Increased Hyperglycemia and Hospital-Acquired Infections Following Withdrawal of the RAPIDS Early Intervention Model of Diabetes Care in Medical and Surgical Inpatients

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Hyperglycemia is associated with hospital-acquired infection (HAI) and mortality, and treating hyperglycemia can improve outcomes in noncritical care (1,2). We previously reported the cluster Randomized Study of a Proactive Inpatient Diabetes Service (RAPIDS), where an early intervention model of diabetes care was investigated in medical and surgical inpatients (3). A proactive specialist diabetes team performed electronic glycemic surveillance and provided early bedside management for all inpatients with diabetes or hyperglycemia and demonstrated a 55% reduction in severe hyperglycemia (patient-days with mean blood glucose [BG] >270 mg/dL) and a 62% reduction in HAI. At the conclusion of RAPIDS, the proactive model of care was ceased due to lack of ongoing funding for this health care initiative. We performed this RAPIDS-extension observational study to evaluate glycemic and clinical outcomes after cessation of early intervention care, hypothesizing that hyperglycemia and HAI incidence would deteriorate back to baseline levels.

RAPIDS included patients of eight medical and surgical wards at the tertiary Royal Melbourne Hospital, who were randomized to control or intervention arms. RAPIDS comprised a 10-week baseline period, where patients in all wards received usual care (diabetes management mostly performed by treating teams), followed by a 12-week active period, when patients in the intervention wards received proactive care (by an inpatient diabetes team), while the patients in the control wards continued to receive usual care. RAPIDS recruited consecutive adult inpatients with preexisting diabetes or new hyperglycemia (random capillary BG >200 mg/dL), admitted for ≥ 24 h duration (3). In this extension study, we continued recruitment for a 12-week extension period, immediately following the active period, when patients in all wards reverted back to receiving usual care.

Akin to RAPIDS, point-of care capillary BG measurements for each patient from day 1 of admission until discharge (censored at 14 days) were used to analyze glucometric outcomes. HAI, adjudicated by a blinded assessor, was defined as clinical or microbiological evidence of wound or surgical site infection, urinary tract infection, bacteremia, or pneumonia that developed at least 48 h after admission. Hyperglycemia and HAI incidence were compared among the baseline, active, and extension periods within each treatment group. The change in HAI incidence was analyzed with use of mixed-level multivariable logistical regression with adjustment for age, sex, comorbidities, diabetes type, insulin treatment, and admission team.

We analyzed 1,518 consecutive inpatients during baseline, active, and extension periods comprising 220, 291, and 261 in the intervention arm and 221, 270, and 255 in the control arm, respectively. Patient characteristics (mean [SD] age 70 [14] years; 55% of patients were male, 88% had type 2 diabetes, 28% were insulin treated, and 36% had a surgical admission), were consistent across the three time periods within each treatment arm. Glucometric analysis included 8,610 patient-days.

In the intervention wards, patient-day weighted mean (SD) glucose was 169 (59) mg/dL during baseline period, 162 (48) mg/dL during active period (P = 0.003 vs. baseline), and 169 (56) mg/dL during extension periods (P = 0.001 vs. active). Hyperglycemia metrics decreased during the active period but reverted back to baseline levels during the extension period (Fig. 1). The incidence of HAI paralleled hyperglycemia incidence: 6.4% at baseline, 2.4% during the active period (P = 0.025 vs. baseline), and 5.4% during the extension period (P = 0.06 vs. active) (Fig. 1). There was no difference in hyperglycemia or HAI incidence in the control arm.

Following cessation of the successful 3-month proactive diabetes care intervention, we observed deterioration in hyperglycemia incidence back to baseline

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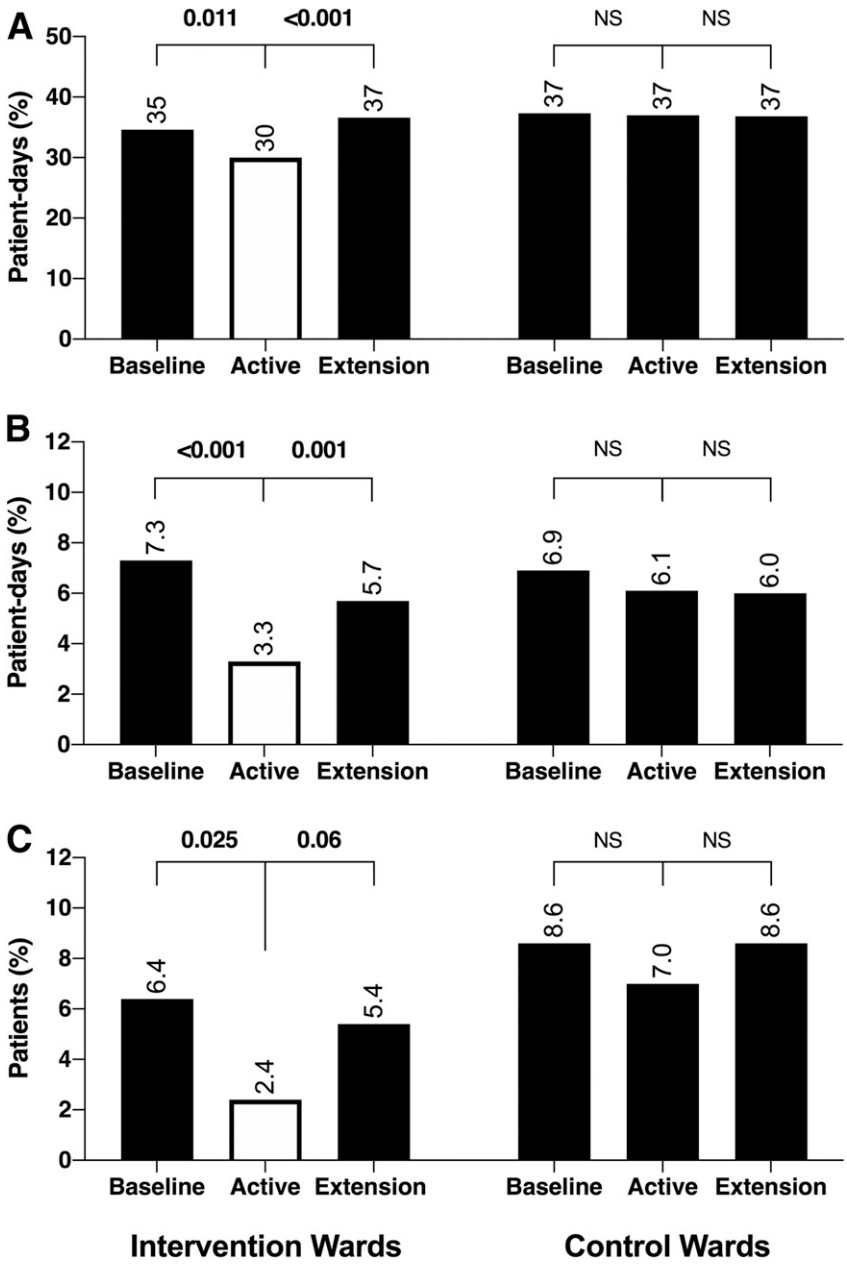

Figure 1—Hyperglycemia and infection outcomes during the baseline, active, and extension periods in the intervention wards and the control wards. *A*: Proportion of patient-days with mean glucose >180 mg/dL (>10 mmol/L). *B*: Proportion of patient-days with mean glucose >270 mg/dL (>15 mmol/L). *C*: Proportion of patients with HAI. ■, usual care; □, early (proactive) intervention care. NS, not significant.

levels. This finding could be attributable to insufficient upskilling of treating medical and surgical teams, compounded by regular rotation of junior medical staff, and is concordant with previous studies demonstrating nonsustained glycemic improvements following inpatient programs of limited duration (4). In contrast, a sustained proactive intervention with a strong emphasis on case-based education, such as the virtual glucose management service (5), demonstrated sustained improvements in clinician knowledge and glycemia after several years.

The incidence of severe hyperglycemia paralleled the incidence of HAI, supporting a biological link between hyperglycemic extremes and HAI. This observation suggests that significant reductions in hyperglycemic extremes may be associated with improved clinical outcomes, despite modest changes in mean glucose.

We analyzed a large cohort of prospectively recruited consecutive inpatients with complete capture of BG measurements and detailed glucometric analysis. Although other clinical factors may influence HAI incidence, there is a well-established immuno-pathophysiological link between infection and hyperglycemia, potentially accounting for the observed increased incidence of infection.

Upon withdrawal of an effective, but limited-duration, early intervention model of inpatient diabetes care, we observed an increase in the incidence of hyperglycemia and HAI back to baseline levels. Hence, sustainable early intervention models of diabetes care in hospital may be required to achieve long-term improvements in glycemic and clinical outcomes.

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