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Improving type 2 diabetes mellitus management in Ministry of Defense Hospitals in the Kingdom of Saudi Arabia 2018–2021

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ABSTRACT

Diabetes mellitus is a metabolic disease characterised by elevated levels of blood glucose and is a leading cause of disability and mortality. Uncontrolled type 2 diabetes leads to complications such as retinopathy, nephropathy and neuropathy. Improved treatment of hyperglycaemia is likely to delay the onset and progression of microvascular and neuropathic complications.

This article describes the efforts of 18 governmental hospitals in the Kingdom of Saudi Arabia that enrolled in a collaborative improvement project to improve the poor glycaemic control (HbA1c >9% to be less than 15%) of patients with diabetes by the end of 2021 among all the chronic illness clinics in the enrolled military hospitals. Enrolled hospitals were required to implement an evidence-based change package that included the implementation of diabetes clinical practice guidelines with standardised assessment and care planning tools. Furthermore, care delivery was standardised using a standard clinic scope of service that focused on multidisciplinary care teams. Finally, hospitals were required to implement diabetes registries that were used by case managers for poorly controlled patients.

The project timetable was from October 2018 to December 2021. Diabetes poor control (HbA1c >9%) showed improved mean difference of 12.7% (34.9% baseline, 22.2% after) with a p value of 0.01. Diabetes optimal testing significantly improved from 41% at the start of the project in the fourth quarter of 2018, reaching 78% by the end of the fourth quarter of 2021. Variation between hospitals showed a significant reduction in the first quarter of 2021.

The collaborative multilevel approach of standardising the care based on the best available evidence through policies, guidelines and protocols, patient-focused care and integrated care plan by a multidisciplinary team was associated with noticeable improvement in all key performance indicators of the project.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Collaborative multilevel approach of standardising diabetes care has demonstrated promising results. However, this has been understudied in the Ministry of Defense Health Services, the Kingdom of Saudi Arabia.

WHAT THIS STUDY ADDS

⇒ The collaborative multilevel approach of standardising the care based on the best available evidence through policies, guidelines and protocols, patient-focused care and integrated care plan by a multidisciplinary health team was associated with noticeable improvement in all key performance indicators of the project.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Findings suggest that such an intervention can substantially decrease the number of patients with uncontrolled blood glucose levels (HbA1c >9%). Further improvement projects are recommended to study the cost-effectiveness of each intervention to prioritise comprehensive diabetes care provision. Additional quality improvement projects should be designed to evaluate the effectiveness of implementing clinical decision support system interventions for patients with uncontrolled type 2 diabetes mellitus.

PROBLEM

The purpose of this quality improvement project was to evaluate the efforts of 18 governmental hospitals in the Kingdom of Saudi Arabia (KSA) that participated in a quality improvement collaboration which aimed at reducing the percentage of patients with uncontrolled type 2 diabetes (HbA1c >9%).

A clinical audit was performed in the *Ministry of Defense Health Services* and revealed high prevalence (34.9%) of uncontrolled type 2 diabetes mellitus (DM) (HbA1c >9%) compared with the international benchmarks as per the Advancing Care with National Committee for Quality Assurance (NCQA) Diabetes Recognition Program.[1]

The *Ministry of Defense Health Services* is a governmental healthcare system in the KSA that provides integrated healthcare services to the Ministry of Defense employees and their

dependents. Eighteen hospitals were enrolled in the study with a cumulative capacity of 5666 beds across 15 cities, including Madinah, Dhahran, Riyadh, Jubail, Najran, Wadi Aldawasir, Taif, Tabuk, Jizan, Alkharj, Jeddah, Hafer Albatin, Khamis Mushait, Qassem and Sharurah.

BACKGROUND

DM is a chronic non-communicable disease. The prevalence of DM is snowballing in the Middle East, especially in the KSA, regardless of the age bracket.[2] According to WHO, the KSA is second in the Middle East and seventh worldwide in terms of prevalence,[2] affecting 34.1% of the males and 27.6% of the females with over 3 million individuals enduring pre-diabetes and 7 million individuals with DM.[3] These numbers have been projected to double by the year 2035.[4] In stark difference to the worldwide prevalence of 6.28% (6059 per 100 000 population), about 7661 per 100 000 Saudi individuals were believed to be suffering from type 2 DM in 2017 as per the Global Burden of Disease report of 2020.[5]

Uncontrolled type 2 diabetes can lead to adverse clinical complications such as retinopathy, nephropathy and neuropathy. Improved treatment of hyperglycaemia is likely to delay the onset and progression of microvascular and neuropathic complications in patients with this disease.[6]

This metabolic disorder is multifactorial, including unhealthy food intake, sedentary and inactive lifestyle, tobacco consumption and body mass index beyond the accepted range. Approximately 25%–40% of the young population and over half of the adult population in the Gulf countries, including the KSA, are either overweight or obese.[2 7] Followed by an increased number of type 2 DM is the rising prevalence of cardiovascular disease (CVD) complication and premature death.[8] Nearly half of the mortality in the Saudi population is attributed to CVD.[9]

In 2014 alone, about 25 billion Saudi Arabian Riyal (SAR) was spent on diabetic individuals from the allocated healthcare budget of SAR180 billion. This highlights that 14% of the total healthcare expenses in the KSA were consumed on DM. Notably, the KSA witnessed a massive 500% surge in healthcare-associated expenditures due to DM in the past two decades.[3]

Glycaemic control is the bulwark to many complications of type 2 DM. It is a well-known fact that high levels of blood glucose increase the hazard of DM complications and associated mortality, and the opposite is true for reduced risk.[10] A handful of studies from KSA demonstrated poor glycaemic control in three-fourths of the patients with type 2 DM.[11 12] However, one of the possible solutions to this looming problem is the deployment and active surveillance of a comprehensive diabetes management plan to improve the quality of patient care which involves physicians and patients.

Table 1 Operational definition of selected measures

Indicator	Type	Description	Numerator	Denominator	Target	Starting date
Haemoglobin A1c (HbA1c) poor control (>9%)	Outcome	Percentage of patients 18–75 years of age with diabetes who had HbA1c >9.0% during the measurement period.	Patients whose most recent HbA1c level (performed during the measurement period) is >9.0%.	Total number of patients aged 18–75 years with type 2 diabetes who visited the chronic illness centre during the assigned month.	≤15% (Advancing Care with National Committee for Quality Assurance (NCQA) Diabetes Recognition Program)	4th quarter 2018
All-or-none process measure (optimal testing)	Process	Patients with type 2 diabetes, 18–75 years of age and alive as of the last day of the measurement period who had at least two HbA1c tests: one urine albumin/creatinine ratio test and one eGFR test annually.	Number of patients who had at least two HbA1c tests: one urine albumin/creatinine ratio test and one eGFR test annually.	Total number of patients within the population of initial eligibility criteria.	≥73.3% (average performance on Wisconsin Collaborative for Healthcare Quality (WCHQ) healthcare systems)	1st quarter 2019
Patients with diabetes who developed severe hypoglycaemia	Balancing	Percentage of patients with diabetes who developed severe hypoglycaemia, which occurs if blood concentration is <54 mg/dL (3 mmol/L) and/or characterised by altered mental and/or physical functioning that requires assistance from another person for recovery.	Total number of patients with one attack of severe hypoglycaemia.	Total number of patients aged 18–75 years with type 2 diabetes who visited the chronic illness centre during the assigned month.	–	1st quarter 2019

eGFR, estimated glomerular filtration rate.

Table 2 Baseline KPI measurements

KPI	Type	Baseline measurement (%)	Postintervention (%)
Diabetes poor control (HbA1c >9%)	Outcome measure	34.9	22.2
Diabetes optimal testing	Process measure	41	78
Self-reported severe hypoglycaemia	Balancing measure	1	1

KPI, key performance indicator.

Chronic care model (CCM) has been shown to improve the quality of diabetes care. Such evidence-based performance measures use indicators that provide standardised and consistent information that helps quantify improvements in patient care from individual physicians and healthcare organisations. In addition, these findings can be benchmarked against other organisations for comparing their effectiveness.[13]

A clinical audit was performed in the Ministry of Defense Health Services and revealed high prevalence (34.9%) of uncontrolled type 2 DM (HbA1c >9%) compared with the international benchmarks as per the Advancing Care with NCQA Diabetes Recognition Program.[1] A 5-year effectiveness study of the CCM in 53 436 primary care patients with type 2 diabetes suggested that the use of this model of care delivery reduced the cumulative incidence of diabetes-related complications and all-cause mortality. Patients who were enrolled in the CCM experienced a reduction in CVD by 56.6%, microvascular complications by 11.9% and mortality by 66.1%.[14]

The purpose of this quality improvement project was to evaluate the efforts of 18 governmental hospitals in the KSA that participated in a quality improvement collaboration which aimed at reducing the percentage (to be less than 15%) of patients with uncontrolled type 2 diabetes (HbA1c >9%).

Measurement

Our primary outcome measure was HbA1c poor control (>9%). This indicator measures the percentage of patients aged 18–75 years with diabetes who had HbA1c >9% during the measurement period.

The process measure was the all-or-none process measure (optimal testing). This indicator measures the patients with type 2 diabetes, 18–75 years of age and alive as of the last day of the measurement period, and had

Table 3 Strategies for change in each cycle and lessons learnt

Cycle No	Strategy for change	Key learning from the cycle
First learning session	► Implement diabetes guidelines and care delivery tools. ► Standardise chronic illness scope of service. ► Educate healthcare providers with diabetes guidelines.	► Hospitals had difficulty in establishing multidisciplinary teams, especially diabetic educators and case managers. ► Some hospitals faced supply issues related to albumin/creatinine and GFR laboratory reagents. ► Some hospitals had prescribing restrictions on newer antidiabetic medications, for example, GLP-1 receptor agonists. ► Difficulty in developing diabetes registry.
Second learning session	► Leadership engagement. ► Training programme for diabetic educators and case managers. ► Provision of essential supplies related to diabetes laboratory tests. ► Update prescribing privileges for diabetes medication. ► Development of central diabetes registry.	► Hospitals demonstrated modest improvements on process measures and outcome measure. ► Hospitals that implemented case management and integrated care had better outcomes. ► Leadership support facilitated improvements.
Third learning session	► Implementing diabetes registry for the enrolled hospitals. ► Patient stratification in relation to risk factors and HbA1c level. ► Including physician compliance to diabetes management guidelines in the physician yearly evaluation.	► Diabetes registry helped overview the sociodemographic and clinical measures of patients with diabetes. ► To track patients with uncontrolled type 2 diabetes who are prone to complication, develop more frequent follow-ups for them and manage the risk factors. ► Implementing sustainable interventions, for example, physician's yearly evaluation with diabetes compliance to management guidelines.

GFR, glomerular filtration rate; GLP-1, glucagon-like peptide-1.

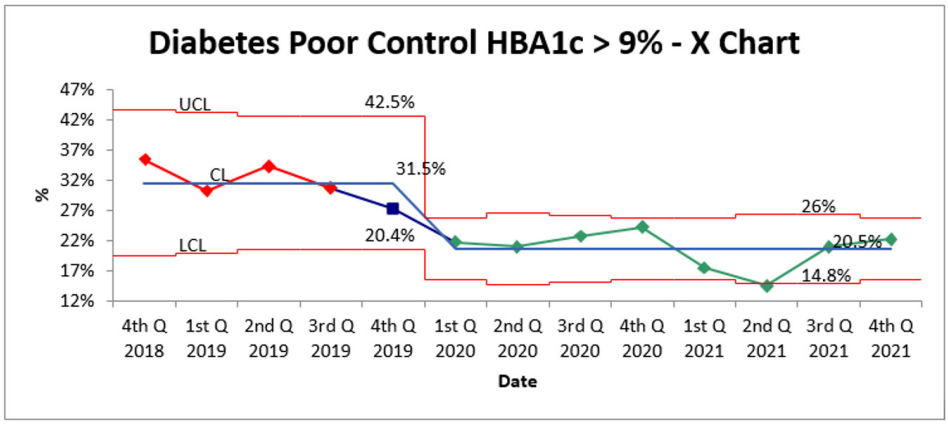

Figure 1 Diabetes Poor Control HbA1c >9% - X Chart

at least two HbA1c tests: one urine albumin/creatinine ratio test, and one estimated glomerular filtration rate test annually.

Our balancing measure was patients with diabetes who developed severe hypoglycaemia. This indicator measures the percentage of patients with diabetes who developed severe hypoglycaemia, which occurs if blood concentration is <54 mg/dL (3 mmol/L) and/or characterised by altered mental and/or physical functioning that requires assistance from another person for recovery. Table 1 describes the operational definition of our selected measures and table 2 details the results of our baseline measurement.

Online supplemental material describes the examples of interventions that led to improvement in key performance indicator (KPI) outcomes for patients with uncontrolled type 2 DM. Online supplemental table provides the details of hospitals enrolled in the project.

Data were analysed using control charts. Xbar-S chart was used to analyse pooled hospital data and compare variation between subgroups of participating hospitals. A before-and-after comparison of a calculated mean difference of percentage of HbA1c poor control (>9%) using t-test was performed. Correlation analysis was conducted to further investigate the relationship between the outcome measure and other measures. Statistical software *QI Macros* was used.

Intervention

Enrolled hospitals were required to implement an evidence-based change package that included implementation of diabetes clinical practice guidelines with standardised assessment and care planning tools. Furthermore, care delivery was standardised using a standard clinic scope of service that focused on multidisciplinary care teams. Finally, hospitals were required to implement diabetes registries that were used by case mangers for poorly controlled patients.

Strategy

Each hospital established an improvement team that included primary care physicians, nurses and quality experts. Improvement teams used the Institute for Healthcare Improvement (IHI) model for improvement as a tool for testing and implementing changes. Collaboration and learning between different hospitals were facilitated by conducting collaborative learning sessions using the IHI's Collaborative Model for Achieving

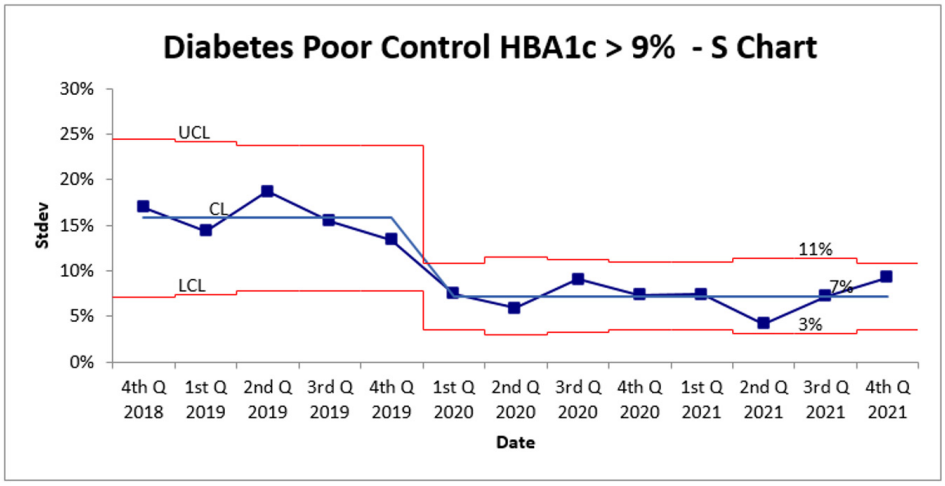

Figure 2 Diabetes Poor Control HbA1c >9% - S Chart

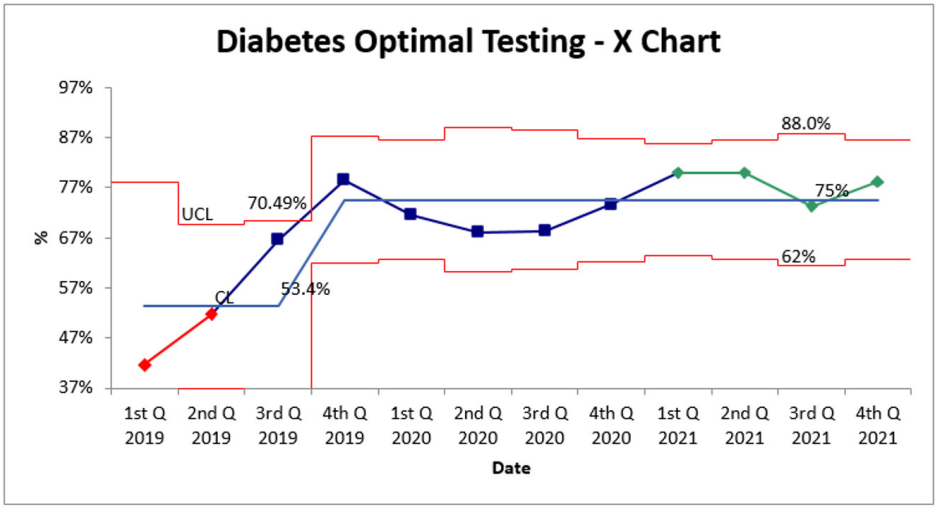

Figure 3 Diabetes Optimal Testing - X Chart

Breakthrough Improvement. In between these learning sessions, teams were required to provide progress reports every 6 weeks. During learning sessions, team members learnt from one another as they reported on successes, barriers and lessons learnt in general sessions, workshops, storyboard presentations and informal dialogue and exchange. The improvement teams underwent four learning sessions and an additional four action periods. Each hospital implemented and presented at least three improvement cycles. Table 3 summarises the strategies for change in each cycle and lessons learnt.

RESULTS

Outcome measure

Poor diabetes control (HbA1c >9%) showed improved mean difference of 12.7% (34.9% baseline, 22.2% after). Furthermore, the control chart demonstrates a downward shift in the outcome measure that started in the fourth quarter of 2018 (figure 1). Variation between hospitals was reduced by the end of the fourth quarter of 2021 (SD before: 16% and SD after: 9%) (figure 2).

Process measure

Diabetes optimal testing significantly improved from 41% at the start of the project in the fourth quarter of 2018, reaching 78% by the end of the fourth quarter of 2021 (figure 3). Variation between hospitals showed a significant reduction in the first quarter of 2021 among 49 452 patients (figure 4). Correlation between poor diabetes control (HbA1c >9%) and diabetes optimal testing showed a statistically significant negative correlation (correlation coefficient −0.64, p value 0.01), as shown in figure 5.

Balancing measure

Self-reported severe hypoglycaemia averaged at 1% with no significant change before and after conducting the improvement project (figure 6).

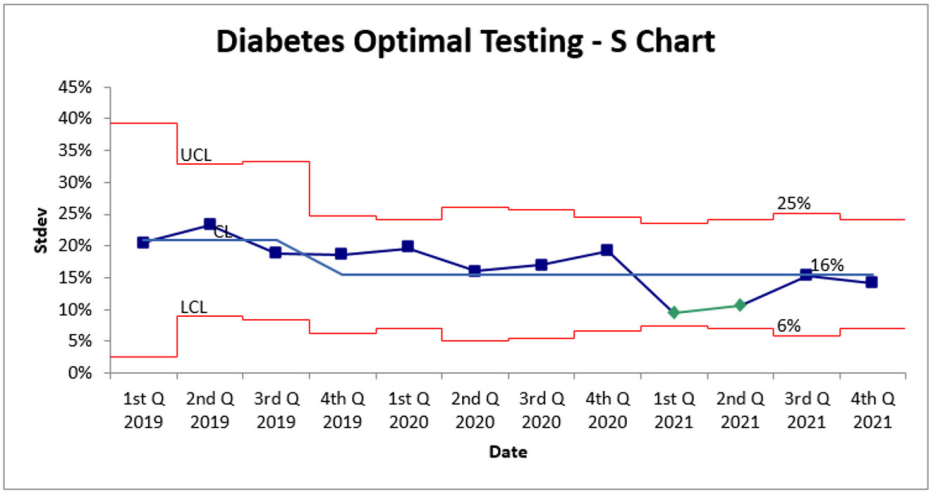

Figure 4 Diabetes Optimal Testing - S Chart

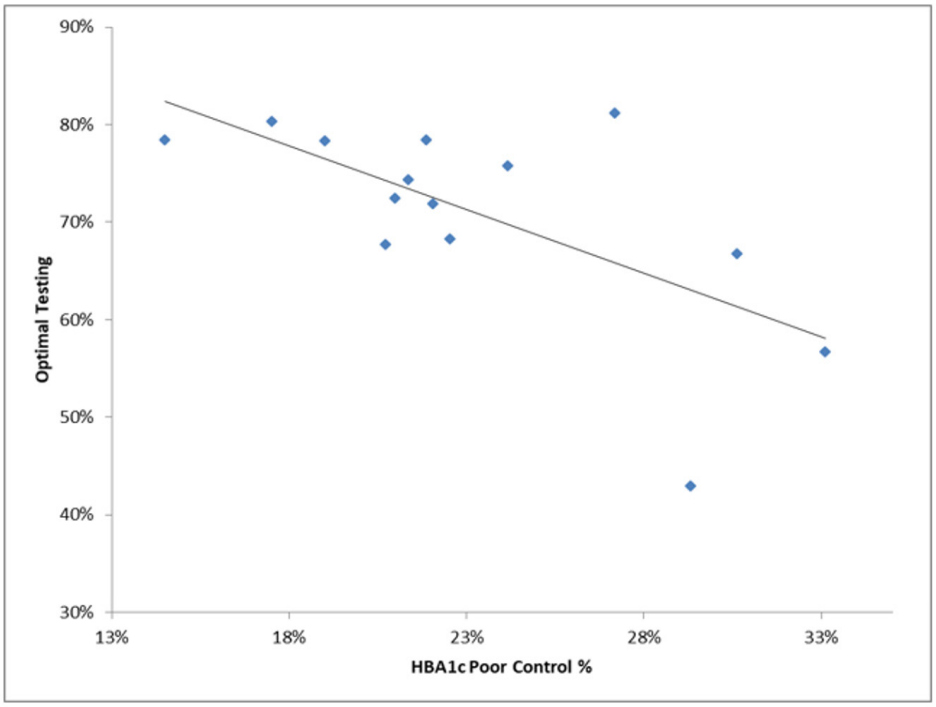

Figure 5 Scatter diagram showing the comparison between HBA1c Poor Control % and Optimal Testing

Lessons and limitations

The aim of the project was to improve the percentage of patients with poorly controlled type 2 diabetes to less than 15%.

This improvement project showed that the implementation of multilevel integrated healthcare interventions had positive impact on patients with uncontrolled type 2 DM. Interventions targeting individuals with a baseline HbA1c of >9% (>211.9 mg/dL) demonstrated significantly improved mean difference in HbA1c before and after the intervention. Evidence of downward shift was noted starting from the first quarter of 2020 to the fourth quarter of 2021. In spite of these results, hospitals had difficulty in sustaining the percentage of patients with uncontrolled type 2 diabetes below 20%.

The focus of change was to implement up-to-date clinical practice guidelines with all the required patient assessment and reassessment forms, and redesign the service provision in terms of integrated care,[15] multidisciplinary comprehensive team approach, patient stratification as per risk factors and comorbidities, resource availability, including physicians' compliance to diabetes management protocols in the annual evaluation,[16] and high administration support. The total number of patients included in this quality improvement project was 49 452.

Some of the challenges faced during project implementation were: the nature of the diabetes as a disease and the non-medical risk factors that influence HbA1c improvement as an outcome measure. Some of these factors are cultural pressures and sedentary lifestyle. These challenges were overcome by educating patients through diabetic educators as well as by implementing telemedicine clinics especially during the COVID-19 pandemic for more frequent patient follow-ups.[17]

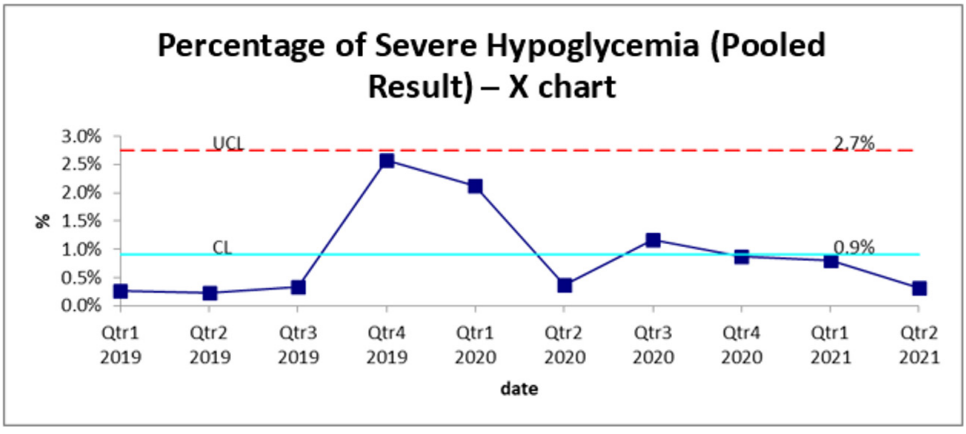

Figure 6 Control X Chart showing Percentages of Severe Hypoglycemia (Pooled Results)

Availability of multidisciplinary team members, especially the diabetic educators and case managers, was another challenge. The case managers were responsible for ensuring patients who met the criteria for patient enrolment in the integrated care services were provided with the appropriate patient care according to chronic illness clinic policies and guidelines, assessing changes in the process (such as timely testing for disease markers), standing orders for established clinical practice guidelines regarding the frequency of requesting laboratory tests (HbA1c, low density lipoprotein (LDL) and nephropathy screening), yearly retina examination and foot examination, and making sure that the comprehensive care plan which was agreed on by integrated care members was implemented.[17]

Key lesson learnt was that the collaborative multilevel approach of standardising the care based on best available evidence, integrated multidisciplinary services and patient-focused care were appropriate strategies to improve the HbA1c of patients with diabetes. While the present project could not achieve its aim, more realistic aim is advised as we adopt the NCQA Diabetes Recognition Program.[1] The interventions which will sustain improvement have to be thought of and implemented such as developing the policies, procedures and guidelines, including diabetes management in the annual physician evaluation.

One limitation of the project was comprehensive team availability in terms of diabetic managers and case managers in all hospitals at the same time which affected the outcome. Another limiting factor was the project duration which makes judging the sustainability of the outcome and process measures difficult. During the implementation phase of the project, the COVID-19 pandemic directly affected the care provision. Diabetes registry programme was not implemented in all hospitals at the same time due to logistic implementation problems which might have affected the generalisability of the project outcome. Also, comparing this project outcome with other studies might not be plausible due to methodological differences, diversity of interventions adopted and multidisciplinary healthcare teams included in this project. However, the assumption that the decline in HbA1c would certainly lead to substantial decrease in morbidity and mortality associated with type 2 DM and subsequent complications like CVD could be true.

CONCLUSION

Learning sessions and action period with continuous feedback strategy had a great effect on the outcome measures of the project.

Collaborative multilevel approach of standardising the care based on best available evidence throughout the policies, guidelines and protocols, patient-focused care, integrated care plan by multidisciplinary health team, both in-person and telemedicine clinics, regular follow-up visits, active surveillance and education via case managers and nurse educators, respectively, introduction of diabetes data registry and pharmacy home delivery services was associated with noticeable improvement in KPI outcomes for patients with poorly controlled type 2 DM with HbA1c >9% (>211.9 mg/dL).

Authorities concerned with the care of patients with type 2 DM should target patients with uncontrolled blood glucose levels (HbA1c >9%), as those individuals are more likely to gain the benefits of such multilevel integrated healthcare interventions. In addition, monitoring the process measures and at least one balancing measure is essential to improve the quality of diabetes care.

Recommendation

Finally, the findings of this project suggest that the implemented interventions could substantially decrease the number of patients with uncontrolled blood glucose levels (HbA1c >9%). Further improvement projects are recommended to study the cost-effectiveness of each intervention to prioritise comprehensive diabetes care provision. Additional studies should be designed to evaluate the effectiveness of implementing clinical decision support system interventions for patients with uncontrolled type 2 DM, which intends to better the healthcare services by improving medical decision-making with the help of patient-specific health information.[18]

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Contributors YKA: project team leader, conceptualisation and formal analysis. NA-N: planning, reporting of the paper. TJAH: planning, methodology and review of the manuscript. AMT: writing the manuscript. MMM: review and editing. TJAH is responsible for the overall content.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the Central Research Ethics Committee of Medical Services Directorate (CREC-MSD).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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