



# School Nurses' Comfort With Diabetes Management and Technology From 2012 to 2019

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**OBJECTIVE** | School nurses are integral to optimizing diabetes management for students with type 1 diabetes. The aim of this study was to describe the use of diabetes technology in schools over time and assess school nurses' comfort level performing diabetes management tasks.

**STUDY DESIGN** | From 2012 to 2019, school nurses who attended a diabetes education program completed a survey about their experience and comfort level with diabetes management.

**RESULTS** | A total of 1,796 school nurses completed the survey; 56% had at least 5 years of school nursing experience. Most (86%) had at least one student with type 1 diabetes. Among school nurses with at least one student with type 1 diabetes, 73% had at least one student using insulin pump therapy, and 48% had at least one student using continuous glucose monitoring (CGM). There was no change in pump use over time, but the percentage of nurses who had a student using CGM increased significantly from 24% in 2012 to 86% in 2019 ( $P < 0.001$ ). School nurses' comfort level using pumps remained stable over time. Overall, 47% reported being mostly/very comfortable giving boluses using a pump, and 17% reported being mostly/very comfortable troubleshooting problems with a pump. However, there was a significant increase in school nurses reporting feeling mostly/very comfortable working with CGM devices, increasing from 9% in 2012 to 44% in 2019 ( $P < 0.001$ ).

**CONCLUSION** | School nurses are an important part of diabetes management for school-aged youth with type 1 diabetes. There is a need for additional diabetes education and support to build their confidence with diabetes management and technology, especially with further technological advancements in management.

Young people with type 1 diabetes spend about half of their waking hours during the week at school. Diabetes management is complex and demanding; it requires frequent glucose monitoring, insulin administration, and awareness of carbohydrate counting and physical activity to achieve and maintain target glycemic control (1). School nurses play a crucial role on the health care team by ensuring attention to all of these tasks (2,3) and thus helping to optimize students' diabetes well-being during the school day (4–7).

Yet, the management of diabetes has changed dramatically in the past 10 years, with the development and rapid uptake of advanced technology, including insulin pumps, continuous glucose monitoring (CGM) systems, and hybrid closed-loop automated insulin delivery (AID) systems (8). Diabetes technology use in school presents an opportunity to improve collaboration with all care team members and reduce the

overall burden of diabetes management (9). However, school nurses report challenges with effective implementation of modern diabetes devices in the school setting, including limited access to training (10,11). Some small studies have demonstrated that education for nurses can increase their diabetes knowledge, confidence, and perceived competence (12–14).

The multidisciplinary team of pediatric providers at the Joslin Diabetes Center has offered a general diabetes education program for school nurses for more than 30 years. In 2007, in response to school nurses' requests for more education and hands-on training with insulin pumps, Joslin developed an insulin pump education program for school nurses. Attendees at recent general diabetes education and pump education programs completed an anonymous survey about their experience and comfort level providing diabetes care in school.

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For this project, we analyzed survey data from the years 2012–2019, when these educational programs were delivered in person, prior to the start of the coronavirus disease 2019 (COVID-19) pandemic. We aimed to describe the use of advanced diabetes technology in schools and assess school nurses' comfort level working with diabetes technology and performing various diabetes management tasks. The goal of this work was to further clarify and elaborate the needs of school nurses to provide optimal diabetes care in the school setting as technology continues to advance at an expeditious pace.

## Research Design and Methods

### *Diabetes Education Programs*

Attendees at diabetes education programs for school nurses completed a survey (Supplementary Figure S1) about their experience as a school nurse and diabetes management in their schools. Joslin Diabetes Center's multidisciplinary pediatric diabetes team (physicians, nurse practitioners, nurse educators, dietitians, social workers, and psychologists) provided three education programs for school nurses each year; two programs provided general diabetes education for the school setting, and one specifically focused on insulin pumps. Attendees pre-registered for the full-day programs (~8 hours each), which were held at the Joslin Diabetes Center in Boston, MA (Supplementary Table S1). Although nurses could attend the education programs as many times as they wished, the majority of nurses attended a single program, with only about one-third of program attendees reporting attendance at a previous Joslin education program. The local nursing credentialing board approved the curricula for continuing education credit of ~6.5 contact hours.

### *School Nurse Survey*

At the beginning of each program, school nurses completed a survey asking about their experience and comfort with diabetes management in school. The survey was developed by members of Joslin's multidisciplinary pediatric research and clinical diabetes team. It took ~10 minutes to complete and included questions about nursing experience, the size and grade levels of the school(s) where the nurses worked, the number of students with type 1 diabetes at their schools, and their experience and comfort level with diabetes management and devices. School nurses rated their level of comfort for various diabetes management tasks on a 5-point scale (not at all comfortable, just a little comfortable, somewhat comfortable, mostly comfortable, or very comfortable).

For this project, we analyzed data from surveys completed in the years 2012–2019. Survey responses were anonymous and

did not include any questions asking for personally identifying information. For the analyses, responses of “not at all comfortable” and “just a little comfortable” were combined and reported as not at all/just a little comfortable, and responses of “mostly comfortable” and “very comfortable” were combined and reported as mostly/very comfortable. The Joslin Diabetes Center's institutional review board reviewed this project and determined that it constituted research but did not meet the definition of research involving human subjects.

### *Statistical Analysis*

Analyses were conducted using SAS, v. 9.4, statistical software (SAS Institute, Cary, NC). Categorical data are presented as frequencies or percentages. Data for continuous variables are summarized using appropriate measures of central tendency and dispersion (e.g., mean  $\pm$  SD or median and range). Group comparisons were performed using  $\chi^2$  tests. A *P* value  $< 0.01$  was used to evaluate statistical significance.

## Results

### *School Nurse Characteristics*

Across the 8 years, 1,809 of 2,118 attendees completed the survey (85% response rate). Given the anonymous nature of the survey, we were unable to compare characteristics of the 309 survey nonresponders with those of the 1,809 responders, nor could we identify survey responses of those who attended more than one program. Thirteen surveys were excluded from analyses because the respondent was not a school nurse, resulting in 1,796 survey responses from school nurses. Survey completion was fairly consistent by year, ranging from 195 to 261 surveys per year.

Table 1 presents characteristics of the school nurses. Seventy percent of the nurses attending the in-person education program worked in schools in Massachusetts, 28% worked in other New England states, and the remaining 2% worked in other states. The majority of nurses (56%) were experienced school nurses with at least 5 years of school nurse experience. Half of the school nurses cared for  $\leq 500$  students, 32% cared for 501–1,000 students, and 18% cared for  $> 1,000$  students in their schools. Most of the school nurses ( $n = 1,540$  [86%]) had at least one student with type 1 diabetes, and the median number of students with type 1 diabetes was 2.

### *Technology Use Over Time*

Among school nurses with at least one student with type 1 diabetes, 73% ( $n = 1,070$ ) had at least one student using insulin pump therapy. This percentage was relatively stable over time (Figure 1). Among school nurses with at least

**TABLE 1** Characteristics of School Nurses Completing the Survey ( $N = 1,796$ )

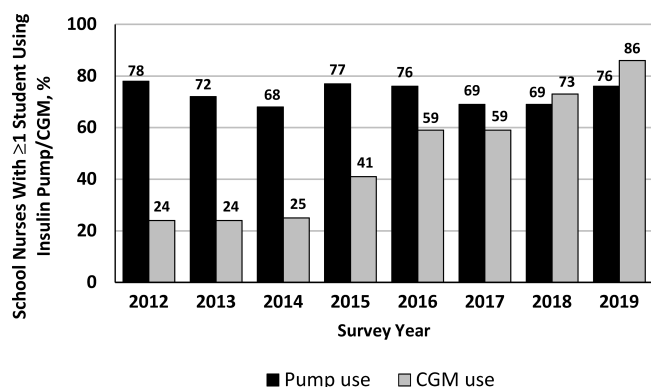
Characteristic	% or Median (IQR)
Experience as a school nurse, years	
<5	44
5-10	21
>10	35
School practice setting	
Elementary school (kindergarten to 5th grade)	37
Middle school (6th to 8th grade)	14
High school (9th to 12th grade)	13
Multiple grade levels	36
Number of students in school(s)	
≤500	50
501-1,000	32
>1,000	18
Have at least 1 student with type 1 diabetes	86
Number of students with type 1 diabetes	2 (1-4)

IQR, interquartile range.

one student with type 1 diabetes, 48% ( $n = 696$ ) had at least one student using CGM. However, this percentage increased significantly over time ( $P < 0.001$ ), from 24% in 2012 to 86% in 2019 (Figure 1). Notably, >50% of school nurses had students using CGM starting in 2016, which was likely related to improvements in the technology and the U.S. Food and Drug Administration's approval of CGM for nonadjunctive use (15).

### Comfort With Diabetes Management Tasks

Overall, school nurses reported a high level of comfort with checking blood glucose levels (95% mostly/very comfortable), giving insulin injections (90% mostly/very comfortable), treating low and high blood glucose levels (84% and 77% mostly/



**FIGURE 1** Percentage of school nurses with  $\geq 1$  student using an insulin pump or CGM system over time from 2012 to 2019. The denominator is school nurses with  $\geq 1$  student with type 1 diabetes.

very comfortable), checking ketone levels (76% mostly/very comfortable), and calculating insulin doses (76% mostly/very comfortable). Comfort levels were lower for diabetes management involving insulin pumps and CGM systems (47% mostly/very comfortable giving boluses using the pump, 17% mostly/very comfortable troubleshooting problems with the pump, and 22% mostly/very comfortable working with a CGM device). School nurses with  $\geq 5$  years of school nursing experience endorsed significantly greater comfort ( $P < 0.001$ ) with almost all diabetes management tasks than nurses with <5 years of school nurse experience (Figure 2). The two exceptions were checking blood glucose levels ( $P = 0.04$ ), for which there was a high level of comfort regardless of school nursing experience, and working with a CGM device ( $P = 0.16$ ), for which there was a low level of comfort regardless of school nursing experience. Furthermore, while the majority of school nurses with  $\geq 5$  years of school nursing experience endorsed feeling mostly/very comfortable with many fundamental tasks, including communicating with health care providers, treating a high blood glucose level, checking ketone levels, calculating insulin doses, calculating carbohydrate content, and training school personnel about diabetes, nearly one in five did not endorse such comfort with these diabetes tasks.

School nurses who had at least one student using pump therapy or CGM reported greater comfort with these devices than nurses who did not have a student using them. For the task of giving boluses using the pump, 56% of nurses with a student using pump therapy reported being mostly/very comfortable compared with 31% of nurses without a student using pump therapy ( $P < 0.001$ ). For troubleshooting problems with the pump, 21% of nurses with a student using pump therapy reported being mostly/very comfortable, compared with 11% of nurses without a student using pump therapy ( $P < 0.001$ ). For working with a CGM device, 42% of nurses with a student using CGM reported being mostly/very comfortable, compared with 9% of nurses without a student using CGM ( $P < 0.001$ ).

### Comfort Using Technology Over Time

School nurses' comfort level with insulin pumps was stable over time, but school nurses were more comfortable delivering an insulin bolus using a pump (range 42–54% mostly/very comfortable [Figure 3A]) than troubleshooting problems with an insulin pump (range 15–19% mostly/very comfortable [Figure 3B]). In contrast, there was a significant increase in school nurses reporting feeling mostly/very comfortable working with CGM devices ( $P < 0.001$ ), increasing from 9% in 2012 to 44% in 2019 (Figure 3C). Despite this significant increase in comfort over time, still less than half of the school nurses reported feeling mostly/very comfortable working with CGM

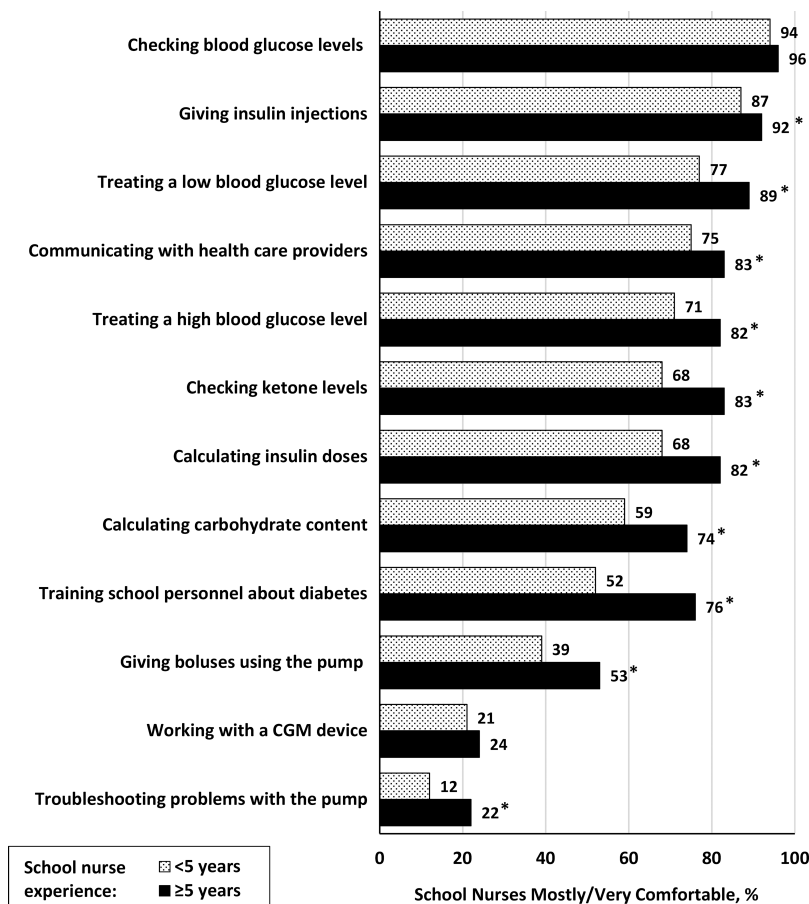


FIGURE 2 Comfort level with diabetes management tasks by years of school nurse experience. \* $P < 0.001$ .

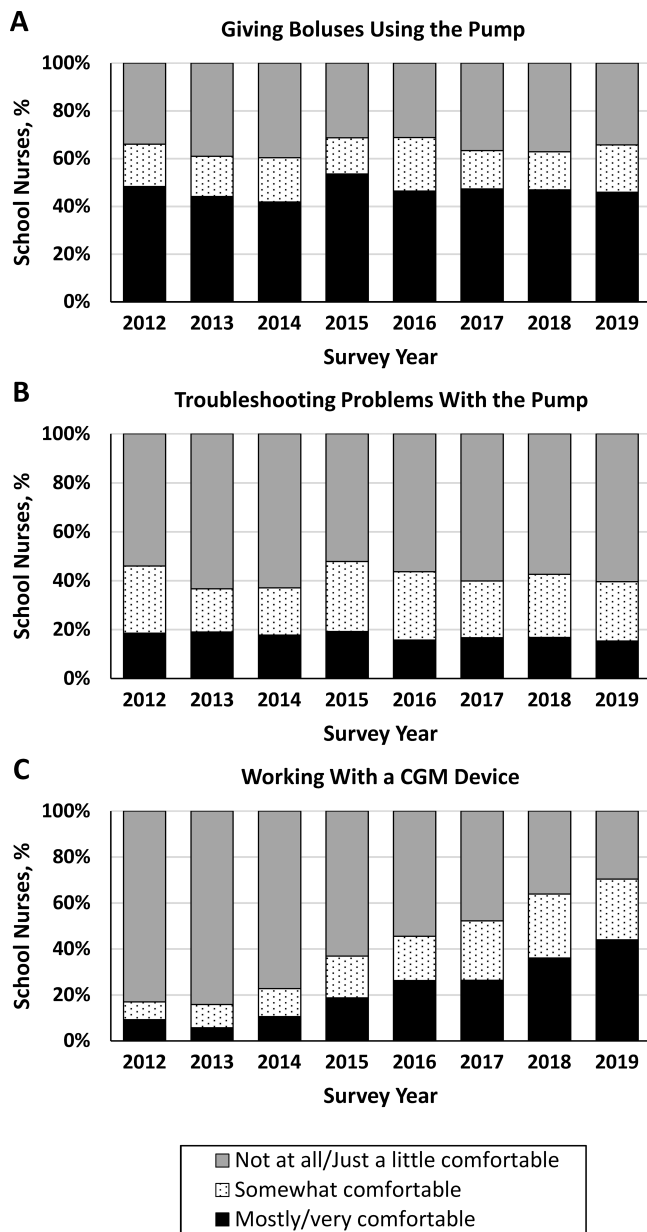
devices in the most recent years. There were no significant changes in comfort level over time for any of the other diabetes management tasks.

### Discussion

School nurses must manage the health care needs of many students, including the often complex medical needs of students with chronic health conditions such as type 1 diabetes. Among the school nurses who attended the Joslin diabetes education programs for school nurses from 2012 to 2019, 86% had at least one student with type 1 diabetes. Given that this was a specialized school nurse education program for diabetes, it is not surprising that school nurses caring for students with diabetes would elect to attend such a program. In contrast, in a survey about medication management completed by >5,000 school nurses, 59% of school nurses reported administering insulin daily (16). Importantly, the care provided by school nurses has become increasingly complex, with most nurses in this sample reporting having at least one student using insulin pump therapy and a rapidly increasing number of students using CGM.

School nurses must constantly adapt to the ever-changing landscape of diabetes management, particularly with regard to diabetes technology. Insulin pump therapy can be complicated, especially the task of troubleshooting issues such as pump site failures and error messages or managing ketones. A previous study highlighted how school nurses reported limited knowledge of insulin pump use (17), and an additional qualitative report revealed that nurses felt “scared” when using insulin pumps (18). Our analysis demonstrated that fewer than one in five school nurses felt comfortable with troubleshooting an insulin pump. Furthermore, nearly one in five did not endorse comfort with fundamental diabetes tasks.

Notably, insulin is considered a high-alert medication given that it can cause serious harm if used incorrectly, and it is known that dosing errors occur commonly in the hospital setting (19–21). Thus, it is not surprising that nurses may feel less comfortable using and troubleshooting a device that delivers insulin compared with other diabetes devices. This distinction is important and underlines the need for continued support and education for school nurses as diabetes technology advances, and particularly with the dissemination of



**FIGURE 3** Comfort level for diabetes technology-related tasks from 2012 to 2019: giving boluses using the pump (A), troubleshooting problems with the pump (B), and working with a CGM device (C).

hybrid closed-loop AID systems, for which an insulin pump is fundamental to their operation and with which nurses may have less control over automated insulin dosing decisions during the school day.

Furthermore, recent reports reveal an eightfold or higher increase in the use of CGM in young people with type 1 diabetes (8). Real-time CGM provides glucose trend information and allows for remote monitoring of glucose levels—features that can be vitally important to help diabetes management at school (9,22). The use of CGM and insulin pumps will

likely continue to increase as new integrated algorithms are developed and approved for use, contributing to the complexity of diabetes management in schools.

As expected, in our sample, school nurses with students using insulin pumps or CGM systems were more comfortable using those devices, similar to the experience described by March et al. (10), in which nurses with real-world practice using diabetes devices became more comfortable over time. Additionally, our analysis demonstrated that, as more students used CGM, nurses' comfort with the devices also increased. However, in the most recent years, less than half of the school nurses reported feeling comfortable using CGM, and there was no significant difference in comfort between nurses with less experience and those with more experience.

A major strength of this work is the collection of data over an 8-year time span, during which the use of diabetes technology in the pediatric population greatly expanded, thus allowing this analysis to assess school nurses' comfort level with diabetes management in relation to these advances in diabetes technology over time. However, there remain a few limitations. School nurses who completed the survey were attending a diabetes education program and therefore may not represent all school nurses caring for young people with type 1 diabetes. In addition, most of the school nurses were from one geographic region. Therefore, the results may not be generalizable to the rest of the United States or abroad. Furthermore, future efforts can include a validated survey such as the recently published Diabetes Device Confidence Scale for school nurses (23). Finally, these data reflect the school nurse education programs delivered before the start of the COVID-19 pandemic, which required a rapid transition from in-person to virtual school nurse education programs that did not include survey collection. Therefore, additional evaluation of school nurse education is needed for the pandemic period, which parallels the increased availability of hybrid closed-loop AID systems.

## Conclusion

School nurses are an integral part of the diabetes management team for young people living with type 1 diabetes and hold a primary responsibility for the coordination and provision of diabetes care during the school day. This analysis revealed that school nurses' comfort with diabetes management is not universal and may be especially limited with respect to advanced diabetes technology use. Thus, there is an urgent need for additional support, education, and re-education for school nurses to increase their comfort with diabetes management in general and diabetes devices in

particular, especially as technology advances and school nurses must adapt to the dynamic nature of diabetes care.

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### DUALITY OF INTEREST

No potential conflicts of interest relevant to this article were reported.

### AUTHOR CONTRIBUTIONS

A.G. contributed to data visualization, performed formal data analysis, and wrote, reviewed, and edited the manuscript. K.W. wrote, reviewed, and edited the manuscript. L.A.H. participated in the study conceptualization, reviewed and edited the manuscript, and handled project administration. L.K.V. participated in the study conceptualization, developed the methodology, performed formal data analysis, and reviewed and edited the manuscript. L.M.L. participated in the study conceptualization, developed the methodology, performed formal data analysis, reviewed and edited the manuscript, and acquired funding for the project. L.M.L. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

### PRIOR PRESENTATION

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