# Indirect Support for the Use of Supplemental Insulin in Hospitalized Insulin-Requiring Diabetic Patients

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Hyperglycemia has detrimental effects on many physiological processes, e.g., causing phagocytic dysfunction, immune suppression, enhanced thrombosis, and increased inflammation (1). This translates into worse outcomes in those hospitalized patients with stroke, myocardial infarction, or sepsis (1).

A common method for treating hyperglycemia in hospitalized patients utilizes a sliding scale approach with short-acting insulin. There is general agreement in the literature that the sliding scale method is not very effective (2–14). A major reason is the underlying rationale for the sliding scale method, i.e., one waits until the glucose concentration reaches a certain level (often 200 mg/dl) before one treats it. Thus, instead of attempting to prevent hyperglycemia, this approach waits until it occurs before dealing with it.

There have never been (and probably never will be) published randomized trials comparing different modes of treating hyperglycemia in hospitalized patients. Based on the poor outcome of the sliding scale method (2–14), a "basal" and "nutritional" needs approach is suggested (1). This is most often given in a mixed/split regimen. A "supplemental" or "correction" dose of short-acting insulin added (or occasionally subtracted) from the preprandial insulin dose is also advocated to improve the treatment of hyperglycemia in hospitalized patients (1).

The following data compare the glycemic outcomes of the sliding scale method to a mixed/split regimen in insulin-requiring hospitalized diabetic patients. At King-Drew Medical Center, which serves a minority population, internal medicine residents under the supervision of an attending physician typically used the sliding scale method with glucose measurements and subcutaneous regular insulin administration performed every 4 or 6 h in insulin-requiring hospitalized patients. Several years ago, the Endocrine Consult Service took over insulin administration on the medical wards using a mixed/split regimen. With this approach, glucose concentrations are measured before meals and the bedtime snack. When glucose concentrations were high, the appropriate insulin dose was increased (depending on which glucose value was elevated) in order to lower the following day's glucose concentration. This method of adjusting insulin doses followed the pattern used by these physicians in the outpatient setting, where "supplemental" or "correction" doses of short- or rapid-acting insulin are seldom used in our population.

The results of glucose monitoring on each ward, given by a point of care meter that recorded plasma glucose concentrations, date, and time, are collected in a central database. Similarly, the pharmacy keeps a database of medications ordered for each inpatient. These two databases were cross indexed to yield glucose concentrations measured in each insulin-requiring hospitalized patient. Two 6-month periods were compared: the last 6 months, in which the house staff (sliding-scale regimen) managed insulin dosing, and the first 6 months, in which the Endocrine Consult Service (mixed/split regimen) took over. Unless stated otherwise, the data are means ± SD and analyzed by Student's *t* test with significance accepted at the 0.05 level (two tailed).

The results in all of the patients receiving insulin are shown in Table 1. The number of glucose values measured per patient was significantly lower in the mixed/split group. This might have been expected because with preprandial testing, the maximal number would be four values a day. In the sliding-scale method, monitoring is often performed every 4 h, leading to six values per day. There was a trend for patients treated with the mixed/split regimen to spend less days in the hospital. This could reflect the fact that these patients were seen 6 months later than the patients treated with the sliding-scale regimen and hospital lengths of stay were decreasing, especially during the year these patients were evaluated (1 September 2001 to 31 August 2002).

Since the number of days the patients received insulin was few, there was probably not enough time for the mixed/split regimen to lower glucose levels significantly. Therefore, the data were reanalyzed, including only those patients who received insulin for ≥5 days. There were no significant differences between the two groups (Table 2).

Although these results cannot prove the effectiveness of adding "supplemental" or "correction" doses to short- or rapid-acting preprandial insulin doses in hospitalized patients, they certainly demonstrate that not adding them in a mixed/split regimen leads to no better control than the discredited sliding-scale method (2–14). Given the current short lengths of stay, an aggressive sched-

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A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

**Table 1—*All patients* receiving insulin***

| | Sliding scale (group 1) | Mixed/split (group 2) | *P* (group 1 vs. 2) |
|---|---|---|---|
| *n* | 450 | 316 | — |
| Number of glucose values after first dose of insulin | 14.5 ± 17.5 | 11.3 ± 17.6 | 0.012 |
| Median number of glucose values | 8.0 | 7.0 | — |
| Glucose concentration (mg/dl) just before first dose of insulin | 223.6 ± 108.0 | 222.2 ± 101.5 | 0.890 |
| Glucose concentration (mg/dl) during insulin therapy | 203.3 ± 70.8 | 204.3 ± 70.7 | 0.842 |
| Number of days patient received insulin | 3.8 ± 4.9 | 3.1 ± 5.3 | 0.067 |
| Median number of days patient received insulin | 2.0 | 2.0 | — |

Data are means ± SD. *One patient with a 305-day hospitalization was excluded.

**Table 2—*Patients* receiving insulin for ≥5 days***

| | Sliding scale (group 1) | Mixed/split (group 2) | *P* (group 1 vs. 2) |
|---|---|---|---|
| *n* | 109 | 53 | |
| Number of glucose values after first dose of insulin | 34.4 ± 25.8 | 33.1 ± 34.3 | 0.835 |
| Median number of glucose values | 25.5 | 25.0 | — |
| Glucose concentration (mg/dl) just before first dose of insulin | 221.1 ± 104.6 | 230.7 ± 105.3 | 0.544 |
| Glucose concentration (mg/dl) during insulin therapy | 197.6 ± 60.4 | 190.5 ± 50.2 | 0.534 |
| Number of days patient received insulin | 9.9 ± 10.2 | 10.2 ± 9.9 | 0.556 |
| Median number of days patient received insulin | 7.0 | 7.0 | — |

Data are means ± SD. *One patient with a 305-day hospitalization was excluded.

ule of supplemental insulin is probably warranted.

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