

RESEARCH ARTICLE

Understanding Osteopathic Physician Beliefs & Attitudes Toward Medication Adherence in Patients with Diabetes Mellitus

Kevin Junus BS, OMS IV, Clipper Young PharmD, MPH, CDE & Jay H. Shubrook DO, FACP

College of Osteopathic Medicine, Touro University California, Vallejo CA

KEYWORDS:

Diabetes

Adherence

Medications

Aim: Develop a greater understanding of healthcare providers' beliefs on patients' medication adherence with an emphasis on the factors clinicians perceive being the most contributory toward non-adherence in type 1 (T1DM) and type 2 diabetes patients (T2DM).

Methods: A 40-item survey was sent to osteopathic family physicians exploring beliefs pertaining to medication adherence, including most important factors that felt to be the most influential to non-adherence. Each of these factors was classified into different categories as proposed by the World Health Organization (WHO) to determine the level of attribution and significance.

Results: A total of 183 osteopathic family physicians completed the survey. The physicians perceived that the mean patient adherences were 81.7% for oral anti-diabetic medications (e.g. metformin) and 72.4% for insulin. The physicians rated social and economic factors as the most impactful factors (e.g. high cost of healthcare and medication as well as poor socioeconomic status) contributing to non-adherence and condition-related factors as the least influential. Overall, physicians also rated patient-related factors as more significant than physician or healthcare team-related factors.

Conclusions: Physicians generally believe medication adherence is high in their patients. Interventions to improve medication adherence and overall glycemic control may be effective at the provider level by educating them of their impact, which may include conversations of hypoglycemia, depression, and overall importance of the provider-patient relationship that may play a more significant role than previously believed.

INTRODUCTION

The burden of diabetes mellitus (DM) in our country is increasing and will continue to rise for the foreseeable future. Approximately 9% of the population in the United States has diabetes, with 1 - 2 million more diagnosed each year.¹ It is estimated that 1 in 3 people will have diabetes by 2050.² Diabetes is largely self-managed, and keeping diabetes in control is a complex balance involving significant lifestyle changes, adherence to complex medication regimens, and unique requirements in health care providers with providing intentional encouragement and guidance for chronic disease management.³

Despite an array of effective treatments, including an abundance of new advances that can help promote optimal glycemic targets, it has been shown that only about 50% of patients achieve a target

HbA1c of less than 7.0%.¹⁴ Non-adherence of prescribed therapies is a significant but underappreciated facet of the management of diabetes.⁵ Along with pulmonary disorders, diabetes was found to be a chronic condition among the highest associated with non-adherence.⁶ Large studies have reported variable findings in medication adherence in both oral medications (36% to 93%) and insulin (38% to 69%).^{7,8}

Understanding the lack of adherence to diabetes medications is an ongoing problem, and several studies have tried to elucidate factors that contribute to poor medication adherence. Studies have shown factors, including age, gender, socioeconomic status, are all significantly associated with medication adherence, but meta-analyses thus far have not been able to show consistent results in definite factors that can be specifically implemented and improved upon to increase adherence, implying the complexity of factors that lead to adherence.^{9,10}

Research suggests that a physician's role may have a larger influence on patient adherence than originally believed, with positive correlations between clear physician-patient communication and

CORRESPONDENCE:

Jay H. Shubrook DO, FACP | jay.shubrook@tu.edu

adherence.¹¹ The World Health Organization (WHO) released a report, *Adherence to Long-Term Therapies: Evidence for action in 2003*¹² that acknowledges management strategies in combating non-adherence in chronic diseases, including diabetes, suggesting that optimal management requires a multidisciplinary strategy initiated by physicians that also promotes shifting away from patient-blaming with regards to non-adherence.

Hence, the goal of this study is to determine what healthcare providers believe is the level of adherence in their patients with diabetes and what specific factors lead to low-adherence to treatment recommendations. Low adherence to American Diabetes Association (ADA) treatment guidelines is not uncommon,¹³ and it has been found that physicians often do not follow recommended guidelines in their management of diabetes due to their own beliefs and attitudes,¹⁴ thus physicians' beliefs are essential to understanding. It is worthwhile to also investigate the extent to which providers believe their role is in improving adherence in their patients.

METHODS

The present study is a cross-sectional, descriptive study that seeks to elucidate the beliefs of practicing physicians through a survey distributed by email. A 40-item survey was utilized to explore attitudes of osteopathic family physicians who regularly manage patients with diabetes. The initial nine survey questions were related to demographics and also requested quantitative inputs on perceived levels of adherence to oral anti-diabetic medications and insulin nationwide. The next set of questions looked at 21 items designated as factors that might affect medication adherence and asked the physicians to rate the influence of these items on patient adherence. These items were based on the World Health Organization recommendations: social and economic factors; condition-related factors; therapy-related factors; healthcare team and system-related factors; and patient-related factors.¹² Survey participants were asked to rank from 1 to 5 for each proposed factor with five being most relevant in affecting medication adherence and one being the least.

The remaining ten items consisted of ordinal five-point Likert-scale items designed to measure beliefs regarding different aspects of diabetes management and medication adherence, wherein participants designated that they either "strongly disagree," "disagree," are "neutral," "agree," or "strongly agree" with the particular statement in question.

The survey questions were developed and designed by the first author and pretested for validity and clarity by a primary-care physician with specialization in diabetology and a faculty member the College of Pharmacy at the institution, both independently, and listed as authors in the present study. Further revisions were additionally made in discussions in a diabetes-focused research group at the institution. This study and the survey in its final form was reviewed and determined to be exempt by the University Institutional Review Board.

The survey was distributed via email to the American College of Osteopathic Family Physicians (ACOFP) mailing list of 8368 physicians. The survey was sent via an electronic link to the email database of the ACOFP in January and May of 2016, asking healthcare providers to contribute their time and thoughts if they regularly

managed patients with diabetes. Inclusion criteria consisted of providers (DOs) in the US and are directly responsible for diabetes management in their patients.

Completion of the survey qualified them to enter in a gift card lottery that was drawn at random and delivered via email at the conclusion of the survey. Survey distribution and generated reports for analysis were completed in Qualtrics and SPSS. Ranked factors relevant to adherence underwent Mann-Whitney U analysis to explore differences in ranked factors between two groups of providers that were divided at the median by years of experience in practice post-residency (less than 15 years versus greater than or equal 15 years) and also divided by age of provider, also split at the median (less than 46-years-old versus 46-years-old and older)

RESULTS

There were in total 227 survey responses (a response rate of 2.7%), of which 183 of the responses were complete, detailed in Table 1 (page 12). Surveys that were not complete were excluded from the present analysis. All responses were from physicians, among which 97.8% (n = 179) designated themselves as generalists, and 2.2% (n = 4) as specialists in diabetes (diabetologists). The mean year at which physicians have been in practice post-residency was 17 years; each physician saw a mean estimated 86 patients a month whom they directly managed their diabetes. Osteopathic physicians from all but 14 states were represented in the responses.

In general, physicians believed that the level of adherence in their patients was high, with a reported perceived adherence mean of 81.7% of prescribed doses of oral anti-diabetic medications and 72.4% of prescribed doses of insulin. Additionally, the participating physicians believed the nationwide level of adherence was 65.5% for oral anti-diabetic medications and 57.0% for insulin. Furthermore, 77.6% of participating physicians inquired about their patients' adherence to their anti-diabetic medications at every appointment, 17.5% inquired at most appointments, and less than 5% inquired at half or fewer of their appointments.

With regards to patients on insulin therapy, just under half (44.3%) of survey participants believed that the risk of drug-induced hypoglycemia is adequately regarded among healthcare providers in the context of diabetes care, while 30.6% believed that the risk of hypoglycemia is not adequately addressed among healthcare providers (25.1% responded neutrally). When asked about the care of their patients, 70.5% of participating physicians inquired about hypoglycemic events at every appointment, 22.5% asked more than half of the time, and 7.1% asked half of the time or fewer. The physicians reported that 79.3% of their patients were aware of signs and symptoms of hypoglycemic events.

Factors that the physicians rated as the most influentially toward medication non-adherence in diabetes are shown in Table 2 (pages 14 and 15). Physicians rated social and economic factors as the highest in contributing toward non-adherence (mean = 4.83), followed by therapy-related factors (mean = 3.15), patient-related factors (mean = 3.11), healthcare team and system-related factors (mean = 2.95), and lastly, condition-related factors (mean = 2.76). The high cost of healthcare and medication was the highest rated factor, and lack of knowledge or training of health care providers in managing chronic diseases was rated as the least contributory to non-adherence.

TABLE 1:

Survey participant demographics of completed surveys.

CHARACTERISTIC		#	%
Age		Mean: 48 SD: 13.0	
Number of Years In Practice Post-Residency		Mean: 16 SD: 12.1	
Number of Patients with Diabetes Seen Per Month		Mean: 64 SD: 48.5	
Type of Provider	Generalist (Family Medicine, Internal Medicine, Pediatrics)	177	96.7%
	Specialist (Diabetologist, Endocrinologist)	3	1.6%
	Other Specialist*	3	1.6%
Practice Type	Single-Specialty Group	43	23.5%
	Hospital Employment	35	19.1%
	Multi-Specialty Group	37	20.22%
	University or Academic	14	7.7%
	Solo Practice	34	18.6%
	Military or Government	7	3.8%
	None of Above	13	7.1%
Practice Setting	Rural	60	32.8%
	Suburban	91	49.7%
	Urban	32	17.5%
Which guidelines do you follow to treat patients with diabetes?	AACE/ACE**	51	27.9%
	ADA/EASD***	84	45.9%
	Hospital or Office algorithm	23	12.6%
	No guidelines	19	10.4%
	Other (combination of guidelines, c-peptide level, guideline not listed)	6	3.3%

*Sports Medicine, Osteopathic Manipulative Treatment, Emergency Medicine

**American Association of Clinical Endocrinologists/American College of Endocrinology

***American Diabetes Association/European Association for the Study of Diabetes

When providers were divided into two equal groups based on age by the median (providers younger than 46-years-old versus providers 46-years-old and older), there were significant differences in factor ratings for the following factors: fear of injections for insulin ($p=0.009$), increasing age in their patients ($p=0.02$), patient forgetfulness ($p=0.015$), and a long duration of diabetes ($p=0.038$) (Table 2, pages 14 and 15). With the same respondents divided into two groups equally according to length of practice split at the median, only one factor was significant: there was a significant difference in rating increasing age in their patients between physicians who were practicing at least 15 years after their residency versus practicing physicians with less than 15 years of experience ($p=0.005$).

Physicians were split on believing whether patients' locus of control affected adherence to their management of their diabetes; 33.3% of physicians agreed or strongly agreed that patients have a strong internal locus of control (patients believing they have

strong sense of control over their diabetes), 36.6% of responders disagreed or strongly disagreed that patients have a strong internal locus of control while 30.1% remained neutral. A majority of physicians (68.3%) also agreed or strongly agreed that patient factors (e.g., their knowledge, attitudes, expectations) play a larger role in contributing to non-adherence than healthcare team-related factors, such as poor education of diabetes by caregivers (16.4% disagree/strongly disagree and 15.3% neutral).

DISCUSSION

In general, physicians believed that the level of adherence in their patients was relatively high (81.7% for oral anti-diabetic medications and 72.4% for insulin) when compared to large systematic reviews that investigated medication adherence (36%-93% for oral medications and 38-69% for insulin).^{8,15} These findings are rather surprising given the well-accepted notion that a majority of

adults with diabetes are not achieving adequate glycemic control, with patient nonadherence found to be one of the most influential factors contributing to such poor outcomes.¹⁶ Large survey data that analyzed diabetes care over the past decade show that up to 48.7% of adult patients assessed did not meet adequate glycemic targets.¹⁵ Given our results, medication non-adherence may overall still be an underappreciated aspect of diabetes care among physicians.

The factor that responding physicians rated as the most influential with regards to non-adherence in diabetes management was the cost of care and medications. This is well agreed upon, and consistent with literature.⁹ In a separate systematic review, over 85% of the studies examined reveal a correlation between increasing patient share of costs and decreased medication adherence.⁸ In general, the high cost of care in patients is a well-acknowledged barrier to both adherence to treatment regimens and subsequently achieving HbA1c targets.

The majority of responding physicians (68.3%) believed that patient-related factors (e.g., patient forgetfulness) were more substantial than physician/healthcare team-related factors (e.g., poor physician communication or lack of proper education of diabetes). This was consistent with the higher mean rating as well (healthcare team-related factors ranked second to last). This may suggest that providers might underestimate their role in the management of their patients. Improved communication between providers and patients, especially in providing training to patients that also include sharing risks and benefits of insulin is an area of intervention that is highly associated with medication adherence.¹⁷ It has been recently reported that patient perceptions of the quality of physician-patient interactions--whether they appeared rushed or distracted--are linked with insulin adherence behavior and glycemic control,¹⁸ and it may be valuable for physicians to take this into consideration.

Condition-related factors and more specific factors related to other comorbidities that included depression were ranked the lowest factors in this study, implying a possible area of intervention. Some meta-analyses have shown strong associations between depression and non-adherence to medications. It has been found that patients with depression had a significant association between its severity and impact on medication adherence, and providers may need to recognize even more the impact of depression on adherence when it comes to treating their patients with diabetes.^{9,19}

Interestingly, patients' fear of hypoglycemia was rated as the second lowest factor in contributing toward non-adherence by survey participants. A majority of survey participants responded that the risk of drug-induced hypoglycemia among all providers is adequately acknowledged, which may partially explain why the factor is rated so lowly. This is consistent with other reports that investigated barriers to optimal glycemic control, with one showing that only 19% of physicians acknowledged patients' fears of hypoglycemia being a significant contributor toward non-adherence.²⁰ However, patient-focused studies found that hypoglycemic episodes can lead to immense changes in adherence including self-alteration of their insulin regimen, and more research needs to be done to explore the extent physicians understand this area of diabetes care.^{21,22} A recent study also reported a majority of patients (65% of patients with type 1 diabetes and 50 - 59% of patients with type 2 diabetes) rarely or never informed their health-

care provider of hypoglycemic episodes.²³ Low ratings of the fear of hypoglycemia in the present study may signify a prompt for greater need of discussion between physicians and patients on an underestimated burden which opens the discussion for the need of improved communication between them, as studies have shown that there is often a significant difference in between physicians' and patients' beliefs of hypoglycemia, most notably in knowledge of symptoms.²⁴

When examining physician's ratings of factors that lead to adherence, there were some significant differences in ratings between younger (<45-years-old) and older (≥ 46 -years-old) physicians, but this does not necessarily correspond to experience in practice. When comparing physicians' ratings in terms of years in practice, physicians with more years of experience (≥ 15 years out of residency) and physicians with comparatively fewer years of experience (<15 years out of residency) rated factors nearly identically with one exception--there was a significant difference in ratings for increasing patient age as a factor in contributing toward non-adherence. It has been proposed that physicians over time may gain a greater intuition in the context of reading social and behavioral cues with increasing age and years of experience in practice, which can translate substantially in the care of elderly patients with chronic conditions with relative complexity such as diabetes.²⁵ Whether this difference in factor ratings implies that more experienced physicians understand elderly patients in a different light is yet to be investigated.

Adherence to medication in a chronic disease is complex, and a recent systematic review revealed that no single intervention exists to promote global adherence to anti-diabetic medications in patients with type 2 diabetes.¹⁰ However, to address improving medication adherence, a multifactorial approach will be needed.^{4,10} Improved physician-patient communication -- provider-level intervention in particular -- is where published research is sparse but appears to play an important role in medication adherence.²⁶

Our current study provides important insight into physician beliefs on barriers to adherence in patients with diabetes, an area of research that is few and far between with regards to the provider level, but certain limitations must be recognized. The number of responses was smaller than expected, which also opens the possibility of selection bias, which the survey may not be representative of all providers who manage diabetes. The authors acknowledge that the small response rate may limit generalizability, and at best, only provides a small representation of osteopathic family physicians. It is unclear if there is a difference that may be attributed to osteopathic philosophy in affecting physician-and-patient-level barriers to medication adherence. A recent study showed that empathy is maintained in graduating osteopathic medical students, but it is yet to be determined if this affects patient adherence.²⁷ Further study is recommended to assess beliefs that also expands beyond the realm of osteopathic family physicians who treat diabetes, ideally with the inclusion of specialists, the inclusion of allopathic physicians, and also non-physician providers (e.g., physician assistants and nurse practitioners).

All in all, these findings reveal the provider-level factors need further study and emphasis and analysis when assessing patients' medication adherence. It may also be worthwhile to quantitatively assess relationships between patient-provider relationship differences (e.g., length of appointment time) and medication adherence.

TABLE 2:

Factors that contribute to medication non-adherence, rated from most relevant to least according to responses.¹ (least relevant),⁵ (most relevant).

FACTORS: Social and economic, condition-related, therapy-related, health care team and system-related, patient-related	Average Value	Median
High cost of healthcare and medication	4.04	4
Fear of injections for insulin	3.72	4
Poor socioeconomic status	3.68	4
Low level of education	3.56	4
Poorly developed health services (e.g. inadequate reimbursement by health insurance plans)	3.55	4
Lack of motivation in patients (lack of perceived importance of adherence)	3.49	4
Complexity of medical regimen (e.g. duration of treatment)	3.46	4
Short provider-patient consultations	3.40	3
Weak capacity of the system to educate patients and provide follow-up	3.32	3
Lack of effective social support networks	3.26	3
Increasing age	3.18	3
Patient forgetfulness	3.08	3
Lack of immediate medical beneficial effects of medicine	3.04	3
Medication side effects	2.95	3
Poor physician communication (e.g. failure to explain benefits and side effects of a medication adequately)	2.92	3
A long duration of diabetes (10 years)	2.77	3
Other co-morbidities such as depression, drug and alcohol abuse	2.75	3
Low self-esteem and self-efficacy in patients	2.70	3
Lack of provider knowledge on adherence and effective interventions for improving adherence	2.62	3
Fear of hypoglycemia	2.54	2
Lack of knowledge or training in health care providers on managing chronic conditions	2.51	2

*SD = standard deviation

	Mode	SD*	Average Value (<15 years post-residency, n=81)	Average Value (≥15 years post-residency, n=81)	2-tailed p-value (Mann- Whitney U)	Average Value (age<46, n=81)	Average value (age≥46, n=81)	2-tailed p-value (Mann- Whitney U)
	5	1.09	4.13	3.89	0.113	4.15	3.86	0.054
	4	1.12	3.93	3.54	0.083	4.01	3.47	0.009
	4	1.09	3.7	3.57	0.606	3.75	3.52	0.252
	4	1.10	3.58	3.43	0.433	3.60	3.41	0.317
	4	1.17	3.43	3.65	0.378	3.45	3.63	0.467
	4	0.99	3.52	3.36	0.259	3.56	3.32	0.107
	4	1.10	3.58	3.33	0.188	3.58	3.33	0.148
	3,4	1.10	3.40	3.38	0.924	3.42	3.36	0.864
	4	1.18	3.28	3.33	0.846	3.36	3.26	0.594
	3	1.07	3.24	3.30	0.731	3.35	3.19	0.321
	3	1.01	2.91	3.38	0.005	2.96	3.33	0.020
	3	0.93	3.20	2.93	0.060	3.23	2.89	0.015
	3	1.07	3.10	2.96	0.423	3.11	2.95	0.406
	3	1.06	3.08	2.90	0.240	3.08	2.90	0.241
	3	1.15	2.79	2.93	0.435	2.83	2.89	0.808
	3	1.15	2.83	2.64	0.288	2.90	2.57	0.038
	3	1.12	2.89	2.60	0.110	2.85	2.64	0.190
	3	1.12	2.77	2.63	0.359	2.81	2.58	0.135
	2	1.13	2.53	2.72	0.333	2.65	2.59	0.690
	2	1.09	2.46	2.60	0.372	2.51	2.56	0.675
	2	1.14	2.38	2.65	0.086	2.46	2.57	0.482

Lastly, as the study asks participants to respond based on their beliefs, there is an element of recall bias to be attributed when comparing this study with others, especially in measuring their perceived adherence. Thus, it would be prudent to view them as approximate estimates, especially when referring to literature.

CONCLUSION

Medication non-adherence is a pervasive and multi-factorial hidden problem that affects the care of our patients and the outcomes we can achieve in diabetes care. This survey reveals that physicians may underestimate medication non-adherence as a whole in diabetes management, including in their potential role as providers and also burdens associated with several factors such as the impact of hypoglycemia. This survey study reveals that social and economic factors play an essential role from the perspective of osteopathic family physicians. The role (positive or negative) of the osteopathic family physician on adherence needs further exploration.

ACKNOWLEDGEMENTS:

We would like to thank the American College of Osteopathic Family Physicians (ACOFPP) for providing the means to distribute the survey mentioned in the present study to the physician membership mailing list, which made the completion of this study possible.

DISCLOSURES:

JS serves as a consultant for Lilly Diabetes and Novo Nordisk

CONFLICTS:

None of the authors (KJ, CY, JS) have any conflicts to declare regarding the content of the manuscript.

REFERENCES

- Centers for Disease Control and Prevention. A1c Distribution Among Adults with Diagnosed Diabetes, United States, 1988–1994 to 1999–2006. 2014; https://www.cdc.gov/diabetes/statistics/a1c/a1c_dist.htm. Accessed May 14, 2017.
- Boyle JP, Thompson TJ, Gregg EW, Barker LE, Williamson DF. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. *Popul Health Metr*. 2010;8:29.
- Bailey CJ, Kodack M. Patient adherence to medication requirements for therapy of type 2 diabetes. *Int J Clin Pract*. 2011;65(3):314–322.
- Polonsky WH, Henry RR. Poor medication adherence in type 2 diabetes: recognizing the scope of the problem and its key contributors. *Patient Prefer Adherence*. 2016;10:1299–1307.
- Currie CJ, Peyrot M, Morgan CL, et al. The impact of treatment noncompliance on mortality in people with type 2 diabetes. *Diabetes Care*. 2012;35(6):1279–1284.
- DiMatteo MR. Variations in patients' adherence to medical recommendations: a quantitative review of 50 years of research. *Med Care*. 2004;42(3):200–209.
- Cramer JA. A systematic review of adherence with medications for diabetes. *Diabetes Care*. 2004;27(5):1218–1224.
- Davies MJ, Gagliardino JJ, Gray LJ, Khunti K, Mohan V, Hughes R. Real-world factors affecting adherence to insulin therapy in patients with Type 1 or Type 2 diabetes mellitus: a systematic review. *Diabet Med*. 2013;30(5):512–524.
- Krass I, Schieback P, Dhippayom T. Adherence to diabetes medication: a systematic review. *Diabet Med*. 2015;32(6):725–737.
- Sapkota S, Brien JA, Greenfield J, Aslani P. A systematic review of interventions addressing adherence to anti-diabetic medications in patients with type 2 diabetes--impact on adherence. *PLoS One*. 2015;10(2):e0118296.
- Ratanawongsa N, Karter AJ, Parker MM, et al. Communication and medication refill adherence: the Diabetes Study of Northern California. *JAMA Intern Med*. 2013;173(3):210–218.
- World Health Organization. Adherence to Long-Term Therapies: evidence for action. 2003; http://www.who.int/chp/knowledge/publications/adherence_full_report.pdf. Accessed May 14, 2017.
- Lian J, Liang Y. Diabetes management in the real world and the impact of adherence to guideline recommendations. *Curr Med Res Opin*. 2014;30(11):2233–2240.
- Qiu Y, Li Q, Tang J, et al. Why physicians do not initiate dual therapy as recommended by AACE guidelines: A survey of clinicians in the United States. *Diabetes Res Clin Pract*. 2015;108(3):456–465.
- Ali MK, Bullard KM, Saaddine JB, Cowie CC, Imperatore G, Gregg EW. Achievement of goals in U.S. diabetes care, 1999–2010. *N Engl J Med*. 2013;368(17):1613–1624.
- Blackburn DF, Swidrovich J, Lemstra M. Non-adherence in type 2 diabetes: practical considerations for interpreting the literature. *Patient Prefer Adherence*. 2013;7:183–189.
- Garcia-Perez LE, Alvarez M, Dilla T, Gil-Guillen V, Orozco-Beltran D. Adherence to therapies in patients with type 2 diabetes. *Diabetes Ther*. 2013;4(2):175–194.
- Linetsky B, Jiang D, Funnell MM, Curtis BH, Polonsky WH. Exploring the role of the patient-physician relationship on insulin adherence and clinical outcomes in type 2 diabetes: insights from the MOSAIC study. *J Diabetes*. 2016.
- Bauer AM, Parker MM, Moffet HH, et al. Depressive symptoms and adherence to cardiometabolic therapies across phases of treatment among adults with diabetes: the Diabetes Study of Northern California (DISTANCE). *Patient Prefer Adherence*. 2017;11:643–652.
- Dalal MR, Grabner M, Bonine N, Stephenson JJ, DiGenio A, Bieszk N. Are patients on basal insulin attaining glycemic targets? Characteristics and goal achievement of patients with type 2 diabetes mellitus treated with basal insulin and physician-perceived barriers to achieving glycemic targets. *Diabetes Res Clin Pract*. 2016;121:17–26.
- Lopez JM, Annunziata K, Bailey RA, Rupnow MF, Morisky DE. Impact of hypoglycemia on patients with type 2 diabetes mellitus and their quality of life, work productivity, and medication adherence. *Patient Prefer Adherence*. 2014;8:683–692.
- Edridge CL, Dunkley AJ, Bodicoat DH, et al. Prevalence and Incidence of Hypoglycaemia in 532,542 People with Type 2 Diabetes on Oral Therapies and Insulin: A Systematic Review and Meta-Analysis of Population Based Studies. *PLoS One*. 2015;10(6):e0126427.
- Ostenson CG, Geelhoed-Duijvestijn P, Lahtela J, Weitgasser R, Markert Jensen M, Pedersen-Bjergaard U. Self-reported non-severe hypoglycaemic events in Europe. *Diabet Med*. 2014;31(1):92–101.
- Bohme P, Bertin E, Cosson E, Chevalier N, group G. Fear of hypoglycaemia in patients with type 1 diabetes: do patients and diabetologists feel the same way? *Diabetes Metab*. 2013;39(1):63–70.
- Elstad EA, Lutfey KE, Marceau LD, Campbell SM, von dem Knesebeck O, McKinlay JB. What do physicians gain (and lose) with experience? Qualitative results from a cross-national study of diabetes. *Soc Sci Med*. 2010;70(11):1728–1736.
- Polonsky WH. Poor medication adherence in diabetes: what's the problem? *J Diabetes*. 2015.
- Kimmelman M, Giacobbe J, Faden J, Kumar G, Pinckney CC, Steer R. Empathy in osteopathic medical students: a cross-sectional analysis. *J Am Osteopath Assoc*. 2012;112(6):347–355.