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The Effectiveness and Appropriateness of Educational Strategies for Insulin Pump Therapy: A Systematic Review

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EXECUTIVE SUMMARY

Objective of the systematic literature review	The primary objective of the systematic review was to update a previous literature review completed in 2011 identifying evidence on the effectiveness and appropriateness of Educational Strategies for insulin pump therapy (IPT) users.
Inclusion criteria	All studies in adults or adolescents (aged ≥ 16 years) investigating the effectiveness of diabetes education in people with type 1 diabetes using IPT therapy were included regardless of study design.
Search strategy	A systematic review of the literature between 2011 and 2015 was undertaken to provide a synthesis of the available research evidence regarding the effectiveness and appropriateness of the educational components of Insulin Pump Therapy to update a report published in 2011.
Evidence sources	The search was conducted using the following electronic bibliographic databases: MEDLINE, CINAHL, The Cochrane library (Cochrane Database of systematic review, Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Methodology Register), EMBASE, Current Contents, PsycINFO, Digital Dissertations and the World Health Organisation International Clinical Trail Registry search platform.
Methodological quality	Identified studies were assessed by two independent reviewers for methodological quality using the Johanna Briggs Institute (JBI) SUMARI.
Results	The search resulted in 2,389 unique records of which 2,217 were excluded based on exclusion criteria during the title and abstract screening. Of the remaining 172 records 163 full text articles were excluded based on exclusion criteria, thus 9 studies were included. No relevant grey literature was located.
Conclusions	No conclusions can be drawn regarding the effectiveness or appropriateness of insulin pump education programs or delivery strategies due to a lack of high quality studies.
Recommendations from the Literature	The results of this review support the conclusions and synthesised findings of the previous two reports stating the difficulty in determining the effectiveness and appropriateness of educational components associated with IPT due to a lack of high quality evidence to support conclusions. The current review presents an additional recommendation that patients' pump use knowledge should be regularly assessed to identify and rectify knowledge gaps.

BACKGROUND

Introduction	Insulin pump therapy (IPT) also known as continuous subcutaneous insulin Infusion (CSII) is a way of delivering insulin using an insulin pump, a small electronic device which replaces the need for multiple injections by delivering a precise dose of rapid acting insulin 24 hours a day. Insulin pump therapy has evolved since the introduction of the first portable infusion pump in the 1970's [1]. Over time insulin pumps have become smaller, safer and easier to use, specific improvements include electronic memory, multiple basal rate profiles, different bolus options, a soft cannula, a quick release option for the infusion tubing and enhanced safety alarms [1]. There is strong evidence supporting the clinical effectiveness of insulin pump therapy in people with type-1 diabetes, with reported improvements in glycaemic control and quality of life (due to greater lifestyle flexibility and independence) [1-4]. The Australian Institute of Health and Welfare Institute (AIHW) reported that 10,510 Australians were using insulin pumps in 2011, representing approximately 10% of Australians with type 1 diabetes [5] and almost half of insulin pump users were aged 25 years or less [5]. Using an insulin pump requires more training than other insulin delivery systems such as insulin pens or syringes therefore it is important to determine the most effective education strategies. The previous two literature reviews (2008 and 2011) both concluded that it was difficult to determine the effectiveness and appropriateness of educational components associated with IPT due to a lack of high quality evidence to support conclusions. Following the results of the previous two reports the Australian Diabetes Educators Association has commissioned this report to update the literature with recent research (2011-2015) to better inform Diabetes Educators on the optimal methods of educating people in the use of IPT and to inform the Position statement.
Objective	In June 2011, the ADEA published an updated systematic review combining evidence from January 1998 to March 2011 examining the effectiveness and appropriateness of the educational components of Insulin Pump Therapy (IPT). The objective of this report is to update the report and recommendations by incorporating new information from the literature published up until October 2015.

METHODOLOGY

Purpose of the review	The primary objective of the systematic review was to update a previous literature review completed in 2011 identifying evidence on the effectiveness and appropriateness of educational Strategies for insulin Pump therapy users.
Specific review questions	This review will address the question: • What are the most effective and appropriate methods of teaching adults or adolescents with type 1 diabetes to use insulin pump therapy (IPT)?
Type of studies	All studies investigating the effectiveness of diabetes education in people with type 1 diabetes using IPT were included regardless of study design.
Type of participants	Adults and adolescents (aged ≥ 16 years), with type 1 diabetes using IPT as their primary form of therapy, who participated in education or training, or clinicians and educators providing education and/or training. Adolescents aged ≤ 15 years of age were excluded as children in this age group present with more diverse and unique challenges in IPT education. This would include issues such as children having multiple people managing the IPT (i.e. parents, school nurse) or the cognitive changes and subsequent changing maturity levels associated with normal growth and development.
Type of intervention	Education and/or training in IPT, all forms of education, including resources used during education will be sought.
Type of outcomes	All outcomes will be considered as primary including: • Glycaemic control measured by glycated haemoglobin concentration (HbA1c-level) and/ or fasting plasma glucose level; • Continuous blood glucose monitoring; • Body Mass Index and mass/weight; • Episodes of Diabetic ketoacidosis; • Frequency and severity of hypoglycaemia; • Frequency of admission/presentation/contact with healthcare professionals for blood glucose level problems; • Frequency of site complications (including infection); • Quality of life or wellibeing; • Patient satisfaction; • Experience (as described by those delivering and those receiving education or training); • Insulin pump knowledge; • Patient self-care behaviours; • Self-management skills.

Type of comparators	N/A
Peer-reviewed databases	The search was conducted using the following electronic bibliographic databases: MEDLINE, CINAHL, The Cochrane library (Cochrane Database of systematic review, Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Methodology Register), EMBASE, Current Contents, PsycINFO and Digital Dissertations. The World Health Organisation International Clinical Trials Registry Platform will be searched for ongoing trials. Relevant grey literature (i.e. government reports) was also considered for this review. The following grey literature resources were searched using the same key words: Agency for Healthcare Research and Quality (AHRQ), Alberta Medical Association (Towards optimized practice), Alberta Health and Wellness decision provincial reviews , Australian Government Department of Health and Ageing, Canadian Agency for Drugs and Technologies in Health (CADTH), Euroscan, Google Scholar, Healthcare Improvement Scotland, Health Quality Council of Alberta, Health Quality Ontario, Health information and Quality Authority, International Network of Agencies for Health Technology Assessment (INAHTA), Manitoba Centre for Health Policy, McGill University Health Centre , Monash Health (Centre for Clinical Effectiveness), National Institute for Health (Horizon Scanning Centre), National Institute for Health and Care Excellence (NICE), National Health Service UK, NLCAHR: Newfoundland and Labrador Centre for Applied Health Research (contextualized Health Research Synthesis program), Ottawa Hospital Research Institute, Pan-Canadian HTA collaborative, Programs for Assessment of Technology in Health (Canada), Register of Australian Primary Healthcare Research (ROAR), The Alberta College of Family Physicians (ACFP) Tools for Practice, University of British Columbia (Centre for Health Services Policy Research), WorldCat.org and the World Health Organisation (Health Evidence Network).
Search strategy for identification of studies	The search terms were adapted for use in each bibliographic database, using appropriate punctuation and truncation. The search was restricted to English language studies published between January 2011 and October 2015.
Pearling	Reference lists of included trials, systematic reviews, and grey literature were checked to identify additional studies.
Key words	• Type 1 diabetes, type 1 diabetes mellitus, diabetic ketoacidosis, insulin dependent, gestational diabetes, pregnancy in diabetics; • Insulin pump, insulin infusion systems, insulin pump therapy, insulin, blood glucose, continuous subcutaneous infusion (CSII); • Patient education, diabetes education, diabetes educators, education, learning, counseling, health behavior.

Data extraction	Titles and abstracts of studies located using the search strategy and those from additional sources were screened independently by two review authors to identify studies that potentially meet the inclusion criteria outlined above. The full text of these potentially eligible studies were retrieved and independently assessed for eligibility by two review team members. Any disagreement between them over the eligibility of particular studies will be resolved through discussion with a third reviewer. Two reviewers extracted data independently; discrepancies were identified and resolved through discussion between the two review authors. A standardised, pre-piloted data extraction form (excel) was used to extract data from the included studies for evidence synthesis. Extracted information included: • Author, year and place of publication; • Study setting; • Study population and participant demographics • Details of the intervention and if applicable control conditions • Study methodology • Recruitment and study completion rates • Outcomes and times of measurement (including follow up) • Experience of educator/trainer • Results • Information for assessment of bias • Authors conclusions
Critical appraisal	Identified studies that met the inclusion criteria were assessed by two independent reviewers for methodological quality before inclusion in the review using the JBI SUMARI. This critical appraisal tool was used to maintain consistency between this review and previous reviews.
Data synthesis	Descriptive summaries of data extracted from each study were created. A narrative synthesis is used to report findings across included studies for the domains of the outcomes.

RESULTS

Search results

The search resulted in 2,389 unique records of which 2,217 were excluded based on exclusion criteria during the title and abstract screening. Of the remaining 172 records 163 full text articles were excluded based on the exclusion criteria (Figure 1 includes reasons for exclusion) leaving 9 studies in the analysis.

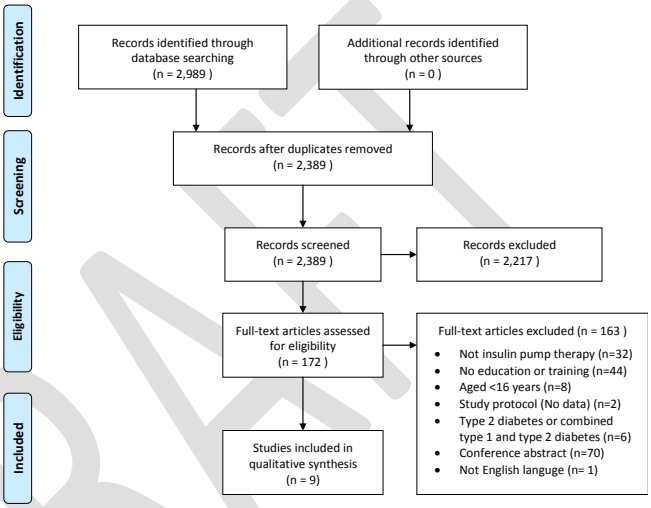

Figure 1. Flow diagram of study screening

An extensive search on grey literature databases yielded no results relevant to the review question. The search of The World Health Organisation International Clinical Trials Registry Platform returned one study registration titled 'Efficiency Assessment of the Structured Education Program for Type 1 Diabetes Patients on Insulin Pump Therapy'[6]. The authors report that the study was completed in February 2013, however to date no results regarding the effectiveness or appropriateness of the educational strategies have been published.

Overall, studies were excluded based on the following criteria:

- Participants were aged 16 years and below.
- Studies were not on IPT.
- No education/training component was involved in the study.
- Study was a report on a specific protocol.

	• Studies that involved participants with Type 2 DM. • Conference abstracts. • Studies were not reported in English.
Overview	The results of the systematic search of the literature from 2011 to 2015 found a small number of studies relating to education and insulin pump therapy. However, there were no comparative studies (e.g. randomised controlled trials) located thus the results of this search are consistent with the previous two reports and it is therefore not possible to determine the effectiveness and appropriateness of educational components and associated with IPT due to a lack of high quality evidence to support conclusions. A description of the included studies and their key findings is provided here, however the majority of studies are small (majority <50 participants) and lack objective (if any) measurement of efficacy.
Initiation of IPT	A qualitative study of children with type 1 diabetes and their parents (n=42) found that the majority of parents and children or young people found glycaemic control easier to maintain within the target range when using insulin pumps compared to injections [7]. Despite reporting many challenges in the early stages of pump therapy initiation, users reported the insulin pump devices were easy to use and more acceptable than injections [7]. Pick up et al. [8] suggest that insulin pump therapy should be initiated by a specialised hospital team comprising a physician, a diabetes nurse, and a dietician trained in pump procedures and Initiation by primary care physicians is not recommended. This was similarly echoed by the American Association of Clinical Endocrinologists and the American College of Endocrinology (AACE/ACE) Insulin Pump Management Task Force. The AACE/ACE Consensus Statement recommended that a multidisciplinary healthcare team be available for patients before the initiation of IPT [9]. Griggs [10] reported that using NICE guidelines were an effective way to select appropriate patients for insulin pump therapy and included patients benefited from improvements in glucose control, quality of life and improved hypoglycaemic awareness. The reduction in admission to hospital with diabetic ketoacidosis also had a cost-saving benefit [10].
Benefits of IPT	The Australian Institute of Health and Welfare (AIHW) [5] reported a variety of benefits for IPT. The benefits cited by survey respondents include: • Affording better control of diabetes; • Being able to eat a variety of foods; • Better lifestyle fit;

	• Better than having several injections everyday even if it means relocating the cannula/tubing every few days; • Feeling better; • More convenient; • More discrete, and • More aware of low sugar levels. The AIHW report also showed that the perceived benefits were ranked differently across genders and age groups. The AIHW caution that although only a small proportion of survey respondents (1.2%) cited no perceived benefits from IPT use, this could be an underestimation, as around 69% of survey respondents were no longer using a pump and did not intend to use one again.
Education programs	There were two potential education programs reported in the literature however both had methodological concerns which prevent the results from being generalised to a population other than that included in the studies. Flexible Insulin Therapy (FIT) The Flexible Insulin Therapy (FIT) is a 4 day inpatient educational program (groups of three to eight people). The multidisciplinary therapeutic-education team consists of three teachers, one medical doctor, one diabetes specialist nurse and one dietician. The interactive educational methods rely upon active patient participation. The objective is to draw from both individual and group resources, starting with the experiences of each patient, to acquire new competencies and to put them into practice. During the programme, the team attempts to identify the factors that govern patients' behaviour such as their health beliefs, locus of control, perceived benefits/barriers and desired targets. The session begins with a roundtable discussion on the theme: "What does diabetes and its treatment mean to you?". Group sessions include several themes, including diet, physical exercise, insulin therapy, and prevention and management of acute complications. If the patients wish to acquire the skills and confidence to adjust their insulin treatment to better match their lifestyle, then greater emphasis is placed on FIT, including an extra day during which a glucidic fast is undertaken [11]. An educational programme of FIT was delivered to a group of adults (n=30) with well controlled T1D patients and found improvements in glucose control as reflected by the average daily risk range (ADRR), however HbA1c did not significantly change [11]. STAR 3 It was also suggested that the STAR 3 training modules may be an appropriate education strategy [12] however to date only one study has investigated this in a paediatric population. STAR 3 is web-based training module featuring basic diabetes education combined with CareLink

	Therapy Management software. Participants in the sensor augmented pump therapy (SAPT) group received an additional 3 weeks of technology-specific training, including homework assignments, worksheets, and brief quizzes to reinforce learning and evaluate information gaps. Importantly, participants were asked to identify topics that would be most beneficial to them, allowing for patient centred care. The STAR 3 program incorporated a patients' own data as a teaching tool, allowing patients and educators to work through issues and concerns with real data. Regular use of therapy management software was useful in exposing common pitfalls such as ignoring active insulin time, attempting too many changes at once, misjudging insulin dosing or timing with respect to carbohydrate consumption, under- or overestimating basal insulin needs, and poor adherence to the basics of diabetes management. Checklist A checklist of possible reasons for unexplained hyperglycaemia and hypoglycaemia is recommended for patients and health care professionals. It is suggested by Pickup et al. [13] that the list should include items such as: • Problems with the cannula (kinked, blocked, or leaking cannula or failure of the cannula to prime after change); • Problems at the infusion site (infection, lipohypertrophy, dislodgment of the infusion set, or a set that has been left in place for longer than 3 days); • Malfunction of the pump (low battery, inactive insulin or insulin past the expiration date, or mechanical or electrical failure with alarms); • Patient-associated issues (missed bolus, incorrect basal rates, overcorrection of hypoglycaemia, illness, use of drugs such as steroids, or menstruation); • Incorrect bolus or basal rates; • Performance of exercise without consumption of extra carbohydrates or reduction of the bolus or basal rate; • Delayed effect of exercise; • Target levels that are set too low; • Consumption of alcohol; • Gastroparesis; • Inadequate self-monitoring of blood glucose levels.
IPT use during hospitalisation	Hospitalisation of patients using insulin pump therapy provides an opportunity to assess a patient's knowledge of insulin pump therapy processes and controls. Patients in most cases can continue using their insulin pump while hospitalised provided they have a sufficient level of knowledge or are able to undertake a 'refresher' education program while in hospital [14].

Assessment of knowledge	Learning processes and information retention varies among patients, therefore continual assessment of knowledge, techniques, and behaviours is required for safe and optimal pump use. A study of adults (n=89) almost all of which had type 1 diabetes were assessed for pump knowledge. The key deficiencies identified were expired or no basal insulin prescription in the event of pump failure or removal and no mupirocin prescription for suspected site infections. Patients needed to be reminded that their prescriptions for basal insulin and mupirocin do not have to be filled, unless necessary. Other key areas included the importance of education regarding the treatment of hyperglycemia, monitoring urine ketones, and the management of sick days. In general, patients should check urine ketones during unexplained hyperglycemia and illness. Authors found that most patients do not regularly check the expiration date of their glucagon kit, so addressing this annually reminds patients to check the date and replace as needed. Finally, the documentation of advanced features allows training to be tailored to meet the needs and interests of the patient [15]. Poor glycaemic control is associated with a lack of parental knowledge of the CSII device. The identification of this gap in knowledge highlights the need for ongoing parental education regarding insulin pump features [16].
Remote Education	A study of adults with type 1 diabetes (n=37) investigating remote education compared to face-face education found that knowledge scores post education were high in both groups, with an average passing grade of 90%. This is possibly due to the training checklist (provided by the manufacturer) that was used in both groups to ensure completeness of training in a logical work flow, as well as the certified diabetes educators who performed the training. Overall, the remote training group presented higher device satisfaction scores, although the group difference was marginal. Importantly, the remote training group indicated that programming the pump settings was easy, a key success factor in the successful use in insulin pump therapy. Importantly in this study all the participants were switching from another brand of insulin pump and were therefore not insulin pump naïve [17].
Implications for practice	• Patient (or parent of a child) knowledge of insulin pump use should be assessed following education and regularly (e.g. annually). • Patients should be seen annually to assess whether prescriptions and medications are current.
Implications for research	To date there are still no published studies reporting the effectiveness and appropriateness of education components and delivery strategies. Therefore research should first focus on conducting high quality

<table>
<tr><td></td><td>comparative studies to determine the required educational components followed by the most appropriate delivery method, including but not limited to inpatient, community, group sessions, face-to-face, remote and the potential for involvement of technology such as smart phones.

Specific recommendations include objective evaluation of:
the FIT education program in people with poor glucose control;
the components of training checklists provided by pump manufacturers;
the STAR 3 training modules in adults with type 1 diabetes;
remote education strategies in insulin pump naïve patients, as this strategy may not be appropriate for pump initiation but may provide an alternative for refresher or update programs.</td></tr>
<tr><td>Comparison of 2011 and 2015 Reviews</td><td>In the current literature review the only relevant additional information identified when compared to the previous reports was the recommendation to assess patient knowledge more frequently. The table below summarises and compares the findings of the previous report completed in 2011 and the present 2015 review. Conclusions and recommendations from 2011 are from the 2011 report of the same title, for more information on individual studies refer to the 2011 report [18].

<table>
<tr><th colspan="2">Effectiveness</th></tr>
<tr><td>2011</td><td>2015</td></tr>
<tr><td>Due to lack of high quality studies, it was difficult to draw a strong conclusion regarding effectiveness.

Supportive evidence regarding the effectiveness of IPT to achieve improved HbA1c and decreased episodes of hypoglycaemia, hyperglycaemia and hospitalisations due to diabetes related complications.

Need for a comprehensive range of advice, education and training
Mixture of various forms of delivering IPT education and training may all be effective.</td><td>No conclusions can be drawn regarding the effectiveness of insulin pump education programs or delivery strategies due to a lack of high quality studies.

One included study showed that insulin pumps were easier to use than injections.

One study reported that patients benefited from improvements in glucose control, quality of life and improved hypoglycaemic awareness. The study also reported a cost-saving benefit from the reduction in hospitalisation due to diabetic ketoacidosis.

A checklist of possible reasons for unexplained hyperglycaemia and hypoglycaemia is recommended for patients and health care</td></tr>
</table></td></tr>
</table>

		professionals. Learning processes and information retention varies among patients, therefore continual assessment of knowledge, techniques, and behaviours is required for safe and optimal pump use. Hospitalisation of patients using insulin pump therapy provides an opportunity to assess a patient's knowledge of insulin pump therapy processes and controls. Knowledge scores post IPT education were high in both remote education and face-face education groups, with an average passing grade of 90%.
	Appropriateness	
	2011	*2015*
	Educational programs should be structured. Content of education programs should facilitate patient's own goals in relation to lifestyle and glycaemic control. No conclusive evidence on the optimal method of training people with T1DM to manage their condition effectively.	No conclusions can be drawn regarding the appropriateness of insulin pump education programs or delivery strategies due to a lack of high quality studies. Insulin pump therapy should be initiated by a specialised hospital team. Initiation by primary care physicians is not recommended. Two structured educational programs were included in the present review (however generalisbility of results is limited to the study populations), finding that: The FIT program showed improvements in glucose control as reflected by the average daily risk range (ADRR), however HbA1c did not significantly change. Regular use of the STAR 3 therapy management software exposed common pitfalls such as ignoring active insulin time, attempting too many changes at once, misjudging insulin dosing or timing with

		respect to carbohydrate consumption, under- or overestimating basal insulin needs, and poor adherence to the basics of diabetes management.
	Implications for Practice	
	2011	*2015*
	Diabetes Educators should complete the approved training for the pump(s) used by their service. Diabetes Educators should provide extensive education/re-education for all self-care management for people with type 1 diabetes and ensure follow up appointments are made prior to recommending an insulin pump. Training with the diabetes educator covering obligatory topics and dietary education with a dietitian over several occasions prior to commencing the pump is considered the minimum required. Competency (of the person receiving the training) should be verified and documented and IPT not commenced until this has occurred. A further 2-3 sessions after pump commencement may be required for optimization. Close follow-up is required to optimize control and ensure safety. Ideally patients should have access to 24 hour support for diabetes-related issues especially during the first few months of IPT. Pump issues should be referred to the pump manufacturers. The diabetes educator, endocrinologist/diabetologist and the dietitian should all be involved to ensure effective patient outcomes when IPT is used. The general practitioner also needs to be fully informed of the patient's progress with IPT. Young adults and women who are pregnant or considering pregnancy	Patient (or parent of a child) knowledge of insulin pump use should be assessed following education and regularly (e.g. annually). Patients should be seen annually to assess whether prescriptions and medications are current.

	can still use IPT but special educational issues apply. (Grade B) Further quantitative research is needed to investigate the potential relationships between education and clinical outcomes. Examine questions regarding patient behaviours, beliefs and the meanings they attach to the educational experience. Qualitative research, particularly in the form of phenomenology would assist in illuminating the meaning of IPT to patients, thus providing valuable insight in to how to target educational strategies more effectively. The experiences and expectations of the diabetes education team have not been well researched, and qualitative research could make a valuable contribution to our understandings of what it means to be involved in education and training as individuals, or as part of a multi-disciplinary team.	
	Implications for Research	
	2011	*2015*
	Further quantitative research is needed to investigate the potential relationships between education and clinical outcomes. Examine questions regarding patient behaviours, beliefs and the meanings they attach to the educational experience. Qualitative research, particularly in the form of phenomenology would assist in illuminating the meaning of IPT to patients, thus providing valuable insight in to how to target educational strategies more effectively. The experiences and expectations of the diabetes education team have	Research should focus on conducting high quality comparative studies to determine the required educational components followed by the most appropriate delivery method, including but not limited to inpatient, community, group sessions, face-to-face, remote and the potential for involvement of technology such as smart phones.

	not been well researched, and qualitative research could make a valuable contribution to our understandings of what it means to be involved in education and training as individuals, or as part of a multi-disciplinary team.	
Conclusions	Although the included studies in the current review were suggestive of the positive outcomes of IPT education and training; no conclusions can be drawn regarding the effectiveness or appropriateness of insulin pump education programs or delivery strategies due to a lack of high quality studies.	
Recommendations from the Literature	The results of this review support the conclusions and synthesised findings of the previous two reports with the additional recommendation that patients pump use knowledge should be regularly assessed to identify and rectify knowledge gaps.	

References

1. Bode, B.W., et al., *Diabetes management in the new millennium using insulin pump therapy.* Diabetes/metabolism research and reviews, 2002. **18**(S1): p. S14-S20.
2. Bode, B.W., W.V. Tamborlane, and P.C. Davidson, *Insulin pump therapy in the 21st century.* Postgrad Med, 2002. **111**(69-77): p. 9.
3. Bergenstal, R.M., et al., *Effectiveness of sensor-augmented insulin-pump therapy in type 1 diabetes.* New England Journal of Medicine, 2010. **363**(4): p. 311-320.
4. Weissberg-Benchell, J., J. Antisdel-Lomaglio, and R. Seshadri, *Insulin pump therapy a meta-analysis.* Diabetes care, 2003. **26**(4): p. 1079-1087.
5. Australian Institute of Health and Welfare, *Insulin pump use in Australia*, in *Diabetes series.* 2012, AIHW: Canberra.
6. Clinical Trials.gov, *Education Effectiveness for Type 1 Diabetes Mellitus on Insulin Pump Therapy (EASEDIAP)*. 19th April 2015, National Library of Medicine (US). Bethesda (MD). p. 5 pages.
7. Alsaleh, F.M., et al., *Insulin pump therapy: impact on the lives of children/young people with diabetes mellitus and their parents.* 2014.
8. Pickup, J.C., *Insulin-pump therapy for type 1 diabetes mellitus.* 2012.
9. Grunberger, G., et al., *Consensus statement by the american association of clinical endocrinologists/american college of endocrinology insulin pump management task force.* Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists, 2014. **20**(5): p. 463-489.
10. Griggs, S., E. Gurnell, and L. Hartley, *Evaluation and audit of an adult pump service.* Journal of Diabetes Nursing, 2012. **16**(1): p. 39-39.
11. Benhamou, P.Y., et al., *Impact of flexible insulin therapy on blood glucose variability, oxidative stress and inflammation in type 1 diabetic patients: the VARIAFIT study.* 2014.
12. Rubin, R.R., S.K. Borgman, and B.T. Sulik, *Crossing the technology divide: practical strategies for transitioning patients from multiple daily insulin injections to sensor-augmented pump therapy.* 2011.
13. Pickup, J.C., *Insulin-pump therapy for type 1 diabetes mellitus.* N Engl J Med, 2012. **366**(17): p. 1616-24.
14. Kannan, S., et al., *Insulin pump patient characteristics and glucose control in the hospitalized setting.* J Diabetes Sci Technol, 2014. **8**(3): p. 473-8.
15. Meade, L.T. and W.E. Rushton, *Optimizing Insulin Pump Therapy: A Quality Improvement Project.* Diabetes Educator, 2013. **39**(6): p. 841-847.
16. Mitchell, K., et al., *Parental Mastery of Continuous Subcutaneous Insulin Infusion Skills and Glycemic Control in Youth with Type 1 Diabetes.* Diabetes Technology & Therapeutics, 2013. **15**(7): p. 591-595.
17. Parks, L., *Effectiveness of Using Remote Communication Technology in Insulin Pump Training: A Pilot Study*. 2014, University of California, Davis: Ann Arbor. p. 36.
18. Clifton, P., A. Cuncins-Hearns, and C. Mathews, *The Effectiveness and appropriateness of educational components and strategies associated with insulin pump therapy (IPT): A systematic review of the literature*. 2011. p. 1-44.

Appendices

Appendix 1 – Search Strategy

MEDLINE search:

1	exp Diabetes Mellitus, Type 1/or type 1 diabetes.mp.
2	exp Diabetic Ketoacidosis/
3	type I diabetes.mp.
4	(IDDM or TIDM or TID).tw,ot.
5	(insulin depend$ or insulindepend$ or insulin-depend$).tw,ot.
6	insulin dependent diabetes.mp.
7	exp Diabetes, Gestational/
8	(gestational adj diabet*).tw,ot
9	Pregnancy in Diabetics/ or Pregnancy, diabetes.mp.
10	OR/ 1-9
11	insulin pump.mp. or exp Insulin Infusion Systems/
12	insulin pump therapy.mp.
13	exp INSULIN/
14	insulin$.tw.
15	(infusion$ or injection$ or CSII).tw.
16	exp Blood Glucose/ or continuous subcutaneous insulin infusion.mp.
17	OR/11-16
18	exp Patient Education as Topic/ or diabetes education.mp.
19	diabetes educators.mp.
20	exp Education/
21	exp Learning/
22	exp Counseling/
23	exp Health Behavio?r/
24	OR/ 18-23
25	exp adolescent/ or exp adult/
26	10 AND 17 AND 24 AND 25
27	Limit 26 to (english language and humans and yr="2011-current")

EMBASE

1	exp insulin dependent diabetes mellitus/or type 1 diabetes.mp.
2	exp Diabetic Ketoacidosis/
3	type I diabetes.mp.
4	(IDDM or TIDM or TID).tw,ot.
5	(insulin depend$ or insulindepend$ or insulin-depend$).tw,ot.
6	insulin dependent diabetes.mp.
7	Gestational diabetes.mp.
8	(gestational adj diabet*).tw,ot
9	exp Pregnancy diabetes mellitus/
10	Pregnancy adj3 Diabet*.mp.

11	OR/ 1-10
12	exp insulin pump/ or exp Insulin Infusion Systems/
13	Implantable programmable insulin pump.mp.
14	artificial beta cell.mp.
15	*artificial endocrine pancreas/
16	insulin pump therapy.mp.
17	exp INSULIN/
18	insulin$.tw.
19	(infusion$ or injection$ or CSII).tw.
20	exp Blood Glucose/ or continuous subcutaneous insulin infusion.mp.
21	OR/12-20
22	exp Patient Education/ or diabetes education.mp.
23	Education of patients.mp.
24	diabetes educators.mp.
25	exp Education/
26	exp Learning/
27	exp Counseling/
28	exp Health Behavior/
29	Health Behavio?r.mp.
30	Workshop.mp.
31	OR/ 22-30
32	exp adolescent/ or exp adult/
33	11 AND 21 AND 31 AND 32
34	Limit 33 to (english language and humans and yr="2011-current"

CINAHL:

1	Diabetes Mellitus AND (Type 1 or type I)
2	Diabetic Ketoacidosis
3	IDDM or TIDM or TID
4	insulin depend* or insulindepend* or insulin-depend*
5	insulin dependent diabetes
6	gestational diabetes
7	gestational N3 diabet*
8	Pregnancy N3 Diabet*
9	OR/ 1-8
10	insulin pump or Insulin Infusion System
11	insulin pump therapy
12	insulin
13	Infusion* or injection* or CSII
14	Implantable programmable insulin pump
15	artificial beta cell
16	artificial endocrine pancreas
17	Blood Glucose
18	continuous subcutaneous insulin infusion
19	OR/10-18
20	Patient Education as Topic

21	Education of patients
22	diabetes education
23	diabetes educators
24	Education
25	Learning
26	Counsel?ing
27	Health Behavio?r
28	Workshop
29	OR/ 20-28
30	adolescent or adult
31	9 AND 19 AND 29 AND 30
32	Limit 31 to English language and humans and yr="2011-2015"

The Cochrane library (Cochrane Database of systematic review, Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Methodology Register

1	"Diabetes Mellitus type 1" OR "Diabetes Mellitus type I" OR "Diabetic Ketoacidosis" OR IDDM OR TIDM OR TID OR "insulin depend*" OR insulindepend* OR insulin-depend* OR "insulin dependent diabetes" OR "gestational diabetes" OR "gestational NEAR3 diabet*" OR "Pregnancy NEAR3 diabet*"
2	"insulin pump therapy" OR "Insulin Infusion System" OR insulin OR Infusion* OR injection* OR CSII OR "Implantable programmable insulin pump" OR "artificial beta cell" OR "artificial endocrine pancreas" OR "Blood Glucose" OR "continuous subcutaneous insulin infusion"
3	"Patient Education" OR "Education of patients" OR "diabetes education" OR "diabetes educators" OR Education OR Learning OR Counselling OR Health Behaviour OR Workshop
4	adolescent or adult
5	1 AND 2 AND 3 AND 4
6	Limit 5 to English language and humans and yr="2011-2015"

Current Contents

1	"Diabetes Mellitus type 1" or "type 1 diabetes mellitus"
2	"Diabetes Mellitus type I" or "type I diabetes mellitus"
3	"Diabetic Ketoacidosis"
4	IDDM or TIDM or TID
5	"insulin dependent diabetes"
6	"gestational diabetes"
7	"Diabetes in pregnancy"
8	OR/ 1-8
9	"insulin pump therapy"
10	"Insulin Infusion System"
12	CSII
14	"artificial beta cell"
15	"artificial endocrine pancreas"
16	"Blood Glucose"
17	"continuous subcutaneous insulin infusion"

18	OR/9-17
19	"Patient Education"
20	"Education of patients"
21	"diabetes education"
22	"diabetes educators"
23	"Health Behaviour"
24	OR/ 19-23
25	adolescent or adult
26	8 AND 18 AND 24 AND 25
27	Limit 26 to English language and humans and yr="2011-2015"

PsycINFO

1	Diabetes Mellitus AND (Type 1 or type I).mp.
2	Diabetic Ketoacidosis.mp.
3	IDDM or TIDM or TID.mp.
4	insulin depend* or insulindepend* or insulin-depend*.mp.
5	insulin dependent diabetes.mp.
6	gestational diabetes.mp.
7	(gestational adj3 diabet*).mp.
8	(Pregnancy adj3 Diabet*).mp.
9	OR/ 1-8
10	insulin pump or Insulin Infusion System.mp.
11	insulin pump therapy.mp.
12	Insulin.mp.
13	Infusion* or injection* or CSII.mp.
14	Implantable programmable insulin pump.mp.
15	artificial beta cell.mp.
16	artificial endocrine pancreas.mp.
17	Blood Glucose.mp.
18	continuous subcutaneous insulin infusion.mp.
19	OR/10-18
20	Patient Education as Topic.mp.
21	Education of patients.mp.
22	diabetes education.mp.
23	diabetes educators.mp.
24	Education.mp.
25	Learning.mp.
26	Counsel?ing.mp.
27	Health Behavio?r.mp.
28	Workshop.mp.
29	OR/ 20-28
30	adolescent or adult.mp.
31	9 AND 19 AND 29 AND 30
32	Limit 31 to (english language and humans and yr="2011-current"

ProQuest Dissertations & Theses Global

1	Diabetes Mellitus AND (Type 1 or type I)
2	Diabetic Ketoacidosis
3	IDDM or TIDM or TID
4	insulin depend* or insulindepend* or insulin-depend*
5	"insulin dependent diabetes"
6	gestational diabetes
7	(gestational N/3 diabet*)
8	(Pregnancy N/3 diabet*)
9	OR/ 1-8
10	SU.EXACT("Insulin Infusion System")
11	"insulin pump"
12	SU.EXACT ("insulin pump therapy")
13	Infusion* or injection* or CSII
14	"Implantable programmable insulin pump"
15	"artificial beta cell"
16	"artificial endocrine pancreas"
17	"Blood Glucose"
18	"continuous subcutaneous insulin infusion"
19	OR/10-18
20	SU.EXACT ("Patient Education as Topic")
21	SU.EXACT ("Education of patients")
22	SU.EXACT ("diabetes education")
23	"diabetes educators"
24	OR/ 21-24
25	adolescent or adult
26	9 AND 20 AND 25 AND 26
27	Limit 27 to English language and humans and yr="2011-2016"

The World Health Organisation International Clinical Trials Registry Platform

1	Diabetes education or diabetes educators or counselling or learning
2	Type 1 diabetes mellitus or diabetic ketoacidosis or insulin dependent diabetes or gestational diabetes or pregnancy diabetic
3	insulin pump or insulin infusion or continuous subcutaneous insulin infusion or CSII

Appendix 2 – Critical appraisal

Quantitative

Reference	Benhamou 2014	Griggs 2012	Kannan 2014	Meade 2013	Mitchell 2013	Parks 2014
Was the sample based on a random or pseudo-random sample?	No	No	No	No	No	No
Were the criteria for inclusionin the sample clearly defined?	Yes	No	Yes	No	Yes	Yes
Were confounding factors identified and strategies to deal with them stated?	No	No	No	No	Yes	Yes
Were outcomes assessed using objective criteria?	Yes	Yes	Yes	Yes	Yes	Yes
If comparisons are being made, was there sufficient descriptions of the groups?	Yes	No	No	Yes	Yes	Yes
Was follow up carried out over a sufficient time period?	Yes	Yes	No	Yes	Yes	Yes
Were the outcomes of people who withdrew described and included in the analysis?	Yes	Unclear	Yes	Unclear	Yes	Yes
Were outcomes measured in a reliable way?	Yes	No	Yes	Yes	Yes	Yes
Was the appropriate analysis used?	Yes	No	Yes	Yes	Yes	Yes

Literature review

Reference	Rubin 2011
Is the source of the opinion clearly identified?	Yes
Does the source of the opinion have standing in the field of expertise?	Yes
Are the interests of the patients/clients the central focus of the opinion?	Yes
Is the opinion's basis in logic/experience clearly argued?	Yes
Is the argument developed analytical?	Yes
Is there reference to the extant literature/evidence and any incongruence with it logically defended?	Yes
Is the opinion supported by peers?	Yes

Qualitative

Reference	Alsaleh, 2014	Pickup, 2012
Do the conclusion drawn in the research report flow from the analysis, or interpretation, of the data?	Yes	Yes
Is the research ethical?	Yes	Yes
Are participants, and their voices, adequately represented?	Yes	Yes
Is the influence of the researcher on the research, and vice versa addressed?	No	Yes
Is there a statement locating the researcher culturally or theoretically?	No	Yes
Is there a congruity between research methodology and interpretation of the results?	No	Yes
Is there a congruity between the research methodology and the representation and analysis of data?	Yes	Yes
Is there a congruity between the research methodology and the methods used to collect the data?	Yes	Yes
Is there a congruity between the research methodology and the research question or objective?	Yes	Yes
Is there a congruity between the stated philosophical perspective and the research methodology?	Yes	Yes

Appendix 3 – Abstracts of included studies

Reference no. 7

Alsaleh, F.M., et al., *Insulin pump therapy: impact on the lives of children/young people with diabetes mellitus and their parents.* 2014.

Background Advances in medical technology and research documenting clinical effectiveness have led to the increased use of insulin pumps worldwide. However, their use by children in the UK is relatively limited and there is little evidence regarding their impact on patients' lives. Objective This study aimed to examine the impact of switching from multiple daily injections to insulin pumps on the glycaemic control and daily lives of children/young people and their families. Setting University College London Hospital, London. Method Face-to-face semi-structured interviews were conducted with children/young people with type 1 diabetes mellitus (5-17 years; N = 34) and their parents (N = 38), receiving insulin pump therapy and attending paediatric diabetes outpatients clinics at a major university teaching hospital in London. Glycated haemoglobin A1c values from 6 months prior to, and after pump therapy were obtained. Qualitative and quantitative approaches were undertaken for data analysis. Main outcome measure Glycated haemoglobin A1c and the impact of the use of insulin pumps on the children and their families. Results The majority of parents (N = 32) and the children/young people (N = 30) reported that glycaemic control was easier to maintain within the target range with pumps compared to injections. This was supported by glycated haemoglobin A1c measures. Participants generally found the devices easy to use and more acceptable than injections. However, parents and children/young people reported many challenges in the early stages of pump therapy (e.g. 7 children/young had worse control at 6 months after starting CSII). Parents and children/young people reported an overall increase in lifestyle flexibility and an improved ability to participate in home, school and social activities whilst maintaining glycaemic control. Conclusion Administration of insulin via pumps rather than injections was generally preferred. Participants reported most difficulty at the commencement of use. Pump therapy conferred benefits in terms of glycaemic control, general well-being, enabling young people to be more in control of their condition and live more normal lives, as reported by most participants. These are important goals of health policy for children/young people with long-term conditions in the UK.

Reference no. 8

Pickup, J.C., *Insulin-pump therapy for type 1 diabetes mellitus.* N Engl J Med, 2012. **366**(17): p. 1616-24.

This Journal *feature begins with a case vignette that includes a therapeutic recommendation. A discussion of the clinical problem and the mechanism of benefit of this form of therapy follows. Major clinical studies, the clinical use of this therapy, and potential adverse effects are reviewed. Relevant formal guidelines, if they exist, are presented. The article ends with the author's clinical recommendations.*
A 39-year-old man with type 1 diabetes of 27 years' duration visits his endocrinologist for review of his blood glucose control. He is overweight (body-mass index [the weight in kilograms divided by the square of the height in meters], 28.4). The overall glycemic control has been suboptimal, with glycated hemoglobin values of 7.5 to 8.0% in recent years. He reports unpredictable swings in self-monitored blood glucose concentrations and frequent episodes of severe hypoglycemia, which markedly disrupt his work and home life. He also reports that he now has fewer warning symptoms of hypoglycemia than he had previously. These findings are present despite the patient's best efforts to achieve glycemic control

with intensified insulin-injection therapy, regular visits to a diabetes clinic, and input from diabetes nurse educators. He attended a structured diabetes education course 1 year previously, which he found to be useful and which led to slight improvements in glycated hemoglobin levels; however, the frequency of hypoglycemic episodes was unchanged. His endocrinologist has ruled out coexisting illnesses, including celiac disease and Addison's disease, as causes of poor glycemic control and wonders whether a trial of insulin-pump therapy is appropriate. Since the endocrinologist has little experience with this type of therapy himself, he refers the patient to a center with a specialized insulin-pump clinic.

Reference no. 9

Griggs, S., E. Gurnell, and L. Hartley, *Evaluation and audit of an adult pump service.* Journal of Diabetes Nursing, 2012. **16**(1): p. 39-39.

Background: The pump service started in 2004 when one of our teenage patients with type 1 diabetes was failing to improve her control and had numerous admissions with diabetes ketoacidosis (DKA). In order to move this teenager onto a pump, we had to gain new skills and were helped enormously by the pump educator. Switching the teenager to a pump stopped her hospital admissions and improved her control, so it was clear we needed to offer this service. We are now starting 20 adults on pump therapy each year and have over 80 pump users. The age range of our pump users is 17–73 years. We have been collecting data to monitor the effectiveness of our service – a consultant who takes the lead in this alongside a specialist nurse. Initially both attended national training days and then organised training from recognised pump professionals here at the diabetes centre. The other specialist nurses in our team have had to develop a good knowledge of pumps to support our patients. NICE criteria is followed for selection for pump therapy and in addition to this patients have to attend a pump interest session where we have a current pump user and a dietitian and the lead specialist nurse. From these sessions some attendees decide not to pursue a pump, but for those that are keen, they then need to attend and be competent in carbohydrate counting and knowledge. We offer this course monthly and knowledge is assessed by completion of a carbohydrate food diary which is reviewed by our dietitian. Team members discuss each patient and if all agree they would be put forward for a pump. Waiting time from the start of the process could be 12 months, this partly is due to our resources as we have had to offer this service within our current capacity. We have set up twice-monthly pump clinics and patients are reviewed every 6 months, unless they are experiencing a problem. They are also expected to attend ongoing education sessions every 6 months and so far we have achieved good attendance.
Data evaluation: We collected data on HbA1c, hypoglycaemic awareness, quality of life and DKA admissions prior to pump start and at 6 and 12 months. The average HbA1c before pump therapy was 72 mmol/mol (8.7%). At 6 months the average was 63 mmol/mol (7.9%); a 0.8% reduction. At 12 months the average was 61.7 mmol/mol (7.8%), representing continued stable improvement. Hypoglycaemic awareness was scored prior to pump therapy; 75% recognised the symptoms. At 6 months 87% had improved hypoglycaemic awareness and at 12 months 90% had improved awareness. This represents an excellent improvement in hypoglycaemic awareness. Prior to pump therapy, the average Problem Areas In Diabetes (PAID) score was 19 (where 0 = no problems and 80 = high problems). At 6 months and 1 year, the score was 12, showing quality of life improvement. We looked at DKA admission over 3 years (2009–11) and found that 5% of these admissions were pump users (eight patients). Two of these people had been admitted at least six times each year for DKA prior to being on a pump. Since becoming pump users they have not been admitted at all.
Conclusion: The results so far indicate that appropriate patients have been selected for pump therapy and have benefited from improvement in control, quality of life and improved hypoglycaemic

awareness. The reduction in admission to hospital with DKA has a cost-saving benefit. We now have 85 adult pump users and 30 children who will be moving to the adult service.
We have a waiting list of 20 people who are ready to start pump therapy. Our study shows that a successful pump service can be developed within a district general hospital, with no extra resources being allocated for this service. However, with the increasing numbers of pump users and ongoing interest in pump therapy we are having to prepare a business case for more resources to support this service.

Reference no. 10

Benhamou, P.Y., et al., *Impact of flexible insulin therapy on blood glucose variability, oxidative stress and inflammation in type 1 diabetic patients: the VARIAFIT study.* 2014.

AIMS: HbA1c only partially predicts vascular risk in patients with type 1 diabetes (T1D), and a role for blood glucose variability (BGV) is a matter of debate. For this reason, this study investigated the impact of an educational programme of flexible insulin therapy (FIT) on BGV and oxidative stress.
METHODS: Tests were conducted on 30 adult T1D patients in a prospective, single-centre trial at baseline (M0), and at 3 and 6 months (M3 and M6, respectively) of the FIT programme to determine BGV, as reflected by mean amplitude of glycaemic excursions (MAGE), low blood glucose index (LBGI), lability index (LI), average daily risk range (ADRR), glycaemic lability (scored by two diabetologists), urinary leukotriene E4 (LTE4), 11-dehydro-thromboxane B2 (TXB2) and 8-iso-prostaglandin F2alpha (PGF2).
RESULTS: HbA1c (7.7 +/- 0.9%), ADRR, MAGE, LBGI and LI did not change from M0 to M3 and M6, although ADRR and LBGI significantly improved at M3 and M6 in patients with the highest baseline indices (> 40 and > 5, respectively). TXB2 declined at M6 (832 +/- 625 vs. 633 +/- 972 pg/mg; P=0.048), whereas LTE4 and PGF2 remained stable. ADRR showed the strongest correlation with glycaemic lability scores at all visits (r>0.84, P<0.0001).
CONCLUSION: A FIT educational programme improved BGV only in patients with the highest baseline variability, and led to no changes in HbA1c, while ADRR closely correlated with glycaemic lability score. Our data do not support a relationship between BGV and oxidative stress in T1D patients, although the impact of variability on TXB2 deserves further investigation (ClinicalTrials.gov NCT00973492).

Reference no. 11

Rubin, R.R., S.K. Borgman, and B.T. Sulik, *Crossing the technology divide: practical strategies for transitioning patients from multiple daily insulin injections to sensor-augmented pump therapy.* Diabetes Educ, 2011. **37 Suppl 1**: p. 5S-18S; quiz 19S-20S.

PURPOSE: To describe the benefits of continuous glucose monitoring (CGM) and continuous subcutaneous insulin infusion (CSII) systems compared with self-monitoring of blood glucose (SMBG) and multiple daily injection (MDI) therapy; to assess the benefits of sensor-augmented pump therapy (SAPT) in patients with type 1 diabetes; and to present an evidence-based practical protocol for introducing SAPT in patients with no prior pump or CGM experience.
CONCLUSION: Continuous glucose monitoring and CSII have advantages over SMBG and MDI, respectively, in terms of A1C and hypoglycemia reduction. The Sensor-Augmented Pump Therapy for

A1C Reduction (STAR) 3 trial demonstrated that initiating both CGM and CSII in selected adult and pediatric patients with type 1 diabetes unable to meet glycemic goals with intensive insulin injection therapy significantly improved glucose control. In all subjects using SAPT, A1C levels fell rapidly from baseline to 3 months and remained significantly lower than among subjects in the SMBG+MDI group for 1 year. A distinguishing feature of the STAR 3 study was its stepwise protocol for systematizing education and self-management support using Web-based training modules and therapy management software. The demonstrated strengths of this education protocol recommend it as a model for implementing SAPT in the broader population of patients with type 1 diabetes who have not achieved their glycemic goals with optimized MDI therapy.

Reference no. 12

Kannan, S., et al., *Insulin pump patient characteristics and glucose control in the hospitalized setting.* J Diabetes Sci Technol, 2014. **8**(3): p. 473-8.

Patients' knowledge of their insulin pumps and glucose control during hospitalization has not been studied. The aim was to study the determinants of glycemic control in patients using continuous subcutaneous insulin infusion (CSII) in the hospital. Three groups of patients were identified: those who did not need any inpatient education and continued on CSII (gorup A), those who received education then continued on CSII (group B), and those for whom CSII was not appropriate and were treated with multiple daily insulin injections (gorup C). We compared the measures of glycemic control between the 3 groups and analyzed which variables impacted glucose control. There were 50 patients, with 51 hospital admissions, 57% males, mean age 48 +/- 13 years, 86% had type 1 diabetes (T1DM). The mean DM duration was 26 +/- 14 years, mean duration of CSII use was 8.7 +/- 6 years, and mean HbA1c was 7.6 +/- 1.4%. The mean duration of hospital stay was 5.6 +/- 4.6 days. Mean blood glucose (BG) and frequency of hyperglycemia and hypoglycemic events among the 3 groups adjusted for their duration of hospital stay were not statistically different. None of the patients developed diabetic ketoacidosis while using their pump. Stepwise multivariate analysis revealed knowledge of hypoglycemia correction was the single most important predictor of mean BG ($P < .001$). Patients who received inpatient education performed similarly to patients who did not need inpatient education. Patients who receive inpatient education on CSII fare similar as patients who did not require inpatient education. © 2014 Diabetes Technology Society.

Reference no. 13

Meade, L.T. and W.E. Rushton, *Optimizing Insulin Pump Therapy: A Quality Improvement Project.* Diabetes Educator, 2013. **39**(6): p. 841-847.

Purpose:The purpose of the study was to assess insulin pump use and provide ongoing education. Methods:A quality improvement project using a pump assessment questionnaire was implemented at an endocrinology office in the southeastern United States. The questionnaire was designed to evaluate all aspects of insulin pump therapy, including pump operations, infusion set failure, management of acute complications, and usage of advanced device features. Eighty-nine patients (80% with type 1 diabetes and 20% with type 2 diabetes) completed the questionnaire at the endocrinology practice. A certified diabetes educator reviewed the questions with each patient, identifying deficiencies and training opportunities.

Results:The most common areas of deficiency identified after implementation of the assessment form included the following: expired or no basal insulin prescription in the event of pump failure or removal, no mupirocin (Bactroban®, GlaxoSmithKline, Research Triangle Park, North Carolina) prescription for suspected site infections, lack of insulin syringe if pump stopped working, failure to check urine ketones, no antiemetic prescription for sick day intervention, using manual bolus instead of bolus calculator, and lack of in-date glucagon kit.
Conclusions: Use of a pump assessment questionnaire allows for focused discussion concerning patient behaviors related to pump operations, troubleshooting, and self-management. Incorporating use of a pump assessment questionnaire into routine practice may result in improved patient education and avoidance of adverse events specific to insulin pump therapy.

Reference no. 14

Mitchell, K., et al., *Parental mastery of continuous subcutaneous insulin infusion skills and glycemic control in youth with type 1 diabetes.* Diabetes Technol Ther, 2013. **15**(7): p. 591-5.

OBJECTIVE: The purpose of this study is to determine whether parental knowledge of the continuous subcutaneous insulin infusion (CSII) device affects glycemic control as measured by hemoglobin A1c (A1C) level.
SUBJECTS AND METHODS: Parents of children with type 1 diabetes mellitus (T1DM) using CSII completed a 14-item questionnaire. Questions 1-10 were knowledge-based questions that required the parent to extract specific information from their child's CSII device. Questions 11-14 asked parents to provide a self-assessment of their CSII knowledge.
RESULTS: Twenty-two parents of youth with T1DM participated in the study. Ten of the youth were in the Low-A1C group (A1C<8%), and the other 12 were in the High-A1C group (A1C>8%). Parents of youth in the Low-A1C group scored statistically better on the 10-item performance survey than parents of youth in the High-A1C group. Most of the parents of children in the Low-A1C group responded that they knew their child's insulin pump "very well" and that their pump knowledge had "increased" since their child started on the insulin pump.
CONCLUSIONS: Our findings reveal that youth with T1DM whose parents are more knowledgeable about pump functions have optimal glycemic control as evidenced by A1C. These findings underscore the importance of ongoing pump training for both pediatric patients and their parents.

Reference no. 15

Parks, L., *Effectiveness of Using Remote Communication Technology in Insulin Pump Training: A Pilot Study*. 2014, University of California, Davis: Ann Arbor. p. 36

Purpose: The purpose of this pilot study was to explore the effectiveness of using remote communication technology in the technical training of an insulin pump as compared to the traditional face-to-face training in adult patients with diabetes who were familiar with insulin pump therapy.
Sample and Methods: Emails with a survey link were sent to 61 eligible people who had purchased an insulin pump between July and October 2013 and had been trained by one of the manufacturer's diabetes educators. The participants were given the choice of receiving their training in a face-to-face meeting or via remote communication technology. The survey consisted of 27 questions that asked the participants' characteristics, knowledge acquisition and their satisfaction with the insulin pump training and their chosen training method. Findings: Thirty-eight participants completed the survey, with a mean

age of 41 years old, average of 24 years with diabetes, and having used an insulin pump for an average of 10 years. There was no statistically significant difference in their characteristics, knowledge acquisition, or satisfaction with either training method between the remote training group (n = 17) and the face-to-face training group (n = 20). Although people in the remote training group reported higher satisfaction scores with the insulin pump after training ($p < .05$), interpreting these study findings needs caution due to the small sample size and self-selection bias. Conclusion: The results of this pilot study encourages that remote communication technology might be an effective tool to provide technical training to adults who are familiar with insulin pump therapy. Further research with larger and more diverse populations is required to examine the effectiveness of remote communication technology methods when used in insulin pump training.

Appendix 4 –Summary of included studies (including 2011 and 2008)

Studies highlighted in grey are the additional studies from this review published between 2011 and 2015.

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
Alsaleh, F.M., et al., *Insulin pump therapy: impact on the lives of children/young people with diabetes mellitus and their parents.* International Journal of Clinical Pharmacy, 2014. **36**(5): p. 1023-1030.	Qualitative	Children with Type 1 diabetes and their families (n= 42). In hospital and at participants home.	N/A	N/A	Administration of insulin via pumps rather than injections was generally preferred. Participants reported most difficulty at the commencement of use. Pump therapy conferred benefits in terms of glycaemic control, general well-being, enabling young people to be more in control of their condition and live more normal lives, as reported by most participants. These are important goals of health policy for children/young people with long-term conditions in the UK.
Benhamou, P.Y., et al., *Impact of flexible insulin therapy on blood glucose variability, oxidative stress and inflammation in type 1 diabetic patients: the VARIAFIT study.* 2014.	Non Randomised (Quasi) experimental	Adults with Type 1 diabetes (n= 30) Hospital.	Educational programmes accommodate groups of 3-8 people, and last for 3 to 4 days. The multidisciplinary therapeutic-education team consists of 3 teachers, a medical doctor, a diabetes specialist nurse and a dietitian. The objective is to draw from both individual and group resources, starting with the experiences of each patient, to acquire new competencies and to put them into practice. During the programme, the team attempts to identify the factors that govern patients' behaviour such as their health beliefs, locus of control, perceived benefits/barriers and desired targets. The session begins with a roundtable discussion on the theme: "What does diabetes and its treatment mean to you?" At this time, the patients get to know one	Glucose variability was assessed using four indices mean amplitude of glycaemic excursions (MAGE); low blood glycaemic index (LBGI); labiliity index (LI); and the average daily risk range (ADRR).	An educational programme of FIT delivered to initially fairly well controlled T1D patients can improve glucose variability as reflected by the ADRR, albeit only in patients presenting with high baseline ADRR values, whereas HbA1c did not significantly change while BMI was reduced.

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
			another, and are encouraged to express their feelings about their illness and its treatment, and what they expect to gain from the programme. Group sessions are structured around several themes, including diet, physical exercise, insulin therapy, and prevention and management of acute complications. In addition, all participants receive an explanation of the principles of FIT.		
Kannan, S., et al., *Insulin pump patient characteristics and glucose control in the hospitalized setting.* J Diabetes Sci Technol, 2014. **8**(3): p. 473-8	Audit	Adults (≥ 18 years) with T1 (90%) & T2 diabetes (10%). Hospital. n=50	Insulin pump protocol. Content not reported.	Patient knowledge of pump use	Patients who received inpatient education performed similarly to patients who did not need inpatient education. Patients who receive inpatient education on CSII fare similar as patients who did not require inpatient education during hospitalisation.
Parks, L., *Effectiveness of Using Remote Communication Technology in Insulin Pump Training: A Pilot Study*. 2014, University of California, Davis: Ann Arbor. p. 36	Cross sectional	N=37	Remote (tele-education) compared to face-to-face education. Training includes pump therapy basic concepts (Basal/bolus, insulin on board, insulin to carbohydrate ratio, correction factor, insulin duration), battery, infusion sets, pump overview (touch screen and general navigation), personal profiles, alert settings, pump settings, pump info (serial number and customer technical support contact info), load, important information, delivering boluses, stop and resume insulin delivery, temporary basal rate, review history, insulin pump messages, Diabetes management application.	Pump use knowledge questionnaire	Knowledge scores were high in both groups, with an average passing grade of 90%, which may have led to the high confidence scores. This is possibly due to the training checklist that was used in both groups to ensure completeness of training in a logical work flow, as well as the certified diabetes educators who performed the training. Overall, the remote training group presented higher device satisfaction scores ($p < .05$), although the group difference was marginal. In addition, all the participants were switching from another brand of insulin pump; therefore their prior familiarity with this therapy could have contributed to their overall satisfaction.
Meade, L.T. and W.E.	Qualitative	Adults with T1	The questionnaire was designed to	Use of a pump	The use of an insulin pump requires more

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
Rushton, *Optimizing Insulin Pump Therapy: A Quality Improvement Project.* Diabetes Educator, 2013. **39**(6): p. 841-847	Quality improvement.	& T2 diabetes. Endocrinology office. n= 89	evaluate all aspects of insulin pump therapy, including pump operations, infusion set failure, management of acute complications, and usage of advanced device features.	assessment questionnaire allows for focused discussion concerning patient behaviors related to pump operations, troubleshooting, and self-management.	initial training than insulin pens or syringes. Since learning processes and information retention varies among patients, continual assessment of knowledge, techniques, and behaviors is mandatory for safe and optimal pump use. Patients need to check that medications have not expired and need to be reminded that their prescriptions for basal insulin and mupirocin do not have to be filled, unless necessary. Other information from this questionnaire revealed the importance of education regarding the treatment of hyperglycemia, monitoring urine ketones, and the management of sick days. In general, patients should check urine ketones during unexplained hyperglycemia and illness. Most patients do not regularly check the expiration date of their glucagon kit, so addressing this annually reminds patients to check the date and replace as needed.
Mitchell, K., et al., *Parental mastery of continuous subcutaneous insulin infusion skills and glycemic control in youth with type 1 diabetes.* Diabetes Technol Ther, 2013. **15**(7): p. 591-5	Cross sectional	N=22	A survey assessing CSII task performance. Questions 1–10 were knowledge-based questions that required the parent to extract specific information from their child's insulin pump, such as the current basal rate, maximum possible bolus, and amount of the last bolus. Questions 11–14 asked parents to provide a self-assessment of their insulin pump knowledge.	HbA1c	Poor glycemic control is associated with a lack of parental knowledge of the CSII device. The identification of this gap in knowledge highlights the need for ongoing parental education regarding insulin pump features.
Griggs, S., E. Gurnell, and L. Hartley,	Cross sectional	Hospital. Sample size not	Group pump clinics	HbA1c, hypoglycaemic	The results so far indicate that appropriate patients have been selected

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
Evaluation and audit of an adult pump service. Journal of Diabetes Nursing, 2012. **16**(1): p. 39-39		reported.		awareness, quality of life and DKA admissions	for pump therapy and have benefited from improvement in control, quality of life and improved hypoglycaemic awareness. The reduction in admission to hospital with DKA has a cost-saving benefit. Our study shows that a successful pump service can be developed within a district general hospital, with no extra resources being allocated for this service. However, with the increasing numbers of pump users and ongoing interest in pump therapy we are having to prepare a business case for more resources to support this service.
Pickup, J.C., *Insulin-pump therapy for type 1 diabetes mellitus.* N Engl J Med, 2012. **366**(17): p. 1616-24	Qualitative review	N/A	N/A	N/A	Insulin-pump therapy should be initiated by a specialized hospital team comprising a physician, a diabetes nurse, and a dietitian trained in pump procedures. Initiation of pump therapy by primary care physicians is not recommended. It is important for the patient to be willing and motivated to use the insulin pump. The necessary commitments include frequent self-monitoring of blood glucose levels (four to six times daily), carbohydrate counting (adjustment of the insulin dose according to the estimated amount of carbohydrate in an intended meal), and working with the pump team to learn pump procedures. Patients and health care professionals need a checklist of possible reasons for unexplained hyperglycemia, with the list including problems with the cannula (kinked, blocked, or leaking cannula or failure of

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
					the cannula to prime after change), problems at the infusion site (infection, lipohypertrophy, dislodgment of the infusion set, or a set that has been left in place for longer than 3 days), malfunction of the pump (low battery, inactive insulin or insulin past the expiration date, or mechanical or electrical failure with alarms), and patient-associated issues (missed bolus, incorrect basal rates, overcorrection of hypoglycemia, illness, use of drugs such as steroids, or menstruation). Similarly, a checklist for unexplained hypoglycemia may include incorrect bolus or basal rates, performance of exercise without consumption of extra carbohydrates or reduction of the bolus or basal rate, delayed effect of exercise, target levels that are set too low, consumption of alcohol, gastroparesis, and inadequate self-monitoring of blood glucose levels.
Rubin, R.R., S.K. Borgman, and B.T. Sulik, *Crossing the technology divide: practical strategies for transitioning patients from multiple daily insulin injections to sensor-augmented pump therapy.* Diabetes Educ, 2011. **37 Suppl 1**: p. 5S-18S; quiz	Literature review	N/A	In STAR 3, Web-based training modules featuring basic diabetes education (eg, diabetes physiology, treating/recognizing hypoglycemia, counting carbohydrates) were provided with CareLink Therapy Management software to all subjects over the initial 2-week training period. Subjects in the sensor augmented pump therapy (SAPT) group received an additional 3 weeks of technology-specific training, including homework assignments, worksheets, and brief quizzes to reinforce learning and evaluate information gaps.	It was observed that patients who consistently applied themselves to assignments, worksheets, and glucose data analysis were often the most successful, regardless of their technological aptitude at baseline.	The demonstrated strengths of the STAR 3 education protocol recommend it as a model for implementing SAPT in the wider population of patients with type 1diabetes who have not achieved their glycemic goals with optimized MDI therapy. It must be emphasized, however, that reinforcement and review continued throughout the study. Many patients were not used to seeing such vast amounts of data and needed help coping with "information overload," as well as prioritizing education goals and therapy

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
19S-20S			They were introduced to CSII first, and then glucose sensors approximately 2 weeks later. Importantly, participants were asked to identify the topics that would be most beneficial to them so that educators could develop learning plans customized to their particular needs and level of knowledge. Moreover, patients' own data were used as a teaching tool to enhance experience based learning. Independent study could also be pursued using workbooks or CD-ROMs.		adjustments. In the latter case, patients were advised, for example, to address hypoglycaemia first, and to pay attention to trends (ie, the direction and rate of glucose change) when looking at their pump screens rather than the actual glucose readings. Common challenges among patients included frustration with frequent high or low glucose threshold alarms and behavioral and/or emotional overreaction to data. When faced with these problems, educators and patients worked toward finding a middle ground conducive to both safety and adherence. Using the patient's own data as an educational tool enables clinicians to guide treatment while teaching the patient to make more effective self-management decisions. The study findings reinforce that the demands of initial training are often counterbalanced by the benefit of more independent, thoughtful decision making by patients, as well as significantly improved A1C and blood glucose levels. Regular use of therapy management software was useful in exposing common pitfalls such as ignoring active insulin time, attempting too many changes at once, misjudging insulin dosing or timing with respect to carbohydrate consumption, under- or overestimating basal insulin needs, and poor adherence to the basics of diabetes management.
Everett, J. and D. Kerr, *Telehealth as*	Pilot study case series	Bournemouth Diabetes and	Patients had to attend two novel group sessions to learn how to use the Axon	HbA1c. Awareness of Hypoglycaemia pre-	Only 12 of the 16 participants used the system and downloaded data HbA1c fell

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
adjunctive therapy in insulin pump treated patients: a pilot study. Practical Diabetes International, 2010. **27**(1): p. 9-10i		Endocrine Centre, Bournemouth, UK Patients referred to this specialist service with Type 1 diabetes who were already on IPT and consented to participating in this study for 12 months. Patients had HbA1c >8% who had been on IPT for at least three years (using the Roche Accu-check model) and had access to a computer. N=16	T4net software (only 3 of 16 did). This software was a telemedicine package which allowed simultaneous viewing of diabetes treatment data by the patient as well as the Diabetes Specialist Centre with an automatic messaging service also attached.	study, 3 and 12 months. PAID scores pre-study, 3 and 12 months. Satisfaction questionnaire-specifically designed for the study to determine the level of satisfaction expressed by the participants in the Axon T4net Software package.	from an average of 9.3 to 8.4% at 3 months and 8.2% at 12 months without the typical plateau in HbA1c often seen at 6 months. No change in either PAID or self-awareness scores. Some patients reported easier pattern recognition, making it easier to adjust basal and bolus infusion with more understanding, insight and control. Main purpose of the software was to better enable patient self-management – claim made was done with less nursing resources although one nurse had to spend 10-15 minutes each day reviewing data transmitted and taking action as needed. Since the pilot study, the software has been expanded to include weekly and monthly charting options as well as a FAQ question area and discussion forum available on-line. Data can be transmitted directly through the Axon website. Authors could not report whether this Telehealth approach could be shown, in future, to be cost effective. Small pilot study with relatively high attrition rate with 4/16 not using the technology at all. One of the primary authors holds stock in Axon UK which manufactures the software. Axon UK funded the study.
Oswald, G., A. Kinch, and E. Ruddy,	Prospective study	Included 70 patients	Intensified conventional therapy (ICT) and IPT.	Following the conversion of 70	IPT did not appear to offer significant glycaemic control advantages over ICT in

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
Transfer to a patient centred, carbohydrate counting and insulin matching programme in a shortened time frame. Practical Diabetes International, 2004. **21**(9): p. 334-338			Methods: 3 step skills-based learning program 1st: 45 minutes training on carbohydrate counting 2nd: One-on-one instruction on insulin dosage to carbohydrate portions and the use of correction boluses for glycaemic excursions. 3rd: Short term follow up program analysing patients' diaries that incorporated food records, blood glucose records, and insulin dosages to ensure appropriate use of insulin dosage and adjustments. Duration: 1st session 45 mins Content: As above Educators: Multidisciplinary team T & L Aids: Bespoke displays, commercially available guides	patients to ICT, 12 of these converted to IPT during some period following ICT. In these 12 patients a significant improvement in HBA1c was seen following ICT (pre-ICT HbA1c 9.6± 1.5%, post-ICT HbA1c 8.3 ± 1.4%, t=2.9, p<0.02), but no further improvement was seen after a further year of IPT (HbA1c 8.4 ± 0.8%, n=9)	this program. The authors recommend that ICT including training program can be used to initiate IPT successfully.
Hunger-Dathe, W., et al., *Insulin pump therapy in patients with Type 1 diabetes mellitus: results of the Nationwide Quality Circle in Germany (ASD) 1999-2000.* Experimental and clinical endocrinology & diabetes: official journal, German Society of Endocrinology [and] German Diabetes	Descriptive study	Included 250 IPT patients with type 1 diabetes mellitus (age 36.0 ± 13.1 years; diabetes duration 16.1 ± 9.9 years) from 21 ASD hospitals in Germany	Treatment and teaching program (TTP) Methods: Structured program, technical instruction. Duration: 7 days Content: Insulin pump, catheter and tape, adjustment of insulin dose, daily living instructions, prevention and management of ketoacidosis and severe hypoglycaemia, blood glucose self-monitoring and documentation. Educators: Not specified T & L Aids: Not specified	One year after participation in TTP, the mean relative HBA_{1c} decreased from 1.51 (0.9-3.2) to 1.44 (0.9-3.6) (p <0.0001), severe hypoglycaemia from 0.46 to 0.12/patients/Year (p <0.001), DKA from 0.08 to 0.05/patients/year (p=0.003) and hospitalisation from 5.2 to	Outcomes (HBA_{1c}, incidents of hypoglycaemia, ketoacidosis, hospitalisation days) improved after participation in a TTP.

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
Association, 2003. **111**(7): p. 428-434				3.1days/patients/year (p=0.002)	
Voevodin, M., et al., *Eating and pumping: evaluating the nutrition service of the insulin pump clinic at the Royal Melbourne Hospital.* NUTRITION AND DIETETICS, 2003. **60**(2): p. 122-124.	Survey (self-administered questionnaire	An eight-part Self-administered questionnaire was sent to 25 adult patients who had attended insulin pump training and 16 responded	Nutrition information session Methods: information and training Duration: 45–60 min nutrition session in a 1½-day program Content: pump management and setting the initial basal rates and premeal boluses Educators: a diabetes educator T & L Aids: written nutritional information on carbohydrate exchanges and glycaemic index and several other learning aids (e.g. 'Facts on fat' 'Sugar update')	Most useful information provided (as rated by four patients) was the information on carbohydrate counting and glycaemic index. Of the 11, eight participants were able to recall a message from the session consistent with the information provided and five participants actively made dietary changes following the session.	Participants provided a positive feedback about the nutrition information session.
Morrison, G., et al., *Using a group education approach to initiate pump therapy.* Journal of Diabetes Nursing, 2003. **7**(5): p. 168-170.	Descriptive Study (questionnaire and interview)	Sample size: not specified Study conducted in the Royal Liverpool University Hospital, UK	IPT education & training Methods: two group sessions and follow up 1st: basic pump programming and operation skills were trained. The participants were allowed to take the pump home that enabled them to more familiar with pump 2nd: participants commenced IPT and the participant programmed in the basal rate, prime the pump and insert the cannula under supervision Follow up: adjusting basal rate and discussed knowledge gaps and problems	All participants were very positive about the group program. Group participation saved approximately 10–27 h professional time compared to individual training.	The group approach for IPT training allows the development of peer support, strengthens the learning process and avoids isolation.

Study	Design	Sample size and setting	Interventions/Education & Training	Outcomes	Author conclusion
			Duration: not specified Contents: in addition to above, discussion about dietary, lifestyle and pump management issues included Educators: not specified T & L Aids: not specified		
Rizvi, A.A., et al., *Beneficial effects of continuous subcutaneous insulin infusion in older patients with long-standing type 1 diabetes.* Endocrine Practice, 2001. **7**(5): p. 364-369.	Observational retrospective	Included five older adults with type 1 diabetes (mean age 66.4 years) who changed to IPT. These patients had suboptimal glycaemic control (HbA1c >80%), microvascular complications , and unacceptably frequent hypoglycaemia	Outpatient intensive insulin pump training Methods: 1st: Group teaching that included both lecture format and interactive sessions. 2nd: Follow-up training program Duration: 1st: 8 hours, 2nd biweekly visits (1 hour) during a period of two to four months. Content: Self-monitoring of plasma glucose by finger-stick analysis, carbohydrate counting for determining premeal insulin boluses, calculation of insulin requirements and practical aspects of insulin pump (e.g. insulin replacement, care of needle insertion sites, and pump malfunction. Educators: Diabetes nurse educator and a registered dietician. T & L Aids: Blackboard, books, printed materials, pictures and models foods and food portions.	Individual and mean HbA1c values showed no significant improvement after intensive training but decreased considerably only after initiation of IPT (HbA1c pre IPT 9.16%, post IPT 7.6% p<0.0025)	Initiation of IPT was the major factor contributing to the observed favourable outcomes.

Study/reference	Opinion/Text and setting	Recommendations	Author conclusions
American Association of Diabetes Educators. *Education for continuous subcutaneous insulin infusion pump users*.	A position statement published by the American Association of Diabetes	Methods: Education & training in either the inpatient or outpatient setting. Duration: Not specified.	Motivated patients with a range of technical skills and self-management capabilities are

Diabetes Educ, 2003. **29**:p. 97-9	Educators	Content: Blood glucose monitoring (e.g. frequency), diet (e.g. carbohydrate counting, nutrition assessment), exercise (e.g. adjustment of food and /or insulin in anticipation of physical activity), technical aspects (e.g. operating procedure), sick day management (e.g. adjusting the insulin infusion), hypoglycaemia management (e.g. blood glucose monitoring), hyperglycaemia management and prevention of DKA (e.g. checking urine ketones), and infection (e.g. changing the infusion site every 48-72 hours). Educators: Not specified. Professional knowledgeable regarding IPT should be accessible 24 hours a day in order to assist the new user of IPT. T & L Aids: Not specified.	required for successful implementation of IPT.
Ref [8] 'From previous report'	A series of follow-up studies involving more than 800 patients in the United States, a paper presents a narrative summary of findings and clinical experience on IPT.	Methods: IPT training Duration: Two 60-90 minute outpatient sessions. Contents: Adjustments of pre-meal bolus doses to accommodate variations in preprandial glucose levels (using correction boluses) and meal size (using carbohydrate counting), prevention of ketoacidosis and hypoglycaemia, algorithms for sports and exercise, care of injection sites, and use of advanced pump features. Educators: Not specified. Patients are encouraged to call their healthcare professional if they have a problem. T & L Aids: Not specified.	Patient education, careful adjustment of basal/bolus doses and close follow-up (including education) are crucial to the success of IPT.
Ref [17] 'From previous report'	This paper is largely based on expert opinion and is set in the United states, with some reference to relevant literature.	Methods: Initial training and follow-up. Initial education: Diabetes nurse should meet with the patients and family and should provide initial education and education at the beginning of the therapy. Participants are encouraged to write down all their questions and bring these into educational sessions. Practical training: A demonstration of loading and programming the pump and inserting the infusion set using a trainer pump. Troubleshooting and sick-day rules specific to IPT should be introduced. Duration: Not specified Content: As above Educators: Not specified. Patient should be able to contact the diabetes nurse with any questions during treatment initially.	It is important that the IPT education should be tailored to the developmental stage of the IPT patient.

Commented [AF1]: Refs listed in table of 2011 report do not match to the reference list. I have done my best to match the correct reference to the information but some don't have enough info so I have referred back to the 2011 report. Suggestions on how to manage this would be welcome.

		T & L Aids: Literature and videos	
Ref [18] 'From previous report'	Expert opinion from a diabetes specialist nurse who has extensive experience in a community clinic in The Netherlands.	Methods: Individual or group setting Duration: In the first week, patients attended daily half an hour educational sessions. After that they attended education sessions weekly or monthly. Content: Introduction to diabetes, treatment and medication including types of insulin and insulin pump management (e.g. adjusting insulin, complications). Educators: Multidisciplinary team (doctors, dieticians and nurses). T & L Aids: Not specified	Patients should not have been access to IPT until they have been well educated about IPT as patients should be able to take responsibility for their decisions concerning their illness.
Ref [9] 'From previous report'	Expert opinion and the relevant literature focused on the technical problems associated with IPT. The authors are situated in Brittany, France, and have had clinical experience with patients utilising pumps in this region.	Methods: Technical education on pump Duration: Not specified Content: Technical failure of IPT and solutions, blood glucose monitoring, prevention of cutaneous complications (e.g. body hygiene, hand washing before insertion of needles, sterile covering of the needle), management of hypoglycaemia due to programming error (e.g. checking basal infusion rates and bolus doses previously), and prevention of DKA (e.g. checking urine ketones). Educators: Not specified. Professional 24-hour on call service and frequent outpatients visits. T & L Aids: Not specified	Technical risk of IPT should not be underestimated.
Phillip M, Battelino T, Rodriguez H, Danne T, Kaufman F. *Use of insulin pump therapy in the pediatric age-group: consensus statement from the European Society for the paediatric Endocrinology, the Lawson Wilkins Pediatric Endocrine Society, and the International Society for Pediatric and Adolescent Diabetes, endorsed by the American Diabetes Association and the European Association for the study of Diabetes*. Diabetes Care. 2007. **30**: 1653-62	A consensus statement from the European Society for pediatric Endocrinology, the Lawson Wilkins Pediatric Endocrine Society, and the International Society for Pediatric and Adolescent Diabetes, which has been endorsed by the American Diabetes Association and the European Association for the Study of Diabetes	Methods: Initial and ongoing education Duration: Not specified Content: Prevention of DKA, pump functions and problem-solving strategies, infusion set insertion, nutrition therapy (carbohydrate counting/estimation), basal-bolus therapy principles, insulin kinetics, hypoglycaemia/ hyperglycaemia management, activity and exercise and its effect on blood glucose, and sick day management. Educators: Not specified T & L Aids: Not specified	Proper education, frequent blood glucose monitoring, attention to diet and exercise and the communicating with diabetes team are vital for minimising IPT risk.

Appendix 4 – Excluded articles including reason for exclusion

Author	Title	Year	Exclusion Reason
Akhter, K.; Zeffertt, A.; Evans, M. et al.	Development and evaluation of a pilot one-stop workshop for young adult people with type 1 diabetes	2012	Conference abstract
Adolfsson, P.; Huot, C.; Veijola, R. et al.	Safety and patient perception of an insulin pen with simple memory function for children and adolescents with type 1 diabetes - The REMINDTM study	2011	Not Insulin pump therapy
Albrecht, D.; Puder, J.; Keller, U.; Zulewski, H.	Potential of education-based insulin therapy for achievement of good metabolic control: a real-life experience	2011	No Education or training in IPT use
Allen, J.; Hovorka, R.; Elleri, D.et al.	Closed loop therapy overnight at home study: Psychosocial impact on adolescents with Type 1 diabetes	2014	Conference abstract
American Diabetes, Association	Diabetes management at camps for children with diabetes	2012	No Education or training in IPT use
Araszkiewicz, A.; Zozulinska-Ziolkiewicz, D.; Pilacinski, S. et al.	Baseline diabetic knowledge after 5-day teaching program is an independent predictor of subclinical macroangiopathy in patients with type 1 diabetes (Poznan Prospective Study)	2014	Not Insulin pump therapy
Balfe, M.; Brugha, R.; Smith, D. et al.	Considering quality of care for young adults with diabetes in Ireland	2013	Not Insulin pump therapy
Beck, J. K.; Sternlof, S. A.; Muhamedagic, C. A. et al.	Development of a young adult type 1 diabetes knowledge assessment tool	2013	Conference abstract
Beckwith, A.	Does the pump dose adjustment for normal eating (Pump DAFNE) programme improve glycaemic outcomes in patients with Type 1 diabetes already established on insulin pump therapy?	2013	Conference abstract
Bergenstal,R. M.; Bode,B. W.; Tamler,R. et al.	Advanced meter features improve postprandial and paired self-monitoring of blood glucose in individuals with diabetes: Results of the actions with the CONTOUR blood glucose meter and behaviors in frequent testers (ACT) study.	2012	Combined Type 1 and Type 2
Beverly, E. A.; Ritholz, M. D.; Bishop, J. et al.	Explaining patients' responses to diabetes education: A qualitative study	2013	Conference abstract
Binek, A.; Rembierz-Knoll, A.; Polanska, J. et al.	The reasons for pump discontinuation in children with diabetes type 1 (T1DM)	2013	Conference abstract
Bodet, A.; Choleau, C.; Coutant, R. et al.	Functional intensified insulin therapy in paediatrics practice: Current situation in France through the AJD's summer camps	2013	Conference abstract
Cafazzo, J A.; Casselman, M; Hamming, N et al.	Design of an mHealth app for the self-management of adolescent type 1 diabetes: A pilot study	2012	Children (Aged <16 years)
Author	**Title**	**Year**	**Exclusion Reason**
Clark, L. F.; Bilbie, J. C.; Abraham, P.	What do patients prefer: insulin pumps or multiple daily injections and structured education? A retrospective audit and patient questionnaire	2011	No Education or training in IPT use

Brorsson, A. L.; Leksell, J.; Viklund, G. et al.	A multicentre randomized controlled trial of an empowerment-inspired intervention for adolescents starting continuous subcutaneous insulin infusion--a study protocol	2013	Study protocol (No data);
Cooke, D. D.; Elliott, J.; Heller, S. R.; Lawton, J.; Uk Nihr Dafne Study Group	Supporting self-management after attending a structured education programme: a qualitative longitudinal investigation of type 1 diabetes patients' experiences and views	2012	Not Insulin pump therapy
Coria, Joseph M.; Harvey, Thomas	A comparative analysis of the effectiveness of diabetes health education on the adult Latino diabetic male	2011	Combined Type 1 and Type 2
Cohen, N.; Hong, E. S.; Van Drie, C. et al.	Long-term metabolic effects of continuous subcutaneous insulin infusion therapy in type 1 diabetes	2013	No Education or training in IPT use
D'Agostino, M N.; Burgess, Stephanie	Continuous subcutaneous insulin infusion in comparison to subcutaneous insulin injections in the preschooler with type 1 diabetes mellitus	2012	Conference abstract
Da Porto, A.; Tommasi, E.; Cum, S.; et al.	Effects of multidisciplinary and structured education programme on glycaemic control during transition of young adults with type 1 diabetes	2014	Conference abstract
Danne, T.; Tsioli, C.; Kordonouri, O.; et al.	The PILGRIM study: In silico modeling of a predictive low glucose management system and feasibility in youth with type 1 diabetes during exercise	2014	No Education or training in IPT use
Danne, T.; Kordonouri, O.; Holder, M.; et al.	Prevention of hypoglycemia by using low glucose suspend function in sensor-augmented pump therapy	2011	Children (Aged <16)
Daskalaki, E.; Diem, P.; Mougiakakou, S.	Development of an actor-critic-based control algorithm for insulin infusion in individuals with type 1 diabetes	2012	Conference abstract
de Vries, L.; Grushka, Y.; Lebenthal, Y.; e al.	Factors associated with increased risk of insulin pump discontinuation in pediatric patients with type 1 diabetes	2011	No Education or training in IPT use
Degenaars, J. L.	Are we using current up-to-date evidence in the delivery and documentation of sick day management education to children and adolescents with type 1 diabetes?	2013	Conference abstract
Daskalaki, E.; Diem, P.; Mougiakakou, S.	Personalized insulin infusion in type 1 diabetes based on reinforcement learning	2014	Conference abstract
Driscoll, K. A.; Gill, E.; Mitchell, A.; et al.	Insulin pumps: What do adolescents and their caregivers know?	2013	Conference abstract
Driscoll, K. A.; Johnson, S. B.; Cuevas, J.; et al.	Intervention needed to optimize insulin pump use	2012	Conference abstract
Dunk, Joanna A.; Colleran-Santos, Cathleen	Diabetes Education Tailored Towards English Speaking Caribbean Immigrants	2015	Not Insulin pump therapy
Drury, J.	Education before medication	2012	Not Insulin pump therapy
Emara, I.	Application and evaluation of Arabic diabetes educational program on diabetic patients and their families	2012	Conference abstract
Eyal, O.; Oren, A.; Weintroub, N.	Achieving the management goals of type 1 diabetes in children and adolescents: Is it feasible?	2013	No Education or training in IPT use

Foulds, L. R.; Boucher, A.; Hamilton, K.; et al.	Reversion to injected insulin from CSII and the "pump probation" process at the Royal Children's Hospital (RCH) Melbourne, Australia	2011	Conference abstract
Farsaei, S.; Radfar, M.; Heydari, Z.; et al.	Insulin adherence in patients with diabetes: risk factors for injection omission	2014	Not Insulin pump therapy
Freeby, M.; Golden, L.; Gandica, R.; et al.	CGMS Improves glucose control in a heterogenous outpatient Population with T1D	2014	Conference abstract
Gagliardino, J. J.; Aschner, P.; Chan, J.; et al.	Education of adults with type-1 diabetes in latin america and the middle east: Results from the international diabetes management practices survey (IDMPS)	2012	Conference abstract
Gajewska, K. A.; Pankowska, E.	Adherence to the Warsaw School of Pump Therapy and using of different types of boluses for meals in children and adolescent with type 1 diabetes	2012	Conference abstract
Gallagher, P.; McDarby, V.; McDowell, N.; et al.	Parental diabetes knowledge: Does CSII education provide superior knowledge?	2011	Conference abstract
Gallo, F.; La Torre, F.; Moramarco, F.	Insulin pump at the onset of type 1 diabetes: An expensive toy or a wise choice?	2014	Conference abstract
Galli-Tsinopoulou, A.	Insulin therapy in children and adolescents with diabetes	2011	No Education or training in IPT use
Gallagher, P.; McDarby, V.; McDowell, N.; et al.	Audit of parental diabetes knowledge	2011	Conference abstract
Gimenez, M.; Vidal, M.; Jansa, M.; et al.	Midterm impact of a specially designed therapeutic education programme in patients transferred from a paediatric to an adult diabetes unit	2013	Conference abstract
Gianini, A.	How to safely and effectively train patients to USE CGM and stay on the device	2014	Conference abstract
Gkastaris, K.; Wylie, S.; Hillier, N.; et al.	Freedom for Life: 13 years of experience from an accredited patients' education course for Type 1 diabetes: A review of the long-term outcomes	2015	Conference abstract
Gomez-Huelgas, R.; Lopez-Carmona, M. D.; Jansen-Chaparro, S.; et al.	Assessment of an educational intervention in the management of non-critical inpatient glycemic control	2014	Combined Type 1 and Type 2
Grey, M; Jaser, S S.; Whittemore, R; et al.	Coping Skills Training for Parents of Children With Type I Diabetes: 12-Month Outcomes	2011	Children (Aged <16)
Hanas, R.; de Beaufort, C.; Hoey, H.; Anderson, B.	Insulin delivery by injection in children and adolescents with diabetes	2011	No Education or training in IPT use
Halbron, M.; Sachon, C.; Simon, D.; et al.	Evaluation of a 5-day education programme in type 1 diabetes: achieving individual targets with a patient-centred approach	2014	No Education or training in IPT use
Hawkins, Josiah Z. s; Wing, Deborah	Abnormal Glucose Metabolism: Diagnosis and Management in the Ambulatory Setting	2012	Not Insulin pump therapy
Hayakawa, T.; Watanabe, M.; Nakayama, H.; et al.	Comparison of once-daily with twice-daily administration of long-acting insulin analogue, detemir, in basal-bolus insulin therapy in Japanese patients with diabetes	2011	Not Insulin pump therapy

Harris, M. A.; Hood, K. K.; Mulvaney, S. A.	Pumpers, skypers, surfers and texters: Technology to improve the management of diabetes in teenagers	2012	No Education or training in IPT use
Hendrychova, T.; Vytrisalova, M.; Smahelova, A.; et al.	Correlates of self-care adherence of adults with type 1 diabetes mellitus	2013	Conference abstract
Hermanns, N.; Kulzer, B.; Ehrmann, D.; et al.	The effect of a diabetes education programme (PRIMAS) for people with type 1 diabetes: Results of a randomized trial	2013	No Education or training in IPT use
Hood, Donna G.	THE NATURE AND MEANING OF INSULIN PUMP USE IN EMERGING ADULTS WITH TYPE 1 DIABETES	2012	No Education or training in IPT use
Houlden, R. L.; Moore, S.	In-hospital management of adults using insulin pump therapy	2014	Not Insulin pump therapy
Hopkins, D.; Lawrence, I.; Mansell, P.; et al.	Improved biomedical and psychological outcomes 1 year after structured education in flexible insulin therapy for people with type 1 diabetes: the U.K. DAFNE experience	2012	Not Insulin pump therapy
Ilanne-Parikka, P.	Treatment of adult persons with type 1 diabetes in Finland	2012	Conference abstract
Jaacks, L. M.; Bell, R. A.; Dabelea, D.; et al.	Diabetes self-management education patterns in a US population-based cohort of youth with type 1 diabetes	2014	No Education or training in IPT use
Jaser, S. S.; Patel, N.; Rothman, R. L.; et al.	Check it! A randomized pilot of a positive psychology intervention to improve adherence in adolescents with type 1 diabetes	2014	Not Insulin pump therapy
Iafusco, D.; Galderisi, A.; Nocerino, I.; et al.	Chat line for adolescents with type 1 diabetes: a useful tool to improve coping with diabetes: a 2-year follow-up study	2011	Children (Aged <16)
Jenkins, A. J.; Krishnamurthy, B.; Best, J. D.; et al.	An algorithm guiding patient responses to real-time-continuous glucose monitoring improves quality of life	2011	No Education or training in IPT use
Joubert, M.; Guillaume, A.; Reznik, Y.	A new web site hosting serious games to promote education for flexible insulin therapy, insulin pump and continuous glucose monitoring	2012	Conference abstract
Jonsson, L.; Hallstrom, I.; Lundqvist, A.	"The Logic of Care" - Parents' perceptions of the educational process when a child is newly diagnosed with type 1 diabetes	2012	Not Insulin pump therapy
Katz, M L.; Mehta, S; Nansel, T; et al.	Associations of nutrient intake with glycemic control in youth with type 1 diabetes: differences by insulin regimen	2014	Not Insulin pump therapy
Joubert, M.; Morera, J.; Vicente, A.; et al.	Cross-sectional survey and retrospective analysis of a large cohort of adults with type 1 diabetes with long-term continuous subcutaneous insulin infusion treatment	2014	No Education or training in IPT use
Keen, A. J.; Duncan, E.; McKillop-Smith, A.; et al.	Dose Adjustment for Normal Eating (DAFNE) in routine clinical practice: who benefits?	2012	Not Insulin pump therapy
Kilmartin, G. M.; Wilkinson, J.; Kilmartin, J. F.; et al.	Improved therapeutic outcomes in an Australian rural diabetes centre undertaking CSII	2013	Conference abstract
Kettle, S. M.; Grass, M. V.; Hubbard, S. M.; et al.	Effect of an intensive, interdisciplinary program for adolescents with type I diabetes to improve their metabolic control	2012	Conference abstract

Konrad, K.; Bartus, B.; Fink, K.; et al.	Current practice of diabetes education in children and adolescents with type 1 diabetes in Germany and Austria: An analysis based on the German/Austrian DPV database	2013	Children (Aged <16)
Konradsdottir, E; Svavarsdottir, E K	How effective is a short-term educational and support intervention for families of an adolescent with type 1 diabetes?	2011	Not Insulin pump therapy
Kordonouri,O; Hartmann,R; Danne,T	Treatment of type 1 diabetes in children and adolescents using modern insulin pumps	2011	No Education or training in IPT use
Klupa, T.; Matejko, B.; Kiec-Wilk, B.; Malecki, M. T.	Factors affecting glycaemic control in adult type 1 diabetic patients treated with personal insulin pumps	2013	Conference abstract
Kosteria, I.; Koui, E.; Arditi, J. D.; et al.	Does glycemic control really improves under insulin pump versus multiple daily injections in type 1 diabetes in all pediatric ages?	2012	Conference abstract
Laffel, L.; Cali, A.; Dain, M. P.; et al.	International evaluation of diabetes management, glycaemic control and quality of life in youth with type 1 diabetes: The teens study	2013	Conference abstract
Lawton, J.; Rankin, D.; Cooke, D.; et al.	Patients' experiences of adjusting insulin doses when implementing flexible intensive insulin therapy: A longitudinal, qualitative investigation	2012	Not Insulin pump therapy
Lessan, N.; Hassan, S.; Taimah, M.; et al.	An audit of insulin pump therapy in two large diabetes centres in the United Arab Emirates (UAE)	2015	Conference abstract
Lichtenberger-Geslin, L.; Braun, K.; Boudailliez, B.; et al.	Does insulin pump therapy improve quality of life and satisfaction in children and adolescents with type 1 diabetes?	2012	Not English
Little, S. A.; Leelarathna, L.; Walkinshaw, E.; et al.	A definitive multicenter rct to restore hypoglycemia awareness and prevent recurrent severe hypoglycemia in adults with long- standing type 1 diabetes: Results from the hypocompass trial	2013	Conference abstract
Manu, C K.; Danawi, H	Developing an Education Program to Increase Diabetes Knowledge and Awareness in Eastern Ghana	2013	Not Insulin pump therapy
Matyka, K.	Continuous glucose monitoring in children and adolescents with type 1 diabetes mellitus: A literature review	2012	Conference abstract
MacLean, C. D.; Littenberg, B.	Change in Health Literacy Over 2 Years in Older Adults With Diabetes	2013	Not Insulin pump therapy
Mauseth, R. S.; Matheson, D. P.; Kircher, R. C.	Progress on a method of insulin pump control using fuzzy logic	2011	Conference abstract
Mokashi, A. S.; Otley, A. R.; Kharrazi, H.	Can a computer game improve adherence to treatment in children with type 1 diabetes?	2011	Conference abstract
Moreau, F.; Spizzo, H.; Bursztejn, C.; et al. et al.	Factitious self-manipulation of the external insulin pump in adolescents with Type 1 diabetes	2011	No Education or training in IPT use
Morello, C. M.; Chynoweth, M.; Kim, H.; et al.	Strategies to improve medication adherence reported by diabetes patients and caregivers: Results of a taking control of your diabetes survey	2011	Combined Type 1 and Type 2
Neu, A.; Beyer, P.; Burger-Busing, J.; et al.	Diagnosis, therapy and control of diabetes mellitus in children and adolescents	2014	No Education or training in IPT use

Munoz, C. E.; Fisher, L. K.	Teen power: Group intervention for poorly adherent teens with insulin-treated diabetes mellitus and their families	2014	Conference abstract
Nixon, R.; Folwell, R.; Pickup, J. C.	Variations in the quality and sustainability of long-term glycaemic control with continuous subcutaneous insulin infusion	2014	No Education or training in IPT use
Nguyen, H. T.; Kirk, J. K.; Arcury, T. A.; et al.	Cognitive function is a risk for health literacy in older adults with diabetes	2013	Not Insulin pump therapy
O'Hara, M.; Byrne, M.; Lawton, J.; et al.	A cross country qualitative investigation of structured education programmes for adults with type 1 diabetes	2013	Conference abstract
Nordfeldt, S.; Angarne-Lindberg, T.; Nordwall, M.; et al.	As Facts and Chats Go Online, What Is Important for Adolescents with Type 1 Diabetes?	2013	Not Insulin pump therapy
O'Connell, M. A.; Donath, S.; Cameron, F. J.	Poor adherence to integral daily tasks limits the efficacy of CSII in youth	2011	No Education or training in IPT use
Olsen, B. S.; Svensson, J.; Johannesen, J.; et al.	Predictors for better metabolic outcome in children treated with CSII	2012	Conference abstract
Olinder, A. L.; Nyhlin, K. T.; Smide, B.	Clarifying responsibility for self-management of diabetes in adolescents using insulin pumps--a qualitative study	2011	No Education or training in IPT use
Ozbay, Ahmet Burak; Larrat, Paul	Evaluation of the effect of medication adherence and utilization of insulin pumps on rates of hypoglycemia and resulting costs	2011	Combined Type 1 and Type 2
Olson, Nancy Lynn; Kumrow, David E.	Bridging the abyss: Seamless transition of care from adolescent to adult in the Type 1 diabetic	2011	Not Insulin pump therapy
Palladino, D. K.; Helgeson, V. S.	Adolescents, Parents and Physicians: A Comparison of Perspectives on Type 1 Diabetes Self-Care	2013	Not Insulin pump therapy
Petrovski, G.; Milenkovic, T.; Petrovska, I.; et al.	Social media and diabetes: Can we improve glucose control in adolescents on pump therapy? One year experience	2012	Conference abstract
Peters, J. E.; Mount, E.; Huggins, et al.	Insulin pump therapy in children and adolescents: changes in dietary habits, composition and quality of life	2013	No Education or training in IPT use
Petrovski, G.; Dimitrovski, C.; Bitovska, I.; et al.	Internet visits using carelink, skype and facebook can improve diabetes control in adolescents on pump therapy	2011	Conference abstract
Petrovski, G.; Milenkovic, T.; Subeska, S.; et al.	Social media and diabetes: A tool to improve glucose control in type 1 diabetic adolescents on insulin pump: Cross-over study	2014	Conference abstract
Petrovski, G.; Milenkovic, T.; Jovanovska, B.; et al.	Can we improve glucose control in type 1 diabetics on insulin pump using social media and diabetes? One year experience	2013	Conference abstract
Agema,P.; Sherifali,D.	Determining the impact of an intervention to increase problem-solving skills in diabetes self-management: The diabetes problem-solving passport pilot study.	2012	Conference abstract
Peyrot, M.; Runion, A.; Kraus, A.; et al.	A cross-sectional survey of patient-reported factors associated with initiation and persistence of pramlintide use among adults with type 1 diabetes (T1DM)	2015	Conference abstract

Pyatak, E.; Sequeira, P. A.; Wood, J. R.; et al.	Designing a peer mentoring program to improve adherence in adolescents and young adults with type 1 diabetes (T1D): Focus group findings	2013	Conference abstract
Punniyakodi, S.; Sundaram, P. C. B.; Greening, J. E.; Tziaferi, V.	Adherence to blood glucose monitoring in children and young people with type 1 diabetes on insulin pump therapy in a teaching hospital	2015	Conference abstract
Rajendran, R.; Manikandan, R. M.; Kar, P.; Cranston, I.	Initiating continuous subcutaneous insulin infusion (CSII) therapy in an adolescent patient with repeated diabetic ketoacidosis (DKA) admissions: High risks for high potential benefit, designing an effective and safe intervention trial	2013	Conference abstract
Ramachandran, A.; Gagliardino, J. J.; Aschner, P.; et al.	Insulin regimen in adults with type-1 diabetes in the middle east: Results from the International Diabetes Management Practices Survey (IDMPS)	2012	Conference abstract
Ramachandran, A.; Gagliardino, J. J.; Aschner, P.; et al.	Characteristics of adults with type 1 diabetes in the middle east: Results from the international diabetes management practices survey (IDMPS)	2012	Conference abstract
Rami-Merhar, B.; Maahs, D.; Warner, J.; et al.	Pump use is less frequent in minority youth: Transatlantic analysis in three large registries representing Austria, Germany, England, Wales and the United States	2014	Conference abstract
Rankin, D.; Cooke, D. D.; Clark, M.; et al.	How and why do patients with Type 1 diabetes sustain their use of flexible intensive insulin therapy? A qualitative longitudinal investigation of patients' self-management practices following attendance at a Dose Adjustment for Normal Eating (DAFNE) course	2011	No Education or training in IPT use
Rankin, D.; Harden, J.; Noyes, K.; et al.	Parents' experiences of managing their child's diabetes using an insulin pump: A qualitative study	2015	No Education or training in IPT use
Rasbach, Lisa Ellen; Jenkins, Carolyn H.	Exploring Self-Efficacy in the Current Era of Type 1 Diabetes Management in Youth	2014	No Education or training in IPT use
Rasmussen, B.; Ward, G.; Jenkins, A.; et al.	Young adults' management of Type 1 diabetes during life transitions	2011	No Education or training in IPT use
Realsen, J.; Goettle, H.; Chase, H. P.	Morbidity and mortality of diabetic ketoacidosis with and without insulin pump care	2012	Conference abstract
Rausch, J. R.; Hood, K. K.; Delamater, A.; et al.	Changes in treatment adherence and glycemic control during the transition to adolescence in type 1 diabetes	2012	Children (Aged <16)
Reid, H.; Potts, L.; Agostini, K.; et al	Group education in adolescent diabetes transition	2013	Conference abstract
Richardson, C.; Lawson, M.; Rashotte, J.; et al.	Seeking harmony: Parents' and adolescents' experience living with sensor-augmented pump therapy	2011	Conference abstract
Rios, P.; Casado, N.; Matas, O.; et al.	Transition of continuous subcutaneous insulin infusion systems in a very short time frame as a consequence of a public tender process	2015	Conference abstract
Riveline, J. P.; Schaepelynck, P.; Chaillous, L.; et al.	Assessment of patient-led or physician-driven continuous glucose monitoring in patients with poorly controlled type 1 diabetes using basal-bolus insulin regimens: A 1-year multicenter study	2012	No Education or training in IPT use

Roman, R.; Ruiz, S.	The impact of a specialized health team with protected time for patient education on diabetes management and metabolic control in children with type 1 diabetes (T1D)	2012	Conference abstract
Saboo, B.	Change in quality of life by multiple education program in type 1 diabetic patients	2011	Conference abstract
Savarimuthu, S. M.; Jay, M.	Can a cognitive therapy group intervention improve glycemia in patients with poorly controlled diabetes?	2012	Not Insulin pump therapy
Scaramuzza, A. E.; Bosetti, A.; Ferrari, M.; et al.	Dietary habits in children and adolescents with type 1 diabetes using continuous subcutaneous insulin infusion vs. Multiple daily injections: A descriptive transverse observational study	2013	Conference abstract
Scaramuzza, A. E.; Iafusco, D.; Rabbone, I.; et al.	Use of integrated real-time continuous glucose monitoring/insulin pump system in children and adolescents with type 1 diabetes: a 3-year follow-up study	2011	No Education or training in IPT use
Sequeira, P. A.; Montoya, L.; Ruelas, V.; et al.	Continuous glucose monitoring pilot in low-income type 1 diabetes patients	2013	No Education or training in IPT use
Serra-Caetano, J.; Ferreira, S.; Lourenco, H.; et al.	Improvement in type 1 diabetes mellitus metabolic control: From conventional to functional insulin therapy	2014	Conference abstract
Shah, V. N.; Riddlesworth, T. D.; Maahs, D. M.; et al.	Does glucose control differ with insulin pump infusion set wear time in adults with type 1 diabetes?	2015	Conference abstract
Sims, L. M.; Haines, S. L.	Challenges of a pharmacist-directed peer support program among adolescents with diabetes	2011	Not Insulin pump therapy
Smith, M.; Roode, A.	A Descriptive Review Article for Pump Initiation in a Pediatric Diabetes Centre	2013	Children (Aged <16)
Smith, M.; Roode, A.	Group insulin pump starts in a pediatric diabetes program	2013	Children (Aged <16)
Snyder, Cynthia K.	Strategies to Improve Insulin Adherence in Adolescents With Type 1 Diabetes	2015	No Education or training in IPT use
Stanger, C.; Ryan, S. R.; Delhey, L. M.; et al.	A multicomponent motivational intervention to improve adherence among adolescents with poorly controlled type 1 diabetes: a pilot study	2013	No Education or training in IPT use
Stringer, E.; Kannan, S.; Greenhalgh, S.	Ambulatory management of children with newly diagnosed type 1 diabetes	2012	Conference abstract
Suh, S.; Jean, C.; Koo, M.; et al.	A Randomized controlled trial of an internet-based mentoring program for type 1 diabetes patients with inadequate glycemic control	2014	Not Insulin pump therapy
Tanenberg, R. J.; Welsh, J. B.	Patient behaviors associated with optimum glycemic outcomes with sensor-augmented pump therapy: Insights from the star 3 study	2015	No Education or training in IPT use
Tang, T. S.; Funnell, M.; Sinco, B.; et al.	Comparative effectiveness of peer leaders and community health workers in diabetes selfmanagement support: Results of a randomized controlled trial	2014	Not Insulin pump therapy
Tate, H.; Pillai, A.; Thomson, G.; et al.	Responders to insulin therapy at 18 months among adults with newly diagnosed Type 1 diabetes: Which insulin regimen should we start?	2012	Conference abstract
Thongsai, S.; Youjaiyen, M.	The long-term impact of education on diabetes for older people: a systematic review	2013	Type 2 diabetes
Toscos, T; Connelly, K R Y	Digital vigilance: Pervasive technology for children with Type 1 diabetes	2011	No Education or training in IPT use

Trief, P. M.; Izquierdo, R.; Eimicke, J. P.; et al.	Adherence to diabetes self care for white, African-American and Hispanic American telemedicine participants: 5 year results from the IDEATel project	2013	No Education or training in IPT use
Unger, J.	Educating patients about hypoglycemia prevention and self-management	2013	No Education or training in IPT use
Van Walleghem, N.; Hoilett, T.; Marks, S.	An evaluation of the manitoba pediatric insulin pump program	2014	Conference abstract
Wheeler, B. J.; Donaghue, K. C.; Heels, K.; Ambler, G. R.	Family perceptions of insulin pump adverse events in children and adolescents	2014	Conference abstract
Wheeler, B J.; Heels, K; Donaghue, K C.; et al.	Insulin pump-associated adverse events in children and adolescents-a prospective study	2014	No Education or training in IPT use
Whipple, K; Greene, G W; Hatfield D	Attendance at type 1 diabetes camp improves nutrition knowledge in children and adolescents	2015	Not Insulin pump therapy
White, D.; Waugh, N.; Elliott, J.; et al.	The Relative Effectiveness of Pumps Over MDI and Structured Education (REPOSE): study protocol for a cluster randomised controlled trial	2014	Study protocol (No data)
Wiley, J.; Westbrook, M.; Long, J.; e al.	Diabetes Education: the Experiences of Young Adults with Type 1 Diabetes	2014	Not Insulin pump therapy
Williams, Lesa; Anderson, Stoerm	Diabetes Self-Management Education Program	2015	Not Insulin pump therapy
Winocour, P. H.	Care of adolescents and young adults with diabetes - Much more than transitional care: A personal view	2014	No Education or training in IPT use
Woolfield, N. F.; Tasker, J. E.	Care plans: Part of improving ability to self care	2011	Conference abstract
Wong, J. C.; Dolan, L. M.; Hood, K. K.	Depressive symptoms are associated with mode of insulin delivery and glycemic control in adolescents with type 1 diabetes (T1D)	2014	Conference abstract
Yan, J.; Deng, H.; Yang, D.; et al.	Factors associated with glycemic control in adults with type 1 diabetes used insulin pump	2014	Conference abstract
Yeoh, E.; Choudhary, P.; Nwokolo, M.; et al.	Interventions That Restore Awareness of Hypoglycemia in Adults With Type 1 Diabetes: A Systematic Review and Meta-analysis	2015	No Education or training in IPT use
Yang, W.	Biphasic insulin aspart 30 in insulin initiation	2011	Not Insulin pump therapy
Zayyad, O A.; Perez-Escamilla, R; Dubrow R	Assessing Diabetes Integrated Patient Education and Glucose Control and Differential Diabetes Treatment Response by Gender in Jordan	2013	Not Insulin pump therapy
Zhang, Y.; Ai, H.; Lv, J.; et al.	Insulin regimes and impact on glycemic control in type 1 diabetes in the Guangdong province	2014	Conference abstract