# IT-supported integrated care pathways for diabetes: A compilation and review of good practices

Hubertus JM Vrijhoef[1,2,3], Antonio Giulio de Belvis[4],
Matias de la Calle[5], Maria Stella de Sabata[6], Bastian Hauck[7],
Sabrina Montante[4], Annette Moritz[8], Dario Pelizzola[5],
Markku Saraheimo[9] and Nick A Guldemond[10]

## Abstract

**Introduction:** Integrated Care Pathways (ICPs) are a method for the mutual decision-making and organization of care for a well-defined group of patients during a well-defined period. The aim of a care pathway is to enhance the quality of care by improving patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources. To describe this concept, different names are used, e.g. care pathways and integrated care pathways. Modern information technologies (IT) can support ICPs by enabling patient empowerment, better management, and the monitoring of care provided by multidisciplinary teams. This study analyses ICPs across Europe, identifying commonalities and success factors to establish good practices for IT-supported ICPs in diabetes care.

**Methods:** A mixed-method approach was applied, combining desk research on 24 projects from the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA) with follow-up interviews of project participants, and a non-systematic literature review. We applied a Delphi technique to select process and outcome indicators, derived from different literature sources which were compiled and applied for the identification of successful good practices.

**Results:** Desk research identified sixteen projects featuring IT-supported ICPs, mostly derived from the EIP on AHA, as good practices based on our criteria. Follow-up interviews were then conducted with representatives from 9 of the 16 projects to gather information not publicly available and understand how these projects were meeting the identified criteria. In parallel, the non-systematic literature review of 434 PubMed search results revealed a total of eight relevant projects. On the basis of the selected EIP on AHA project data and non-systematic literature review, no commonalities with regard to defined process or outcome indicators could be identified through our approach. Conversely, the research produced a heterogeneous picture in all aspects of the projects' indicators. Data from desk research and follow-up interviews partly lacked information on outcome and performance, which limited the comparison between practices.

**Conclusion:** Applying a comprehensive set of indicators in a multi-method approach to assess the projects included in this research study did not reveal any obvious commonalities which might serve as a blueprint for future IT-supported ICP projects. Instead, an unexpected high degree of heterogeneity was observed, that may reflect diverse local implementation requirements e.g. specificities of the local healthcare system, local regulations, or preexisting structures used for the project setup. Improving the definition of and reporting on project outcomes could help advance research on and implementation of effective integrated care solutions for chronic disease management across Europe.

[1]Department of Patient & Care, Maastricht University Medical Center, The Netherlands
[2]Vrije Universiteit Brussels, Belgium
[3]Panaxea b.v., Amsterdam, The Netherlands
[4]Fondazione Policlinico A. Gemelli - Università Cattolica S. Cuore, Italy
[5]Az. USL Ferrara (Local Health Authority), Italy
[6]International Diabetes Federation European Region
[7]dedoc° Diabetes Online Community
[8]Roche Diabetes Care Deutschland
[9]University of Helsinki, Finland
[10]Institute of Health Policy & Management, Department of Health Services Management & Organisation, Erasmus University Rotterdam, The Netherlands

**Corresponding author:**
Hubertus JM Vrijhoef, Department of Patient & Care, Maastricht UMC, The Netherlands.
Email: b.vrijhoef@mumc.nl

## Introduction

Diabetes represents a growing challenge for health care systems everywhere. Its prevalence has been growing continuously over the last decades,[1] with the financial and human burden on healthcare systems increasing as a result. In addition, diabetes is linked to a high risk of comorbidities including depression and cardiovascular diseases, resulting in complications such as retinopathy, nephropathy, neuropathy, stroke, dementia, or lower extremity amputations.[2] The need to treat such long-term chronic conditions, which often require multiple complex interventions, only adds to the pressure on health systems already dealing with the impact of an aging population.[3]

Finding sustainable solutions to curb the morbidity, mortality, and disability associated with major chronic diseases has become an urgent priority for health practitioners and policymakers.[4] Moreover, there is a need for a paradigm shift in how health services are funded, managed, and delivered.[3] In Europe, such services are being restructured to meet changing care needs, via the development and implementation of new, more innovative approaches.[5]

Of these, integrated care (IC) has emerged as one of the most promising strategies, with many countries prioritizing it as a means to support the improvement of health outcomes for people at risk of or living with chronic illnesses.[4,6] More specifically, integrated care pathways (ICPs) are personalized, structured multidisciplinary care plans, which outline essential steps for the care of patients with specific clinical and/or social problems.[7] They also support the transposition of national guidelines into local protocols and daily care practice. ICPs differ from practice guidelines in that they are used by a multidisciplinary team, and focus on improving the quality and coordination of care.[8]

From a patient's perspective, integrated care aims to meet both their health and social needs, taking these as the starting point for redesigning their care. Better coordination and continuity of care not only make for an easier patient journey through treatment; they also contribute to improved outcomes.[9,10] To this end, integrated care can drive greater efficiency and value within health care delivery systems, benefiting patients, healthcare providers, and care systems alike.[9,10]

Multidisciplinary care delivery is to a large extent an information-driven process. Technology for collecting and exchanging information is considered essential to make integrated care work for all stakeholders involved.[11] Current developments in information technologies (ITs) can be the ultimate facilitators for integrated care models.[11] Modern diabetes management is an example of this, making use of internet-enabled devices such as glucose meters, insulin pumps, activity trackers, and calorie counters (through wearables and smartphones), or allowing patient–carer interaction.[11] Furthermore, the data generated by such devices and systems can provide insights into how to further improve operations and decision-making within healthcare services.[12] ICPs also enable the systematic collection and analysis of relevant data for the purposes of audit, or to promote changes in practice.[7] However, it is worth noting that important and necessary functionalities for health technology remain limited, as do sufficient interoperability and an effective roadmap for the implementation and deployment of such technologies.[11,13]

Integrated care hinges on a tailored combination of the right structures, processes, and methodologies to address a patient's needs, alongside specific institutional and community circumstances.[10] Thus, local settings are the most appropriate context for the tailored development, implementation, and deployment of ICPs.[14] Since there is no "one size fits all" or silver-bullet solution for ICPs,[1,10] it's important to study the features of successful IT-supported ICPs for diabetes patients.

The aim of this study was therefore to identify commonalities in good practices of IT-supported ICPs for patients with diabetes mellitus, and subsequently better understand when these ICPs are successful, and for what kind of patients.

## Definitions applied in the research

The European Commission (EC) defines "good or best practices" in the area of active and healthy aging as real-life examples of successful applied innovations.[5] Meanwhile, the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA) initiative, which is supported by the EC, identifies a "good practice" by its feasibility and potential for replicability under various conditions,[5] considering "good" and "best" practices to be interchangeable.

To date, there is no standardized definition of integrated care pathway that has been developed for the management of chronic diseases or, more specifically,

on diabetes. Several organizational models have been created to implement integrated care pathway approaches that are known under the name of *care management programmes, disease management, population management*, and *chronic care models,* to mention but a few.[15]

According to Perleth et al.,[16] an activity, discipline, or method available for identifying, implementing, and monitoring available healthcare evidence is dubbed a "best practice". These can be further identified according to three criteria: input, implementation or dissemination, and outcome. To measure the improvement of a health care system's performance, Perleth et al.[16] suggest further criteria related to safety, efficacy, effectiveness, cost-effectiveness, the appropriateness of health care interventions, the quality of healthcare, and public perception. In addition, the authors recommend taking a collective approach to information-gathering and management since no single one of these approaches forms an entirely successful and all-embracing strategy for ascertaining what constitutes best practice.

Several examples of IC "good practice" models are described in the scientific literature.[5,6,16–26] Integrated care is associated with a number of positive outcomes, including an improvement in system performance, clinical results, service delivery, and patient satisfaction.[17] However, due to the complex, disruptive and context-specific nature of health care service transformation, it is often difficult to directly measure its effects in terms of efficacy and efficiency.[5] Failure to recognize the widely varying definitions and components of ICPs can lead to inappropriate conclusions being drawn in regards to the effectiveness of such programmes.[19]

According to Busetto et al.,[6] the differences in definitions and operationalization of IC interventions, as well as the different classifications of interventions and/or of their components, can make it nearly impossible to compare reviews investigating the relative effectiveness of IC, or to draw overarching conclusions. With this in mind, the chronic care model (CCM) has been proposed in order to narrow down an operational definition of IC that allows for the systematic, reliable identification, and categorization of different kinds of IC interventions.[6,20] This model suggests that improving integrated chronic care requires changes in six areas: community, the health system, self-management support, delivery system design, decision support, and clinical information systems.[20] Of these six, the latter four are considered to be the priority when it comes to improving matters.[6]

A systematic review of integrated healthcare models delivered at the primary–secondary care stage identified the characteristics of models that lead to favorable clinical outcomes.[18] The six common features are

interdisciplinary teamwork, communication/information exchange, shared care guidelines or pathways, training and education, patient access and acceptance, and a viable funding model.[18]

These overlap with the World Health Organization's concept of "building blocks" for care; an expansion of the earlier mentioned CCM[21] entitled the Innovative Care for Chronic Conditions (ICCC) Framework. This is based on a set of guiding principles fundamental to the micro- meso-, and macro-level organization of the healthcare system.[22]

Based on the above, we developed a set of process and outcome indicators by using Delphi-technique described in the methods section, which is listed in Table 1, to select "good practices" and to identify the criteria for successful IT-supported integrated care pathways.[5,6,16–26]

## Methods

A methodological triangulation strategy was used to identify, describe and compare IT-supported ICPs for diabetes, which were recognized as "good practices" in their original documentation. In doing so, three related methods were applied: desk research, a non-systematic, narrative literature review, and a survey, which was followed by in-depth interviews with project participants to gather additional data and expand the insights obtained via the other data collection methods.

The desk research took as its primary source a publication of the EIP on AHA,[26] outlining a new approach to research and innovation bringing together all relevant actors at all levels. The EIP on AHA's goal is to share knowledge on good practices for active and healthy aging, including integrated care, and to deploy these across a network of European regions across Europe known as reference sites.

In November 2015, the EIP on AHA's Action Group on integrated care for chronic diseases presented a report compiling such 86 good practices.[26] Of these, we selected several projects fulfilling the following inclusion criteria: they related to people with chronic diseases, in particular diabetes, with comorbidities in European countries, and they incorporated any kind of IT support where digital information between people and/or devices was exchanged.

Given the European Commission's current work in the area of chronic disease management, we complemented the research with an examination of other good practices identified within the Chrodis Joint Action.[27] JA-CHRODIS is a European collaboration that brings together over 70 associated and collaborating partners from national and regional departments of health and research institutions in 25 European countries. These partners work together to identify, validate,

exchange, and disseminate good practice on chronic diseases across EU Member States.

To capture other good practices of IT-supported ICPs beyond those featured within the EIP on AHA,[5] a non-systematic, narrative review was performed using PubMed, screening all articles published between 1984 and May 2016 using the terms "diabetes", "IT", and "integrated care" in any field (research date: 30 May 2016). Non-European projects, studies focusing on technical developments, and studies focused on diseases other than diabetes mellitus were excluded.

To describe and compare selected ICPs, the research team used the process and outcome indicators listed in Table 1. We applied a Delphi technique as a structured process of "rounds" to collect information among our investigation group. Rounds were held until group consensus has been reached. An initial face-to-face meeting aligned experts with the purpose of the consensus building process; this was followed by two anonymous survey rounds using an internet platform on the different dimensions on process and outcome indicators to characterize ICP.

The following steps were completed in this modified Delphi process: (1) the investigators agreed upon a set of principles to guide the development of the indicators' list; (2) a small working group of investigators scanned the available literature to identify key resources on ICP; (3) a draft document was created based on these reviews and inputs; (4) an expert stakeholder meeting was held to discuss and confirm the issues; (5) two rounds of an on-line survey were completed to revise and reach consensus on the pathway; (6) all the investigators participated in focus groups to validate the list, and (7) a final meeting confirmed the final version of the indicators.

As far as possible, interviews were conducted with representatives of the projects selected from the EIP on AHA catalogue[26,27] to gather additional data. Interviewees were invited to take part in a 30-min phone interview and to provide additional information on the metrics and data used to assess the impact of the practice. The survey included the process and outcome indicators mentioned in Table 1. A complete questionnaire can be found in the Appendix of this article.

## Results

### Desk research

A total of 16 IT-supported ICPs recognized as "good practice" were identified as meeting our inclusion criteria (Table 2, see Appendix).[26,28–30]

The selected projects came from several European countries and from different regions, including Spain,[6] Italy,[4] and one each from Denmark, France, Germany, the Netherlands, the United Kingdom, and Ireland.

The ICPs differ in their stated goals, the composition of the multidisciplinary teams, patient characteristics, number of integrated patients, and local environment (clinic and ambulant settings). According to information available in the EIP AHA catalogue and in the literature, the 16 projects featured outcome indicators such as hospitalization,[11] cost savings,[9] patient satisfaction,[4] and the satisfaction of health care professionals (HCP).[2]

### Literature review

The non-systematic literature review yielded 434 results. After exclusion of reviews and other comparative analysis ($N = 61$), non-European projects ($N = 56$), articles on technical development or other common care subjects ($N = 128$), and articles focused on diseases other than diabetes mellitus ($N = 175$), 13 articles remained. Of these, five articles included redundant information which was covered in other references and were therefore removed from this analysis, resulting in a final total of eight original projects (Figure 1).[31–40]

The majority of the projects were located in Spain and Norway (see Table 2, Appendix). Similar to the desk research, the projects identified in the non-systematic review research differed with respect to their objectives, patient and staff characteristics, organizational structure, and local environment. Projects from the nonsystematic review integrated a measurement of different outcome indicators such as hospitalization, cost-savings, and physiological parameters. Four projects implemented a comparator group to control the effectiveness of the projects.[31,35,36,38]

### Survey results

Participants from 9 out of the 16 selected projects (56%) agreed to take part in the follow-up interviews. These were conducted with representatives of the projects (Table 3, Appendix).

All projects investigated received public funding and relied on multidisciplinary teams for implementation. Seven projects involved public authorities at various stages, seven used eHealth tools, and provided patient education and capacity-building.[41] The few practices relying on m-Health reported using apps or Skype to connect patients and services, and vice-versa. Seven projects reported involving patients at different stages of the practice. "eHealth" generally refers to the use of information technology, including the Internet, digital gaming, virtual reality, and robotics, in the promotion, prevention, treatment, and maintenance of health. "mHealth" refers to mobile and wireless applications, including text messaging, apps, wearable devices,
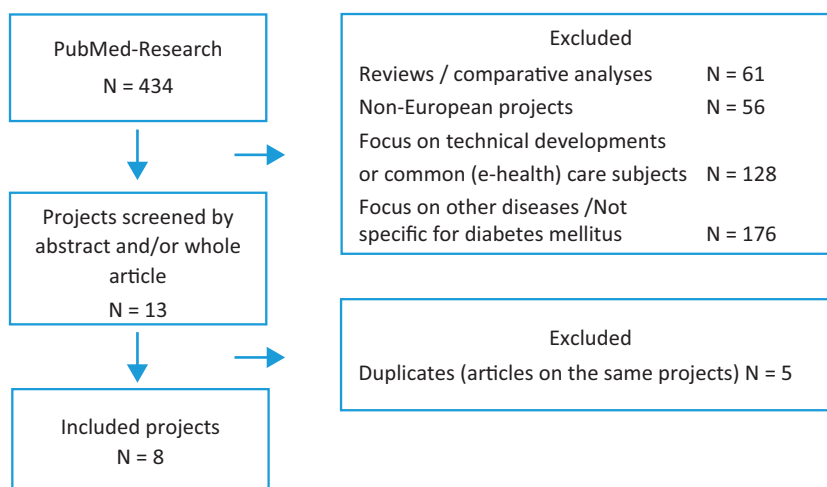
**Figure 1.** Flow chart of research results from the PubMed research (search criteria: "diabetes", "IT", and "integrated care").

remote sensing, and the use of social media such as Facebook and Twitter, in the delivery of health-related services.[42,43]

Usually patients were involved to solicit feedback on the practice worked and how it could be improved. Further patient empowerment was recognized as an area for improvement—respondents believed that there were not enough existing tools and activities available to empower patients.

The respondent identified an improvement in communication between patients and HCPs, as well as an increase in patient satisfaction (evaluated by surveys, semi-structured interviews or workshops within the projects), as advantages of IT-supported ICPs in diabetes. However, it was found that patient access to health records remains unequal and that social and psychological support is not sufficiently embedded in the practices. Most practices did not measure outcomes such as impact on physiologic parameters, hospitalization, or cost-savings.

## Discussion

Our research reviewed 24 examples of IT-supported ICPs in diabetes and chronic diseases which have been applied in different regional settings and were identified as "good practices". A comparative analysis nevertheless demonstrated a surprising level of heterogeneity.

While their implementation is—as a whole—likely to have positive impacts on process, outcome and economic dimensions of care,[44] the ICPs showed differences in objectives, the composition of the multidisciplinary teams, patient characteristics, organization, and local environment. In addition, the assessment of potential success factors did not reveal commonalities which could serve as a starting point to develop ICPs in diabetes throughout Europe.

However, the survey results did provide insights into the possible motivations for local healthcare systems to implement integrated care pathways for diabetes. Representatives surveyed reported improved communication between HCPs and patients, a greater satisfaction for both groups, and/or increased patient empowerment. However, these process indicators were not systematically analysed, and the understanding of what was meant by "improved communication" varied according to respondents; some took it to mean an increase in the level of communication, while other understood it as an improved perception of the doctor–patient relationship, and/or better adherence to treatment.

When focusing on ITs we found that within the majority of the ICPs, ITs were used to facilitate remote management between patients and HCPs. The use of ITs, in particular tele-health, for the support of integrated care for long-term chronic conditions has been described as useful and effective.[36] However, the existing status of IT-supported ICPs suggests that they are only currently being used to a fraction of their full potential.

Our analysis shows that, while good practice projects should have predefined objectives and outcome indicators, only a few of the selected projects actually measured hard outcomes, such as impact on physiologic parameters, hospitalizations, or cost-savings. The number of ICP projects, which applied a comparator group to assess the effectiveness of ICPs[31,35,36,38] was even lower. It is therefore difficult to derive conclusions about the comparative effectiveness of ICPs.

We applied the Delphi technique as described by Kröger et al.[45] to develop process and outcomes indicators, since such an approach has been applied on chronic illness,[46] performance indicators,[47] and indicators for cardiovascular disease.[48]

We are aware that a certain degree of uncertainty exists concerning the parameters of the Delphi technique such as the definition of group consensus, Delphi technique variants, expert selection, number of rounds, and reporting of the method and results.[49] In addition, the set of indicators identified throughout the process might well be incomplete, thus preventing the discovery of potential commonalities. Taken together, these limitations of our methodological approach may have lead to gaps in the set of indicators and the subsequent identification of commonalities.

By using a methodological triangulation strategy, not only could we include projects which have been extensively evaluated, but we were also able to include ongoing projects which have not yet been published in a scientific journal or other formal report. In addition, the projects from the EIP on AHA were followed-up with a structured survey to garner further insights. However, since only 9 out of 16 project representatives took part in an interview, it was difficult to draw a complete picture of all identified projects. This illustrated the difficulty of collecting data around ICP projects even when making use of multiple methods.

The current use of the labels "good practice" or "best practice" should concern policymakers and healthcare providers as much as researchers. It remains unclear what the labels "good practice" and "best practice" mean exactly, since no homogeneous definition has emerged from the collected data, making it difficult to distinguish and evaluate the two. To monitor the ongoing development and success of a project, it is essential to identify, document, and systematically evaluate goals and outcomes, rather than relying on arbitrary labels of "good practice" or "best practice".

When comparing the dataset obtained through desk research with the literature review results, we found that no articles on the EIP on AHA projects had been published in the timeframe covered in the PubMed research (1984 until May 2016). The EIP on AHA report on good practices was published in November 2013, and most of the projects had been running for longer than one year at that time. The follow-up interviews could only partly fill this gap; interviewees were available for only 9 of the 16 projects and the information obtained did not always clarify why the respective projects had been labelled as "good practice".

The lack of published data raises the question of how to draw substantial conclusions about the success of the projects, as well as limiting the ability to design a blueprint for future projects based on these practices, as there are not enough learnings on how to avoid missteps made in the existing good practices. Hence, the lack of published data risks hampering further research.

The conclusion must be drawn that any support or funding for projects in the field of ICP should require robust documentation, and the expectation that as far as possible, the outcomes of these projects be published according to acknowledged standards. This may not be feasible for all projects, such as those with limited resources and the need to put patient care above research efforts, but raising these issues before embarking on a project would be a first step towards greater transparency and consistency.

Currently available data display too much heterogeneity in all aspects of the ICP projects identified as good practices. The reasons behind this are diverse, but likely include the variance between different national European healthcare systems. In many countries, the organization of healthcare delivery is largely a regional responsibility, but funding mechanisms and healthcare provider responsibilities may also be organized differently. It is also arguable that variance may be linked to a lack of standardized definition of integrated care pathways. Efforts to seek consensus on a definition of integrated care pathway for chronic diseases may help address some of the weaknesses identified in this paper.

## Conclusions

European health systems are still "disease oriented" and managed around single medical specialties, thus fragmenting and poorly coordinating care. IT-supported integrated care pathways in diabetes show a great variability in their practical implementation. As a multi-dimensional tool, ICPs differ in their objectives, design, process, and outcome indicators. This makes them adaptable to local needs and different health care systems, but complicates the identification of general criteria for ICP in the field of diabetes.

That being said, and on the basis of our findings, we recommend that an ICP on diabetes ideally should include:

1. A multidisciplinary and multistakeholder project group involving representatives of all HCPs, public stakeholders and patients for the definition of the Diabetes IC Protocol and for the monitoring of indicators;
2. A detailed protocol which translates and standardizes the best evidence into the local context, and defines the roles, tasks, responsibilities, indicators, and targets (to be updated regularly);
3. A disease registry and computerized system for process monitoring to assess the epidemiology dynamics, the application of ICP protocol, management costs, and the achievement of objectives;
4. An evaluation framework collecting quantitative and qualitative information including patient-reported outcomes;

5. A continuous education programme for all HCPs, public stakeholders, and patients to ensure the upscaling of the IC model among European countries, regardless of the healthcare systems governance, and the collection of organizational, financial, and technological needs for the improvement of the care model, including primary, and secondary care.

## Authors' contributions

Study conception, design of the work, collection, analysis and interpretation of data: HV, NG, AGdB. Discussions on data interpretation: HV, NG, AGdB, BH. Manuscript drafting and scientific writing: HV, NG, AM. Critical revision of the manuscript: ALL. Final approval of the manuscript version to be published: ALL.

## Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: HV receives compensation from Roche for scientific input to European Working Group Integrated Chronic Disease Pathway. AGdB has been compensated for developing and delivering educational presentations for Abbvie, Celgene, Novonordisk, and Menarini in the past three years. BH has been working as a consultant for Roche. AM is an employee of Roche. MS received Honoraria for lectures from Abbott Diabetes Care, Eli Lilly, Novo Nordisk, and Sanofi a member of an advisory board of Medtronic Scandinavia and part-time employed by Diabetespolyclinic of Neliapila, which is a subsidiary of Quattrofolia Inc. NG, MdlC, DP, and SdS declare no conflicts of interest.

## References

1. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2015; 386: 743–800.
2. Luijks H, Schermer T, Bor H, et al. Prevalence and incidence density rates of chronic comorbidity in type 2 diabetes patients: An exploratory cohort study. *BMC Med* 2012; 10: 128.
3. World Health Organization (WHO). WHO global strategy on people-centred and integrated health services. http://www.who.int/servicedeliverysafety/areas/people-centred-care/en/ (accessed 21 February 2017).
4. Busetto L, Luijkx KG, Elissen AMJ, et al. Context, mechanisms and outcomes of integrated care for diabetes mellitus type 2: A systematic review. *BMC Health Serv Res* 2015; 16: 18.
5. European Commission. Scaling-up strategy in active and healthy ageing. European Union, 2015 http://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/scaling_up_strategy.pdf (accessed 21 February 2017).
6. Busetto L, Luijkx KG, Elissen AM, et al. Intervention types and outcomes of integrated care for diabetes mellitus type 2: A systematic review. *J Eval Clin Pract* 2016; 22: 299–310.
7. Campbell H, Hotchkiss R, Bradshaw N, et al. Integrated care pathways. *BMJ* 1998; 316: 133–137.
8. Bousquet J, Addis A, Adcock I, et al. Integrated care pathways for airway diseases (AIRWAYS-ICPs). *Eur Resp J* 2014; 44: 304–323.
9. Shaw S, Rosen R and Rumbold B. What is integrated care? Research report, June 2011. Nuffield Trust, London/UK. http://nuffield.dh.bytemark.co.uk/sites/files/nuffield/publication/what_is_integrated_care_research_report_june11_0.pdf (accessed 21 February 2017).
10. National Voices. A narrative for person-centred coordinated care. NHS England Publication Gateway Reference Number: 00076. https://www.england.nhs.uk/wp-content/uploads/2013/05/nv-narrative-cc.pdf (accessed 21 February 2017).
11. Guldemond N and Hercheui MD. Technology and care for patients with chronic conditions: The chronic care model as a framework for the integration of ICT. In: Hercheui MD, Whitehouse D, McIver W and Phahlamohlaka J (eds) *ICT critical infrastructures and society: Proceedings of 10th IFIP TC 9 international conference on human choice and computers.* HCC10 2012, Amsterdam, The Netherlands, 27–28 September 2012. Berlin, Heidelberg: Springer Berlin Heidelberg, 2012, pp. 123–133.
12. van de Klundert J. Healthcare analytics, big data, little evidence. Tutorials in Operations Research, INFORMS, 2016.
13. Global Observatory for eHealth: Directory of eHealth policies. WHO, 2015.
14. The European Framework for Action on Integrated Health Services Delivery: An overview. Division of Health Systems and Public Health. WHO 2016 http://www.euro.who.int/__data/assets/pdf_file/0010/317377/FFA-IHS-service-delivery-overview.pdf2016 (accessed 21 February 2017).
15. Associazione Medici Diabetologi (AMD). SocietáItaliana di Diabetologia (SID). Standard italiani per la cura deldiabete mellito 2016. 2016, pp. 142–146.
16. Perleth M, Jakubowski E and Busse R. What is 'best practice' in health care? State of the art and perspectives in improving the effectiveness and efficiency of the European health care systems. *Health Policy* 2001; 56: 235–250.

17. Kodner DL. All together now: A conceptual exploration of integrated care. *Healthcare Quart* 2009; 13: 6–15.

18. Mitchell GK, Burridge L, Zhang J, et al. Systematic review of integrated models of health care delivered at the primary-secondary interface: How effective is it and what determines effectiveness? *Aust J Primary Health* 2015; 21: 391–408.

19. Ouwens M, Wollersheim H, Hermens R, et al. Integrated care programmes for chronically ill patients: A review of systematic reviews. *Int J Qual Health Care* 2005; 17: 141–146.

20. Improving Chronic Illness Care. The Chronic Care Model. http://www.improvingchroniccare.org/index.php?p=The_Chronic_CareModel&s=2 (accessed 21 February 2017).

21. Wagner EH, Davis C, Schaefer J, et al. A survey of leading chronic disease management programs: Are they consistent with the literature? *Managed Care Quart* 1999; 7: 56–66.

22. Innovative Care for Chronic Conditions – Building Blocks for Action: Global Report (Chapter 3). WHO 2002. http://www.who.int/chp/knowledge/publications/iccc_ch3.pdf?ua=1 (accessed 21 February 2017).

23. Berwick DM, Nolan TW and Whittington J. The triple aim: Care, health, and cost. *Health Affairs* 2008; 27: 759–769.

24. Stellefson M, Dipnarine K and Stopka C. The chronic care model and diabetes management in US Primary Care Settings: A systematic review. *Prev Chronic Dis* 2013; 10.

25. Kodner DL and Spreeuwenberg C. Integrated care: Meaning, logic, applications, and implications-a discussion paper. *Int J Integr Care* 2002; 2: e12.

26. European Innovation Partnership on Active and Healthy Ageing/Action Group on 'Replicating and tutoring integrated care for chronic diseases''. A compilation of good practices. 2013.

27. Good practices in health promotion & primary prevention of chronic diseases. In: Joint Action on Chronic Diseases & Promoting Healthy Ageing across the Life Cycle (2014). http://chrodis.eu/wp-content/uploads/2015/09/Summary-Report-CHRODIS-WP5-Task-3_Version-1.3.pdf (accessed 21 February 2017).

28. Lupianez-Villanueva F TA. Science and policy reports: Strategic Intelligence Monitor on Personal Health Systems Phase 3 (SIMPHS3) – SAM:BO (Denmark) Case Study Report. European Commission JRC. 2015.

29. Franceschi R, Cauvin V, Piras EM et al. Trec diabetes: A new telemedicine system. Abstracts from ATTD 2014. In: *7th international conference on advanced technologies & treatments for diabetes*, 5–8 February 2014. Vienna, Austria: Diabetes Technology & Therapeutics.

30. Angles R, Coll J, Torres E, et al. PITES: Innovation platform in new telemedicine and e-health services for chronic and dependent patients. *Int J Integr Care* 2013; 13.

31. Hernandez C, Alonso A, Garcia-Aymerich J, et al. Integrated care services: Lessons learned from the deployment of the NEXES project. *Int J Integr Care* 2015; 15: e006.

32. Contel JC, Ledesma A, Blay C, et al. Chronic and integrated care in Catalonia. *Int J Integr Care* 2015; 15: e025.

33. Frøisland DH and Årsand E. Integrating visual dietary documentation in mobile-phone-based self-management application for adolescents with Type 1 diabetes. *J Diab Sci Technol* 2015; 9: 541–548.

34. Roelofsen Y, Hendriks SH, Sieverink F, et al. Design of the e-Vita diabetes mellitus study: Effects and use of an interactive online care platform in patients with type 2 diabetes (e-VitaDM-1/ZODIAC-40). *BMC Endocr Disord* 2014; 14: 22.

35. Ribu L, Holmen H, Torbjornsen A, et al. Low-intensity self-management intervention for persons with type 2 diabetes using a mobile phone-based diabetes diary, with and without health counseling and motivational interviewing: Protocol for a randomized controlled trial. *JMIR Res Protoc* 2013; 2: e34.

36. Berndt R-D, Takenga C, Preik P, et al. Impact of information technology on the therapy of type-1 diabetes: A case study of children and adolescents in Germany. *J Pers Med* 2014; 4: 200.

37. Spanakis EG, Chiarugi F, Kouroubali A, et al. Diabetes management using modern information and communication technologies and new care models. *Interact* J Med Res 2012; 1: e8.

38. Ramallo-Fariña Y, García-Pérez L, Castilla-Rodríguez I, et al. Effectiveness and cost-effectiveness of knowledge transfer and behavior modification interventions in type 2 diabetes mellitus patients—the INDICA study: A cluster randomized controlled trial. *Implement Sci* 2015; 10: 47.

39. Holmen H and Torbjornsen A. A mobile health intervention for self-management and lifestyle change for persons with type 2 diabetes, Part 2: One-year results from the Norwegian randomized controlled trial. *Renew Health* 2014; 2: e57.

40. Stroetmann KA, Kubitschke L, Robinson S, et al. How can telehealth help in the provision of integrated care? WHO Health Systems and Policy Analysis, Policy brief #13, 2010.

41. Funnell MM and Anderson RM. Empowerment and self-management of diabetes. *Clin Diab* 2004; 22: 123–127.

42. IDF Europe position on mobile applications in diabetes. http://www.idf.org/sites/default/files/MobAppPosPaper2_finalonlineversion_0.pdf (accessed 30 March 2017).

43. Borelli B and Ritterband LM. eHealth/mHealth. *Health Psychol* 2015; 34. http://www.apa.org/pubs/journals/special/2253415.aspx (accessed 09 May 2017).

44. Rotter T, Kinsman L, James EL, et al. Clinical pathways: Effects on professional practice, patient outcomes, length of stay and hospital costs. Cochrane Database of Systematic Reviews 2010, Issue 3. Art. No.: CD006632. DOI: 10.1002/14651858.CD006632.pub2.

45. Kröger E, Tourigny A, Morin D, et al. Selecting process quality indicators for the integrated care of vulnerable older adults affected by cognitive impairment or dementia. *BMC Health Serv Res* 2007; 7: 195.

46. Roland M, Holden J and Campbell S. *Quality assessment for general practice: supporting clinical governance in primary care groups*. Manchester: National Primary Care Research and Development Centre, 1998.

47. Beattie E and Mackway-Jones K. A Delphi study to iden-
tify performance indicators for emergency medicine.
*Emerg Med J* 2004; 21: 47–50.
48. Normand SL, McNeil BJ, Peterson LE, et al. Eliciting
expert opinion using the Delphi technique: Identifying

performance indicators for cardiovascular disease. *Int J
Qual Health Care* 1998; 10: 247–260.
49. Keeney S, Hasson F and McKenna H. Consulting the
oracle: Ten lessons from using the Delphi technique in
nursing research. *J Adv Nurs* 2006; 53: 205–212.

# Appendix

**Table 1.** Process and outcome indicators used in the analysis of selected projects from the desk research and the non-systematic literature review (collected criteria from studies shown in Table 2, see appendix).

| Type | Item | Questions/Implications |
|---|---|---|
| Process indicators | Involvement of public authorities | Are local authorities involved in the coordination and/or organization of the ICP? How?   Was the implementation of the care ICP financially supported by a public authority? How? |
| | Involvement of private stakeholders | Are other nonstate organizations (professional organizations, medical societies, patients' representatives, insurers, etc.) involved in the implementation or evaluation of the ICP? How? |
| | Multidisciplinary teamwork | Are HCPs from both primary and secondary care from different fields actively and systematically engaged in the implementation of care pathways and/or care guidelines in the ICP? How? |
| | Patient stratification | How many patients are involved in your pathway?   Are risk groups identified and selected based on specificities related to the management of their disease (e.g. age, other complications, BMI, etc.)? What are the parameters for inclusion of patients in the selection? |
| | Patient empowerment | Has responsibility for management of the disease shifted more actively towards patients? How?   Does the practice offer social and psychological support to patients and families?   Does the practice include educational and capacity-building activities?   Does the practice provide for a better access to health records? |
| | Patient involvement | Are patients directly involved in the design, implementation and evaluation of the ICP? How? |
| | Range of use of e-health tools/ Range of use of m-health tools | Are there any e-health tools used within the delivery of health care allowing the transmission of health data from patients to health care professionals by use of mobile devices?   Are there any m-health tools used within the delivery of health care allowing the transmission of health data from patients to health care professionals by use of mobile devices? |
| Outcome indicators | Hospitalization | Did the implementation of the pathway help to decrease hospitalization rates in the group of patients involved? |
| | Cost saving | Were there any cost savings achieved by the practice? (Cost savings related to treatment of acute episodes, use of health care facilities, sick leave, and absenteeism) |
| | Satisfaction of patients | Was patient satisfaction with the pathway measured (questionnaire, survey, etc.)? What is the level of reported satisfaction? |
| | Satisfaction of HCPs | Was HCP satisfaction with the pathway measured (questionnaire, survey, etc.)? What is the level of reported satisfaction? |
| | Scalability | Has the pathway been implemented/ transferred to another region and/ or country? What impact did it have? |

**Table 2.** Selected projects from the EIP on AHA analyzed and benchmarked in relation to the process and outcome indicators abovementioned.

| GOOD PRACTICE | Country | PROCESSES | | | | | | | OUTCOMES | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Involvement of public authorities | Involvement of other stakeholders | Multidisciplinary teams | Patient stratification | Patient empowerment | Patient involvement | m-health tools/ e-Health tools | Hospitalization/ ambulant care time saving | Cost saving | Satisfaction of patient | Satisfaction of HCP | Scalability |
| **SAM: BO** SAM:BO Cooperation on care pathways in the **Region of Southern Denmark** | **DK** | X | X | X | O | O | X | X | – | – | X | O | X |
| MACVIA-LR Multimorbid clinic for chronic diseases, Languedoc Rosuillon, | FR | X | X | X | O | O | O | X | X | X | O | O | – |
| **Personal Health Record TreC** Personal Health Record system and patient/citizens empowerment – TreC – Cartella Clinica del Cittadino, Fondazione Bruno Kessler | IT | X | X | X | O | X | O | X | – | – | X | – | – |
| **Ferrara** The Diabetes Integrated Management Pathway, AUSL Ferrara_ ASSRRERIT | IT | X | O | X | X | X | X | X | X | X | X | X | – |
| **eCare** eCare Network in Bologna, ASSRRERIT – CUP2000 | IT | X | O | X | X | X | O | O | – | – | O | O | X |

(continued)

**Table 2.** Continued

| GOOD PRACTICE | Country | Involvement of public authorities | Involvement of other stakeholders | Multidisciplinary teams | Patient stratification | Patient empowerment | Patient involvement | m-health tools/ e-Health tools | Hospitalization/ ambulant care time saving | Cost saving | Satisfaction of patient | Satisfaction of HCP | Scalability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Personalised Teleservices: Personalised Guidance Service for Teleservices: Chronic Care Management for diabetes patients, Tele-diabetological Competence Centre in Saxony | DE | ○ | X | X | ○ | X | ○ | X | ○ | ○ | ○ | ○ | – |
| Integrated care Valencia Polibienestar Research Institute – University of Valencia | ES | X | X | X | X | X | ○ | – | X | X | ○ | ○ | – |
| PITES Innovation platform in new telemedicine and e-health services for chronic patients, Bio-Med Aragon Spain | ES | X | X | X | X | ○ | ○ | X | X | X | X | ○ | – |
| **Telemedicine Piemont' Telemedicine for Management People with Chronic Diseases, CSI Piemonte** | **IT** | **X** | **X** | **X** | **○** | **○** | **○** | **X** | **X** | **X** | **○** | **○** | **–** |
| BaCUaH Basic Care Unit and Home (BaCUaH), Grupo Aura Andalucía | ES | X | X | ○ | ○ | X | ○ | X | X | X | ○ | ○ | – |
| **HSE Midland Diabetes HSE Midland Diabetes Structured Care Programme, National Diabetes Working Group** | **IE** | **X** | **○** | **X** | **–** | **–** | **X** | **○** | **X** | **X** | **X** | **X** | **–** |

**Table 2.** Continued

| GOOD PRACTICE | Country | Involvement of public authorities | Involvement of other stakeholders | Multidisciplinary teams | Patient stratification | Patient empowerment | Patient involvement | m-health tools/ e-Health tools | Hospitalization/ ambulant care time saving | Cost saving | Satisfaction of patient | Satisfaction of HCP | Scalability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dutch management programme** Dutch diabetes management programme – '**Bundled payments**' | **NL** | X | X | X | 0 | X | X | X | – | – | X | X | X |
| **The Super Six model** The Super Six model of diabetes care, **Wolverhampton, Derby, Leicester, Leicestershire and Rutland, North West London, Portsmouth** | **UK** | X | X | X | 0 | 0 | X | X | – | – | X | X | X |
| Valcronic programme Polibienestar Research Institute – University of Valencia, Valencian Ministry of Health, and Telefónica | ES | X | X | 0 | X | X | 0 | X | 0 | 0 | 0 | 0 | – |
| **PALANTE** Patient leading and managing their health care through EHealth, Regional Minister of Health and Social Welfare Andalusia | **ES** | X | X | X | X | X | X | X | – | – | X | X | X |
| PIPs Population Intervention Plans, Basque Country | ES | X | 0 | X | X | X | X | 0 | 0 | 0 | X | 0 | – |

X means that the practice met the specific criteria; 0 means that the practice did not meet the criteria; – means that the information was not conclusive to assess whether the criterion was met. The data captured in the table present our findings from desk research on the selected EIP practices and, for 9 of the practices, from follow-up interviews conducted with project participants. The practices for which a follow-up interview was conducted are bolded.

**Table 3.** Included studies/projects from the PubMed research (by abstract and/or article).

| Project titles | Objective (chronic conditions) | ICTs | Countries | Number of patients enrolled | Indicators/elements/ conclusions | Reference(s) |
|---|---|---|---|---|---|---|
| Supporting Healthier and Independent Living for Chronic Patients and Elderly (NEXES) | To identify barriers to deployment of four articulated Integrated Care Services supported by Information Technologies in three European sites. Type II diabetes (obstructive pulmonary disease, cardiac failure) | Telemedicine applications | Spain (Barcelona)Norway (Helsinki/4 sites) Greece (Athens) | 11,382 450 388 | The four integrated care services showed high potential to enhance health outcomes with cost-containment. Change management, technological approach and legal issues were major factors modulating the success of the deployment. | 31 |
| Chronic and integrated care in Catalonia Expert Patient Programme Catalonia®' (EPP) | To implement actions which drive the current system towards a new scenario where organizations and professionals must work collaboratively | Shared electronic health record of Catalonia (her) | Spain (Catalonia) | 4000 | Some impact reducing the rate of emergency admissions and readmission related to chronic conditions and better outcome related to better chronic disease control. | 32 |
| Integrating Visual Dietary Documentation in Mobile-Phone-Based Self-Management Application for Adolescents With Type I Diabetes | To affect understanding of carbohydrate counting, to facilitate doctor-adolescent communication with regard to daily treatment. Effect of the designed tool with regard to empowerment, self-efficacy, and self-treatment Type I diabetes (adolescents) | Smartphone applications: DiaMob; diabetes message system (DMS) | Norway | Not specified | The study concludes that implementing a visualization tool is an important contribution for young people to understand the basics of diabetes and to empower young people to define their treatment challenges. By capturing a picture of their own food, The person's own feeling of being in charge can be affected and better self-treatment achieved. | 33 |

**Table 3.** Continued

| Project titles | Objective (chronic conditions) | ICTs | Countries | Number of patients enrolled | Indicators/elements/ conclusions | Reference(s) |
|---|---|---|---|---|---|---|
| e-Vita diabetes mellitus study: effects and use of an interactive online care platform | Feasibility of use of an online platform in routine primary diabetes health care. Effects of use of the platform on treatment satisfaction, quality of life and clinical parameters. Type II diabetes | e-VitaDM | Netherlands | 8300 | Quality assessment (questionnaires), clinical data collection | 34 |
| Impact of Information Technology on the Therapy of Type-I Diabetes: A Case Study of Children and Adolescents in Germany | Impact of using novel mobile, web and communication technologies in assisting therapy and treatment Type I diabetes (children and adolescents) | Mobile diab (mobile app) | Germany | 68 | Good acceptance of the proposed system. An overall improvement in mean levels of HbAlc. The system appeared to be an efficient and time saving tool in diabetes management. | 36 |
| The REACTION Project Diabetes Management Using Modern Information and Communication Technologies and New Care Models | To create a service-oriented architectural platform based on numerous individual services and implementing novel care models that can be deployed in different settings to perform patient monitoring, distributed decision support, health care workflow management, and clinical feedback provision | Technology platform | Greece, Italy, Cyprus, France | Not specified | The REACTION project aims to respond to these challenges by providing integrated, professional management, and therapy services to diabetic patients in different health care regimes across Europe in an interoperable communication platform. | 37 |
| INDICA study (Diabetes Intervention study in the Canary Islands) | To evaluate the effectiveness and cost-effectiveness of educational interventions supported by new | Logs, web-based platform, tailored semi-automated SMS | Spain (Canary Islands) | 2300 (calculated sample) | Endpoints: Change in HbAlc in 2 years; cardiovascular risk factors, macrovascular and microvascular diabetes | 38 |

(continued)

**Table 3.** Continued

| Project titles | Objective (chronic conditions) | ICTs | Countries | Number of patients enrolled | Indicators/elements/ conclusions | Reference(s) |
|---|---|---|---|---|---|---|
| | technology decision tools for type 2 diabetes patients and primary care professionals in the Canary Islands. | | | | complications, quality of life, psychological outcomes, diabetes knowledge, and health care utilization. Cost-effectiveness analysis: direct medical costs per quality-adjusted life year gained and two periods, a "within-trial" period and a lifetime Markov model. Deterministic and probabilistic sensitivity analyses are planned. | |
| Norwegian part of the European Union Collaborative Project – REgioNs of Europe WorkINg together for HEALTH (RENEWING HEALTH) | Effect of a Low-Intensity Self-Management Intervention Type II diabetes | Telemedicine, electronic diary app | Norway | 151 | The change in HbA1c level did not differ between groups after the 1-year intervention. Secondary outcomes did not differ between groups except for an increase in the self-management domain of skill and technique acquisition in the FTA-HC group. Older participants used the app more than the younger participants did. | 35,39 |