

Review of the Insulin Sensitivity Factor Calculator

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II. HOW TO USE

When to Use

Use the insulin sensitivity factor (ISF, also known as the insulin correction factor CorrF, or CF) to guide corrective insulin dosing for treatment of hyperglycemia in adult, non-pregnant patients with diabetes who are managed on insulin therapy. Pediatric applicability is not included in the calculator output but is discussed for contextual completeness.

Pearls / Pitfalls

The 1500-Rule is used with Regular human insulin, and the 1800- and 1700-Rules are used with rapid-acting insulins (e.g., lispro, aspart). Both 1800- and 1700-Rules are widely used in clinical practice and diabetes education programs, and there is no strong evidence supporting one over the other. The 1800-Rule appears to be favored in modern guidelines as the more accepted standard and is more recently endorsed by the American Association of Clinical Endocrinology guidelines in 2022.¹

The ISF calculator provides a standardized starting point for determining insulin sensitivity based on a population average and may not match individual insulin sensitivity. The calculator is intended as a rough starting point because real ISF is dependent on age, time of day, regimen, and glycemia. Take caution using the ISF calculator in patients with severe insulin resistance (daily

Abstract

The insulin sensitivity factor (ISF) calculator provides an estimate of how much one unit of insulin will lower blood glucose, using the 1500-Rule for Regular insulin and the 1800- or 1700-Rule for rapid-acting insulins. The ISF calculator provides a standardized starting point for corrective insulin dosing in adults with diabetes, but requires clinical judgement and adjustment for individual patient factors and clinical context.

insulin dose >100 units/day), as ISF can underestimate insulin needs and result in persistent hyperglycemia. Additionally, in insulin-sensitive patients (e.g., children, elderly, lean), ISF can overestimate insulin needs and risk hypoglycemia.

Avoid using the ISF calculator in these contexts:

- Renal impairment has increased insulin sensitivity and reduced insulin clearance, which may vary with the stage of kidney disease
- Hepatic impairment has reduced gluconeogenesis and altered insulin kinetics
- Pregnancy is associated with rapid and unpredictable changes in insulin sensitivity across gestation. Early pregnancy has increased insulin sensitivity and hypoglycemia risk, while later pregnancy increases insulin resistance and hyperglycemia risk
- Acute illness or hospitalization may be associated with dynamic insulin sensitivity due to the influence of counterregulatory hormones and cytokines from stress and inflammation
- Hyperglycemic crises (diabetic ketoacidosis or hyperglycemic hyperosmolar state) require aggressive insulin and fluid management as outlined in separate guidelines
- Ultrarapid insulin formulations have distinct pharmacokinetic profiles and there is no evidence for using these rules with these agents

Why Use

Sustained or severe hyperglycemia is associated with significant morbidity and mortality related to oxidative stress, endothelial dysfunction, microvascular and macrovascular damage, inflammation and immune dysfunction, and the risk of developing hyperglycemic crises. The ISF calculator provides a practical starting point for dosing short- and rapid-acting insulin therapy to address hyperglycemia. The ISF is used to create custom insulin sliding scales or initial insulin pump settings which empowers patients to correct glycemic highs and participate in diabetes self-management.

III. NEXT STEPS

Advice

This tool is intended to assist with calculation and should not be the sole basis for dosing. Clinicians should use judgment and full clinical evaluation for individualized care. The ISF calculator provides a baseline which should be further refined based on the resulting glycemic values.

Prior to administering insulin, always consider the clinical context, including the influence of patient's diet, activity, and other medications with glycemic effects, such as other diabetes medications and steroids. Corrective insulin doses are given in addition to prandial and basal insulin doses, where applicable. The insulin on board should also be considered for patients receiving insulin more frequently than every 4 hours (for rapid-acting insulin) or every 6 hours (for short-acting, Regular human insulin). Although additional insulin doses may occasionally be necessary, caution is warranted when administering correctional insulin at intervals shorter than every 4-6 hours, as insulin stacking may result in unpredictable glycemic effects and increase the risk of hypoglycemia.

Management

The ISF result estimates how much a patient's blood glucose (BG) will lower with the administration of one unit of short-acting insulin. This result, along with the patient's target BG, can be used to determine how many units of insulin to give for correction of hyperglycemia according to a custom sliding scale ([Table 1](#)).

Add rows to this table in the same pattern until BG values >400 mg/dL, above which point a healthcare professional should be contacted for further evaluation and treatment decisions.

Another way to determine a corrective insulin dose is by calculating the difference between the patient's current BG and their target BG and divide that difference by the ISF:

Table 1. Example sliding scale insulin plan created from ISF and the upper limit of normal (ULN) for target BG.

Blood glucose (mg/dL)	Insulin (units)
≤(ULN Target BG)	0
(ULN + 1) - (ULN + ISF)	1
(ULN + ISF + 1) - (ULN + 2*ISF)	2
(ULN + 2*ISF + 1) - (ULN + 3*ISF)	3
(ULN + 3*ISF + 1) - (ULN + 4*ISF)	4
(ULN + 4*ISF + 1) - (ULN + 5*ISF)	5

$$\text{Corrective insulin dose} = \frac{(\text{Current BG} - \text{Target BG})}{\text{ISF}}$$

This is how an insulin pump might use the ISF and target BG setting to determine how much insulin to deliver. For example, a patient with current BG 310 mg/dL, target BG 110 mg/dL and ISF of 40 mg/dL/unit should receive a corrective insulin dose of 5 units. This is separate and often in addition to prandial insulin doses, which are given with meals to counteract future postprandial BG elevations.

The ISF calculator provides a starting point for insulin corrective dosing. The incidence of hypoglycemia or persistence of hyperglycemia despite these doses should prompt modification of the insulin regimen. With more patient-specific data, ISF may be found to vary throughout the day, leading to meal-specific sliding scales or time-dependent insulin pump programming.² Consult a diabetes specialist for more information.

Critical Actions

N/A

IV. EVIDENCE

Evidence Appraisal

Dr. Paul C. Davidson is credited for first developing the "1500-Rule" to calculate the insulin sensitivity factor based on clinical experience with patients on Regular (short-acting) human insulin in the 1980's. The derivation does not originate from a single peer-reviewed publication. Rather, the ISF was first described by Davidson et al. in several abstracts and posters to the American Diabetes Association meeting, Diabetes Technology meeting, and the International Diabetes Federation Congress in 2002-2003.³⁻⁶ In these, varieties of the "1500-Rule" emerged, including the "1700-Rule" and the "1800-Rule" to reflect the increasing use of rapid-acting insulins like lispro and aspart which are better represented with higher numerators.

In 2008, Davidson et al. did a retrospective study comparing patients with diabetes on insulin pump who were well-controlled from those who were not and examined

the correlation constants used for various pump settings and from that recommended the 1700-Rule.⁷ Walsh et al. had a similar approach to retrospectively look at 396 patients on an insulin pump and identify the optimal ISF based on the settings used by the tertile with the best glycemic control, reporting a numerator of 1970 was optimal.⁸ Another study looked at children and adolescents with type 1 diabetes and found that ideal ISF used a numerator of 1736 in the morning, 1873 in the afternoon, and 2035 in the evening, reflecting how ISF naturally fluctuates by the time of day.²

Today the 1500-, 1700-, and 1800-Rules are widely used in clinical practice and research studies. Each year the American Diabetes Association Standards of Care supports individualized correction factors but does not specify the 1500-, 1800-, or 1700-Rule by name in the main guideline text.⁹ However, many ADA-aligned educational materials, diabetes educator handouts, and certified diabetes education programs teach the use of the 1800- or 1700-Rule for rapid-acting insulins and the 1500-Rule for Regular, short-acting insulin, reflecting general consensus and practice. In 2014, a consensus statement by the American Association of Clinical Endocrinologists/American College of Endocrinology endorsed the 1700-Rule for insulin pump management.¹⁰ Most recently, the American Association of Clinical Endocrinology published a 2022 guideline statement update on developing a comprehensive diabetes care plan which endorsed the 1800-Rule.¹ These rules are derived from clinical experience and convention rather than definitive trials or validation, and there is no high-quality evidence

to support the superiority of the 1800-Rule over the 1700-Rule or vice versa.

Formula

If using Regular human insulin:

$$\text{ISF (mg/dL/unit)} = 1500/(\text{TDD})$$

If using rapid-acting insulin (e.g. lispro, aspart):

$$\text{ISF (mg/dL/unit)} = 1800/(\text{TDD})$$

Or alternative equation for rapid-acting:

$$\text{ISF (mg/dL/unit)} = 1700/(\text{TDD})$$

TDD is total daily dose of insulin, entered as number of units/day.

Facts & Figures

The total daily dose (TDD) of insulin is determined by adding up all basal and bolus insulin dosages, regardless of type, administered to a patient within a 24-hour window. For best results, sum up the TDD from a day where glycemic targets were achieved and the patient followed their usual diet and activity patterns. For otherwise healthy adult patients who are new to insulin, starting TDD may be approximated based on weight: 0.5 units/kg/day in type 1 diabetes and 0.3-0.5 units/kg/day in type 2 diabetes.^{9,11}

The ISF result corresponds to how much a patient's blood glucose is expected to drop from 1 unit of exogenous insulin administration. Use the ISF to estimate corrective insulin bolus doses to achieve glycemic targets.

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