Pediatric Insulin Pump Therapy: Reflecting on the First 10 Years of a Universal Funding Program in Ontario

Rayzel Shulman, Fiona A. Miller, Thérèse A. Stukel, Denis Daneman and Astrid Guttmann

Abstract

We evaluated the universal funding program for pediatric insulin pumps in Ontario by examining the dynamics underlying patterns of pump use and adverse events using population-based health administrative data available at the Institute for Clinical Evaluative Sciences (ICES), supplemented by other data. We found that (1) pump use has increased steadily since 2006 with variation across centres and disparity in use by socioeconomic status; (2) pump discontinuation is uncommon; (3) physicians value pump therapy in numerous ways that provide important insights into patterns of uptake; and (4) the safety profile of pump therapy is, in general, very good; however, individuals of lower socioeconomic status are at an increased risk of acute diabetes complications, most frequently diabetic ketoacidosis. This comprehensive mixed-methods evaluation reveals the need to understand and intervene to reduce social disparities in the use and adverse outcomes of technologies used for diabetes management.

The Issue

Technologies used for managing chronic diseases such as diabetes come with high expectations, making them more likely to be adopted; however, they often bring marginal benefits at increased costs (Anderson et al. 2008; Berwick 2003; Canadian Institute for Health Information 2011; James Lind Alliance 2016). Insulin pumps for children with type 1 diabetes exemplify such challenges, with these being broadly adopted in countries with middle-to-high incidences of type 1 diabetes despite equivocal evidence about comparative long-term effectiveness with insulin injection therapy (Nuboer et al. 2006; Phillip et al. 2007; Sulmont et al. 2011). Many longitudinal studies show an improvement in the level of hemoglobin A1c (HbA1c) – a measure of glycemic control – within the first year of starting pump therapy; however, it appears that the level of HbA1c reverts back towards the baseline thereafter (Shulman et al. 2012). In addition, the impact of pump therapy on the rate of hypoglycemia is mixed, although the rate of diabetic ketoacidosis (DKA), a preventable and life-threatening complication of type 1 diabetes, does not appear to be increased in patients using pump therapy (Shulman et al. 2012). This raises complex questions about the valuation, real-world effectiveness and adequate implementation of a new technology – a challenge for health services delivery and policy development.

The Diabetes Control and Complications Trial showed that long-term complications of diabetes could be reduced by providing intensive insulin therapy through multiple daily injections or an insulin pump (Diabetes Control and Complications Trial Research Group 1994; Nathan et al. 2005). Pump therapy allows for increased flexibility in daily life and eliminates the need for multiple daily injections; therefore, its use has increased markedly in pediatric contexts (Hofer et al. 2010; Olsen et al. 2015; Shulman et al. 2012). Accordingly, in 2006, the Ontario Ministry of Health and Long-Term Care (MOHLTC) announced funding for insulin pumps and related supplies for all children with type 1 diabetes up to the age of 19 years; this facility was provided because of public and professional interest in the pump's potential for optimizing glucose control and to address the two-tiered funding situation that had developed, despite equivocal evidence about long-term comparative effectiveness.

As part of a comprehensive mixed-methods evaluation of this policy decision, we evaluated the dynamics underlying patterns of pump use and adverse events in the following ways: (1) the value physicians place on pump therapy to understand patterns of pump use and inform decisions about funding technology for children with diabetes (Shulman et al. 2016a); (2) the characteristics and resources of pediatric diabetes centres (Shulman et al. 2016b); (3) the manner in which the program is used by centres and by individuals (Shulman et al. 2016c); and (4) the safety profile of pump therapy (Shulman et al. 2016d).

Pump Use in Children and Youth: The Ontario Context

The Network of Ontario Pediatric Diabetes Programs, under the mandate of the Northern Diabetes Health Network, was established in 2001 to improve access to specialized diabetes care for all children in Ontario. In 2013, this mandate was assumed by the Ontario Paediatric Diabetes Network (OPDN) and coordinated by the Provincial Council for Maternal and Child Health, a program of the MOHLTC. The OPDN currently comprises 35 centres, including 30 community and 5 tertiary centres, each employing physicians, nurses, dietitians and social workers with training in diabetes care.

Our evaluation capitalizes on population-based health administrative data from the MOHLTC available for research purposes at ICES, and uses quantitative data on centre practices and qualitative data on provider expectations to illuminate core findings from the administrative data analysis. This mixed-methods approach may be useful to inform funding decisions and implementation processes for technologies used for treatment of diabetes more generally.

Pump Use

Pump use has increased in Ontario since 2006; by 2012, 38% of all children with type 1 diabetes were using pumps (Figure 1). Pump discontinuation is uncommon, suggesting that early enthusiasm does not wane and/or result in higher downstream rates of discontinuation. However, we observed a large variation in pump use across centres (Figure 2) (Shulman et al. 2016c). We were unable to identify any centre-level characteristics, such as centre type (tertiary, large or small community), that were associated with uptake. However, our qualitative study about how physicians value pump therapy provides several important insights into factors that may influence uptake. Enthusiasm may stem, in part, from the idea that novel technologies are inherently appealing to patients and their families; from physicians' own enthusiasm for pump therapy because of what it might achieve in the future; for the social benefits it confers for patients; and as a tool to motivate patients to improve their diabetes self-management (Shulman et al. 2016a).

FIGURE 1.

Pump use following the introduction of a universal funding program in Ontario in 2006

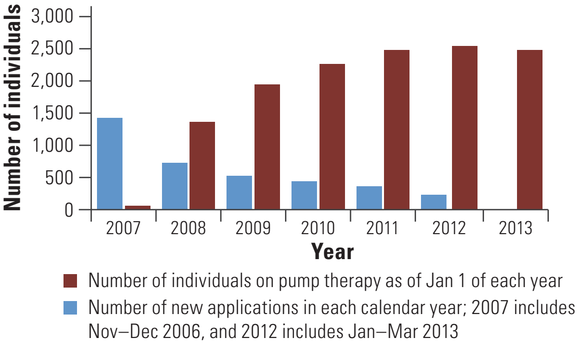
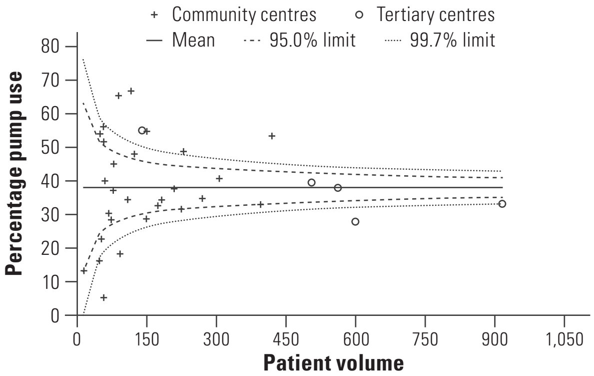


FIGURE 2.

Funnel plot showing the percentage pump use by centre volume of patients with diabetes in Ontario in 2012



Disparity in pump use

Although we report an increase in pump use, we also observed disparity in use by socioeconomic status; pump users were more likely than non-pump users with diabetes to be in the highest-income quintile (29.6 vs. 19.1%, $p < 0.0001$) (Shulman et al. 2016c). This may relate, in part, to the cost of pump therapy, as the additional cost of supplies (25% not covered by the government) may be a financial barrier for low-income families. Further, the findings of our qualitative study suggest that the degree of available ancillary support for diabetes management (family, school) influences physicians' predisposition to recommend pump therapy (Shulman et al. 2016a).

Safety profile

Increased use of the pump enabled by government funding may lead to widespread benefit; however, it may also result in inappropriate use, causing harm. Yet, despite the rapid increase in pediatric pump use in Ontario, the rate of DKA (5.28/100 person-years) (Shulman et al. 2016d) is similar to that reported in other population-based studies of pediatric pump users (6.26/100 person-years) (Danne et al. 2008). Although no causal association can be inferred, the DKA rate among those beginning pump therapy was not higher in the period after initiation compared with that two years before. Also reassuring is that the risk of DKA or death in the first two years of pump use was exceedingly low, suggesting that initial pump use education and implementation of the funding program in Ontario were effective.

Although the safety profile of pump therapy in this context is good, compared with individuals in the least deprived quintile, the risk of DKA or death for those in the most deprived quintile was significantly higher (hazard ratio = 1.58, 95% confidence interval [CI] = 1.05–2.38) as was the rate of diabetes-related acute care use (risk ratio = 1.60, 95% CI = 1.27–2.00).

Although we could not explore why this is the case, these children may have less robust family or school supports – key factors that physicians view as important to achieving favourable outcomes (Shulman et al. 2016a). Provision of 24-h support was not associated with these outcomes. Higher glycated hemoglobin, history of DKA, older age and higher nursing patient load were associated with a higher risk of DKA or death and diabetes-related admissions and emergency department visits. This suggests the need for targeted interventions and additional support for groups of youth with type 1 diabetes who are at the highest risk for adverse events.

Implications

This comprehensive evaluation reveals the need to understand and intervene to reduce social disparities in use and adverse outcomes of technologies used for treatment of diabetes. As new programs and policies for pediatric diabetes care are developed, we should anticipate how potential benefits and harms may be distributed across social gradients and aim to reduce the existing disparities. It is important to evaluate new programs and policies to determine their overall impact and the distribution of the impact across social gradients. These new technologies should be universally available to prevent creation of a two-tier treatment approach based on socioeconomic status. HQ

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