroid Insulin Lispro/insulin Aspart with each dose of steroid

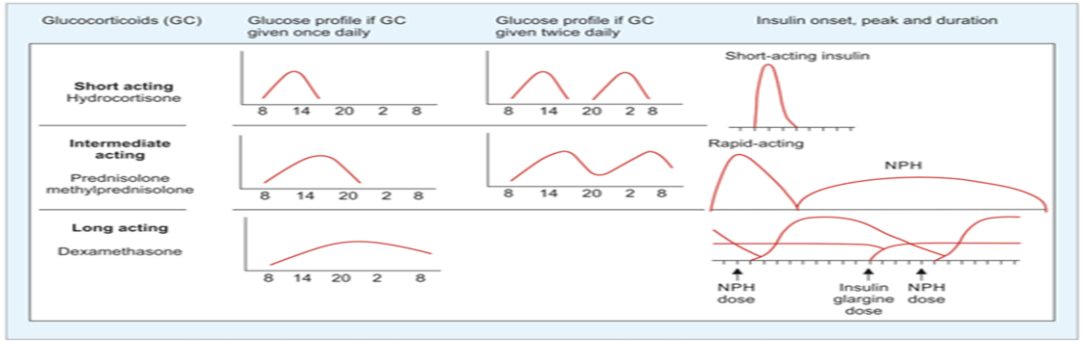


Fig. 5: Representative profile of hyperglycemic effect from steroids to matching profile of different insulins

- **Intermediate Acting Steroid**, the ADA recommends the use of once daily NPH* as a basal supplement. Glargine and Insulin detemir once daily can also be used.
  - ***Mix the NPH thoroughly** (>20 times) to assure the suspension will absorb consistently. Can be taken with each dose of intermediate acting steroid.
- **Long acting steroids**, NPH taken up to 2-3 times per day. Glargine and Insulin Detemir may also need to be taken more than once daily.

Degludec (Tresiba) titration is not recommended due to its slow onset and long duration.

Step 4b. Create a dosing schedule for pumps

If on a Manual or non automated Pump (CSII)

Short Acting Steroid – give a bolus with each dose of steroid taken.

Medium Acting Steroid – Increase the basal starting mid morning and continue to early overnight. Increase lunch and supper bolus.

Long Acting Steroid – Increase basal starting 4 hrs. post dose and continue to next day or longer, small increase at lunch and larger increase at supper. May need increase next day breakfast dose.

In addition to basal and bolus dose (I/CHO ratio) changes , the correction factor and target blood sugar may need to be changed. Sometimes, the insulin on board duration may need to be altered.

If on Automated Pump Therapy – its more complicated

AUTOMATED PUMPS

- **Ask your diabetes team** if the algorithm of your pump will be able to quickly compensate for the expected time based surge of both insulin resistance and increased glucose production. They may have workarounds.
  - The algorithm may be too conservative to address the rapid and pronounced escalation of blood sugar dependent on user settings - (max basal, max bolus, TTD) ((*DYI pump, iLet, Medtronic 780G, Omnipod 5, Tandem Control IQ/ Mobi, Twiist*)
  - The algorithm may use the amount of insulin delivered previously (past 24-72 hrs.) to calculate the subsequent days' basal delivery creating a hypoglycemia risk when the steroid is tapered or discontinued. (*Omnipod 5, Medtronic 780G, iLet Pump*)
  - The Pump may allow the activation of alternate pump settings specific to the steroid dose used. (*Twiist, Tandem Control IQ/Mobi, DYI pumps*)

The Options for Automated Pumps

- *In some cases*, **you might be advised to stop the automated function** and be given guidelines for an increased delivery and altered insulin distribution that you would run on *Manual Mode*.
- *In other cases*, the recommendation **might be to continue the automated mode but add injections of a long acting insulin** to supplement the pump delivery of insulin.
  - **Short Acting Steroid** – Take a bolus of insulin when the steroid is taken.
  - **Intermediate acting Steroid** - NPH can be taken as a basal and bolus supplement. If taken in AM, it will enhance impact of Lunch and Supper insulin. Glargine and Insulin detemir once daily can be used as a supplement for intermediate acting but may need to add more bolus at lunch and supper.
  - **Long acting Steroid** - Glargine and Insulin Detemir taken once or twice daily; NPH taken up to 2-3 times per day.

Medrol Dose 4mg Pak – Intermediate steroid

Step 5. Adapt the insulin schedule to planned decreases in steroid dose

- **WHAT TO EXPECT WITH EACH 4mg DOSE:**
  - Blood sugar starts rising in **2–4 hours**
  - Peaks in **8–12 hours**
  - Improves after **16–20 hours** But can last up to 30+ hrs

- **Day 1:** 2 tablets after breakfast, 1 tablet after lunch, 1 tablet after dinner, 2 tablets at bedtime (6 pills=24mg)
- **Day 2:** 1 tablet after breakfast, 1 tablet after lunch, 1 tablet after dinner, 2 tablets at bedtime (5 pills=20mg)
- **Day 3:** 1 tablet after breakfast, 1 tablet after lunch, 1 tablet after dinner, 1 tablet at bedtime (4 pills= 16mg)
- **Day 4:** 1 tablet after breakfast, 1 tablet after lunch, 1 tablet at bedtime (3 pills =12mg)
- **Day 5:** 1 tablet after breakfast, 1 tablet at bedtime (2 pills= 8mg)
- **Day 6:** 1 tablet after breakfast (1 pill= 4mg)

Daily changes to the insulin dose and distribution are necessary

- Initially, there will be a significant need for increased insulin throughout the day due to the *stacking effect* of the steroids throughout the day and the overnight period. (24mg may require 20 to 50% increase in TTD)
- Each day of taper, the insulin distribution will need to be altered . The insulin dose will need to be reduced in relation to Medrol reduction
  - *One protocol suggests reducing insulin by 50% of the % steroid reduction* → i.e. If steroid reduced by + 20%, then reduce added insulin by 10%
- Repeat as per the steroid taper schedule until steroid is stopped
- Expect that on Day 7, should be able to return to usual insulin plan.

Managing Steroids & Hyperglycemia: A Guide for Health Care Professionals
https://www.waterloowellingtondiabetes.ca/Pathways-and-Protocols.htm

What about Adjunctive Medications ?

Medication Class	Primary Benefit in T1D	Key Evidence / Risk
SGLT2 Inhibitors *	Lowers renal glucose threshold	Only agent linked to lower add-on insulin needs during steroid use; **High DKA risk. Bone Fractures?**
GLP-1 Ras *	Suppresses glucagon; slows digestion	Reduces postprandial spikes; **Lacks specific acute steroid trial data.**
Pramlintide (Symlin)	Slows gastric emptying	FDA-approved for T1D; effective **at attenuating glucose excursions.**
Metformin **	Improves insulin sensitivity	Safe to continue but may increase hypoglycemia risk during steroid tapers.

*Not FDA approved for use in people with T1DM. ** Used off label

Any adjunctive therapy must be closely supervised due to the elevated risk of DKA and hypoglycemia.

To Summarize:

A. Questions for your Medical & Diabetes Team

1. Is there an alternative to a steroid you could prescribe that would be as effective?
2. How big an impact will this steroid have on my glucose?
3. Will this steroid change my diabetes treatment plan and, if so, how?
    a) How long does this steroid take to start working? (Onset of action.)
    b) How long does this steroid last in my body? (Duration of action.)
    c) How long will this steroid affect my blood sugar?
    d) When and how do I start/modify/stop the adjustments?
4. What adverse effects should I monitor for?
5. While taking this steroid, are there any OTC or prescription medications I should avoid using?
6. **How will I contact you if the initial plan is not working?**

B. Daily Tasks:
Steroid Therapy & T1D

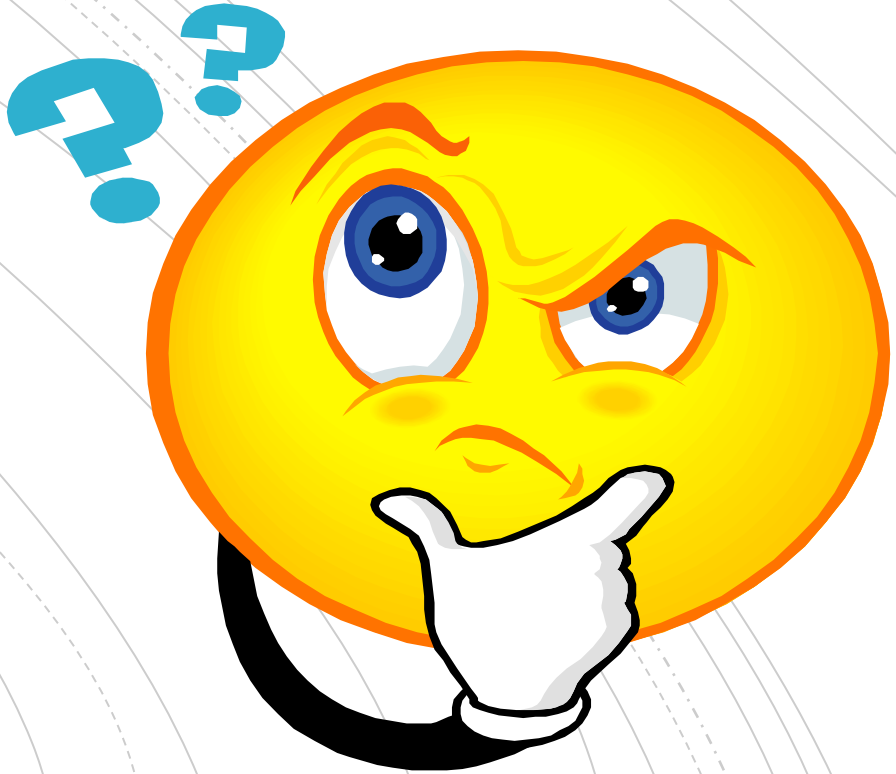
- **Keep the time you take the steroid consistent.**
- **Assess Blood Sugar level every 2 to 4 hours.**
  - *Target: 140 to 180 mg/dl.*
  - *Persistent levels greater than 250mg/dl are too high*
  - *Blood sugar levels below 70mg are too low*
- **Test for Ketones every 4 hours.**
  - Goal: *No urinary ketones or blood ketones under 0.6mmol*
    - *Levels greater than small (urine ketones) or 0.6-1.0mmol (blood ketones) are too high and suggest a need for MORE insulin*
- **Drink at least 8 ounces of fluid every hour.**
  - *Avoid dehydration*
  - *Consider Sugar free electrolyte liquids. .*
- **Eat at least 80-100gm of carbohydrates each day.**
  - *This prevents your body from burning fat/creating ketones.*
  - *Limit your salt intake (sodium)*
  - *Increase your potassium intake*

Discuss with your Diabetes Team how to modify the list to meet your needs

C. When to Call Your Diabetes Team or 911 Immediately ?

- **Your blood sugar is over 300** mg for more than 3 to 4 hrs.
- You feel **nauseated**, are **vomiting** or have **trouble breathing**.
- Your **breathe smells fruity**
- You have **ketones**
  - Your urine shows **"Large" ketones or**
  - **Blood ketones measures 3mmol or greater** for longer than 3 to 4 hours.
- **You cannot drink at least 8 ounces of fluid** every hour.
- You lose **more than 3 pounds in one day** (suggests significant dehydration)

QUESTIONS ???



Top Potassium Rich Foods

(per serving)

- **Vegetables & Legumes:** Baked potatoes (with skin), cooked spinach, cooked lentils, acorn squash, white beans, and pinto beans.
- **Fruits:** Dried apricots, prunes, raisins, bananas, cantaloupe, and orange juice.
- **Protein & Dairy:** Salmon, tuna, white beans, yogurt, and low-fat milk.
- **Healthy Fats & More:** Avocado, coconut water, nuts (cashews, almonds), and tomato sauce.

Top Sodium Rich Foods

- **Processed & Cured Meats:** Bacon, sausage, hot dogs, deli meat (ham, turkey, salami), pepperoni, and anchovies.
- **Convenience & Fast Food:** Frozen pizza, frozen dinners, burritos, tacos, and fast-food burgers.
- **Soups & Broths:** Canned soups, instant soup mixes, and bouillon cubes are high in sodium.
- **Snacks:** Pretzels, potato chips, corn chips, salted nuts, and cheese puffs.
- **Condiments & Sauces:** Soy sauce, steak sauce, salad dressings, ketchup, barbecue sauce, and olives.
- **Cheeses:** Processed cheese, spreadable cheese, and cheeses like American or Parmesan.
- **Breads & Rolls:** Sandwich bread, bagels, and rolls often contain high sodium amounts per serving.

Automated Pump Limititations 1 of 2

- **Omnipod 5** – Alters daily basal plan every 3 days based on insulin utilized by ending pod and past history, tends to distribute basal as 50% of TDD
  - Unlikely to be able to control excursions without additional insulin delivered by injection.
  - Risk of hypoglycemia with cessation of steroid unless a reset is done.
- **iLet Pump** - Functions as a fully autonomous, closed-loop system that eliminates all manual and pre-programmed pump settings. Sudden glucose and sensitivity change requires several days for the algorithm to adjust to higher insulin needs
  - Possible to temporarily alter body weight entry to force a more aggressive algorithm but not that effective
  - Risk of hypoglycemia with steroid taper and cessation
- **Medtronic 780G** – Alters daily basal plan every 24 hrs. based on insulin delivered 24 hrs. ago and past history. Has a robust algorithm for handling excursions.
  - Consider raising Maximum Basal, Bolus and change ISF,
    - Changing the basal profile will have no impact on actual basal delivery
  - Risk of hypoglycemia with steroid taper and cessation

Automated Pump Limititations 2 of 2

- **Tandem Control IQ/Mobi** – Alters daily basal plan every day based on inputted basal profile and automated changes based on BS trends
  - May be able to achieve glucose targets if proactive change.
  - Create an alternate Profile for Steroid with both basal and bolus changes.
- **Twiist or DYI pump** - Alter daily basal plan every day based on inputted basal profile with automated changes based on BS trends
  - May be able to achieve glucose targets if proactive change made to basal and bolus settings
  - Can lower target glucose to 87mg to force pump to be more aggressive.

References for dosing

Route	Guidelines	Insulin Adjustment Recommendations	Evidence
PO	Aberer et al.[28]	General: PE doses of 20, 40, and 60 mg are associated with increases in TDD of ~10%, ~20%, and ~30%, respectively. Short-acting GC: extra rapid-acting insulin at GC intake; correction dose after 3–4 h if hyperglycemia persists. Intermediate-acting GC: (A) Add rapid-acting insulin at GC intake. (B) On NPH/detemir BID → ↑ morning basal insulin at GC intake. (C) On glargine/degludec → use extra rapid-acting insulin at GC intake short-term; for long-term, switch to NPH/detemir BID with larger dose at GC intake. Long-acting GC: adjust basal insulin dose per general recommendations. AID: not advised in acutely hospitalized or critically ill patients.	**Expert opinion**
	Associations of Physicians of India[27]	If on basal-bolus insulin regimen, increase TDD with continuous BG monitoring, and add short-acting insulin if necessary. If on pre-mixed insulin, adjust dosage to prevent glycemic excursions, and add short-acting/basal-bolus insulin if necessary.	**Consensus based on expert opinion**
	Best et al.[29]	Provide special attention to critically ill patients (e.g., cancer patients) as they face increased metabolic demands. Increase bolus insulin doses by ~40% for a 40 mg dose of dexamethasone. If BG remains above target, further adjustments may include raising TDD by 10%–30% and redistributing 60%–75% towards prandial coverage.	**Expert opinion**
	Diabetes Canada[26]	Treatment with basal-bolus insulin correction is more effective than a supplemental only regimen. Maintain BG monitoring for 48 h after initiation. Educate on potential hazards of discontinuing or reducing GCs, such as hypoglycaemia.	**Consensus based on T2D literature**
	JBDS[24]	Transfer evening basal dose to the morning. Increase short/fast-acting insulin by 10%–20% daily until target reached. Aim for BG within 6–12 mmol/L depending on the individual's clinical needs and risk of hypoglycemia.	**Consensus based on expert opinion**
	Pasquel et al.[30]	For high-dose dexamethasone, initiate 0.3 U/kg/day of intermediate-acting insulin divided as 2/3 in the morning and 1/3 in the early evening.	**Expert opinion**
	Shah et al.[19]	For every PE dose of 10 mg, scale basal insulin dose by 0.1 U/kg or administer an additional 10 U of basal insulin at initiation, followed by daily titration in 10–20% increments.	**Consensus based on expert opinion**
IM	Diabetes Canada[26]	Initiate a 25% increase of the bolus insulin dose on the evening of GC administration, followed by a 40% increase in all doses over the next 2 days, a 10%–20% increase in all doses over the subsequent 2 days, and then a gradual taper.	**Consensus based on T1D literature**
	JBDS[24, 25]	Initiate a 50%–80% increase in basal and prandial insulin doses or variable rate IVI following GC administration. Maintain BG targets of 4.0–7.0 mmol/L (traditional) or 5.0–8.0 mmol/L (pragmatic). Check BG hourly, using capillary BG to guide IVI adjustments, and commence IVI if levels remain >7–8 mmol/L on two readings. Administer 0.9% sodium chloride with 5% glucose and potassium chloride at 50 mL/h and reduce both IVI and AID rates by ≥50% immediately after delivery.	**Consensus based on T1D literature**

Diabetes Obes Metab. A systematic review of glucocorticoid use in type 1 diabetes: Glycemic effects and clinical management strategies 2026;28:2594–2614