Proactive Prevention: A Technology Tool for the Management of Insulin Infusions to Ease the Burden for Nursing and Improve Patient Safety

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Background

Scope of Problem

Caring for patients on insulin drips is challenging for the clinical team. The frequent blood glucose checks, and titration of insulin drips translates to increased cognitive burden and task saturation for the nursing staff. Patients on insulin infusions are at risk for hypoglycemic events.

Pre-Implementation Nursing Workflow

Using a linear dosing curve, insulin infusion titration instructions were embedded in the EMR. Nursing referenced the chart to titrate insulin drips per patient's blood glucose results. Nursing reported difficulty in interpreting instructions to move between regimens and this contributed to errors in titration, increased time on insulin drips, and rates of hypoglycemia.

Blood Glucose (mg/dL)	Regimen 1	Regimen 1.5	Regimen 2	Regimen 3	Regimen 4
< 80	0 unit/hour	0 unit/hour	0 unit/hour	0 unit/hour	0 unit/hour
80 -100	0 unit/hour	0.5 unit/hour	1 unit/hour	2 units/hour	3 units/hour
101-120	1 unit/hour	1.5 units/hour	2.5 units/hour	4 units/hour	7 units/hour
121-150	2 units/hour	3 units/hour	4.5 units/hour	6 units/hour	9 units/hour
151-200	3 units/hour	4.5 units/hour	6 units/hour	7.5 units/hour	11 units/hour
201-250	4 units/hour	6 units/hour	8 units/hour	10 units/hour	13 units/hour
251-300	6 units/hour	7.5 units/hour	9 units/hour	11 units/hour	15 units/hour
301-350	8 units/hour	10 units/hour	12 units/hour	14 units/hour	17 units/hour
351-400	10 units/hour	12 units/hour	14 units/hour	16 units/hour	19 units/hour
>400	12 units/hour	13.5 units/hour, Notify physician.	15 units/hour, Notify physician.	20 units/hour, Notify physician.	23 units/hour, Notify physician.

1. Check BGM before initiating insulin drip protocol.
2. Maintenance IV _____ at _____ mL/hr
3. Check blood glucose q 1 hour until two (2) consecutive readings are between 80-120 mg/dL. When two consecutive blood glucose levels are between 80-120 mg/dL, change to q 2 hour blood glucose checks.
4. After each blood glucose reading, adjust the infusion rate according to the ordered regimen.
5. **If the patient's blood glucose level is >120 mg/dL for 2 hours and has increased in the past hour, advance to the next higher regimen. If the blood glucose is >150 mg/dL for 2 hours, advance to the next higher regimen even if it had not increased in the past hour. Consult Endocrinology if Regimen 4 started.**
6. **If the blood glucose level is < 80 mg/dL for 2 hours, move to next lower Regimen.**
7. After any change, check the blood glucose level q1 hour until two consecutive blood glucose readings are between 80-120 mg/dL. Then change to q2 hour checks.
8. Notify physician of blood glucose levels > 400 mg/dL or < 70 mg/dL. Follow hypoglycemia guidelines if <70 mg/dL. Restart insulin infusion when blood glucose levels >120 mg/dL at next lower regimen.
9. **If tube feedings are held for more than one hour, call physician for IV insulin orders.**
10. Start prandial insulin after patient has tolerated first meal (including clear liquids with carbohydrate) and continue insulin infusion (not applicable to patients receiving tube feeds only). Give:
    - (Prandial Insulin should be written by prescriber for patients weighing <50 kg)
    - Novolog 3 units SC TID with meals if weight is 50-70 kg
    - Novolog 5 units SC TID with meals if weight is 71-100 kg
    - Novolog 8 units SC TID with meals if weight is 101-130
    - Novolog 12 units SC TID with meals if weight is >130 kg

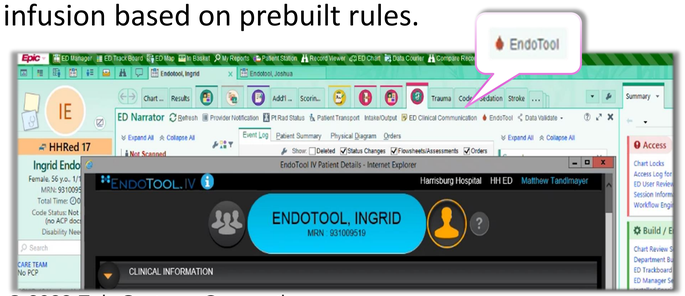
    (Discontinue Prandial Insulin when Insulin Infusion discontinued)
11. When transitioning from intravenous to subcutaneous insulin, contact physician for orders to start basal insulin and discontinue insulin infusion according to "Insulin Infusion Transition Guidelines."

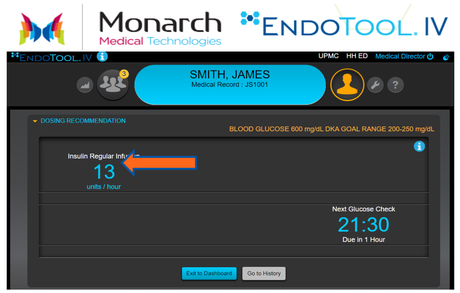
Implementation of Innovative Technology

Go Live for Endo Tool IV August 2022

What is Endo Tool IV? Endo Tool IV is software that uses machine learning and a nonlinear dosing curve to make dosing recommendations for insulin infusions that account for 11 patient-specific factors to adjust to each patient's unique physiology and individual response.

Nursing Workflow: Blood Glucose or CGM readings flow directly from EPIC to Endo Tool. Nursing launches to Endo Tool from within the EMR to see the dosing and next BGM check recommendations. The nurse can confirm or override the dose as well as receive warnings about electrolytes, the need to treat to prevent hypoglycemia, messaging to change to dextrose containing IV fluids or to notify the provider the patient is ready to transition off the infusion based on prebuilt rules.





Results

Three-month sample comparing data from from October to December of 2021 (pre-implementation) to October to December of 2022(post implementation). Covid patients excluded from this data set.

Metric	Pre Endo Tool IV N=125	Post Endo Tool IV N=162	p value
Time on infusion (hours)	58.2	41.4	.0008
Time to Goal (hours) 100-140	18.25	4.7	<.0001
Time to Goal (hours) 120-160	15.1	5.6	<.0001
Number of Glucose Checks	67	31	<.0001
Hospital LOS (days)	11	8.6	.1107
% Glucose Values <70 mg/dl	2.11	0.53	<.0001
% Glucose Values < 40	0.14	0	.0039

Post Implementation

Analysis

Data shows a decreased time on insulin infusion, decreased overall LOS, improved time to goal, decreased number of glucose checks and a four-fold decrease in hypoglycemic events.

What does this mean for nursing?

- Decreased cognitive burden and task workload
- Eliminated the need for nurses to interpret titration instructions
- 46 % decrease in blood glucose checks
- Spent less time caring for a patient on an insulin infusion- decreasing time on infusion by about 17 hours per patient
- Treated significantly fewer patients for hypoglycemia

What does this mean for the patient?

- Fewer blood glucose checks
- Decreased risk of hypoglycemia
- Decreased LOS in the hospital

On-going adjustments for nursing satisfaction without quality impact:

- Rule change that program only recommends rate change if > or = to 0.3 ml/hour increments
- Adjustment to parameters to increase recommendation out to 2 hours BG checks
- At 1 year post implementation: 3,100 patient runs, and 25.4 blood glucose checks per patient