Quality improvement tools to manage emergency callbacks from patients with diabetes in a prehospital setting

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ABSTRACT

Diabetes is rising at an alarming rate, as 1 in 10 adults worldwide now lives with the disease. In Qatar, a middle eastern Arab country, diabetes prevalence is equally concerning and is predicted to increase from 17% to 24% among individuals aged 45 and 54 years by 2050. While most healthcare strategies focus on preventative and improvement of in-hospital care of patients with diabetes, a notable paucity exists concerning diabetes in the prehospital setting should ideally be provided. This quality improvement study was conducted in a middle eastern ambulance service and aimed to reduce ambulance callbacks of patients with diabetes-related emergencies after refusing transport to the hospital at the first time. We used iterative four-stage problem-solving models. It focused on the education and training of both paramedics and patients. The study showed that while it was possible to reduce the rate of ambulance callbacks of patients with diabetes, this was short-lived and numbers increased again. The study demonstrated that improvements could be effective. Hence, changes that impacted policy, systems of care and ambulance protocols directed at managing and caring for patients with diabetes-related prehospital emergencies may be required to reify them.

INTRODUCTION

Diabetes is a global healthcare concern. According to the WHO, diabetes affects 442 million people worldwide, and it caused approximately 1.5 million deaths in 2019.[1] Although it is a controllable chronic disease, its prevalence rate is nevertheless increasing with the number of diabetes-related emergencies, such as hypoglycaemia and diabetic coma, which can sometimes lead to a lethal outcome.[2 3] In addition, research demonstrated that newly diagnosed patients with diabetes might suffer from depression, resulting in their unwillingness to access medical services.[4–6] Most healthcare systems worldwide focus on managing in-hospital diabetic patients' admissions[7]; little attention has been paid to prehospital emergency medical systems (EMS) that could control and help avoid diabetes-related complications. According to data on patients with diabetes in

WHAT IS ALREADY KNOWN ON THIS TOPIC
⇒ According to the WHO, diabetes affects 442 million people worldwide. The prevalence rate and the number of diabetes-related emergencies, such as hypoglycaemia and diabetic coma, are gradually increasing. In an emergency, paramedics must transport patients to an appropriate healthcare facility once they are medically stabilised. However, some patients refuse hospital transport after receiving on-scene emergency treatment. Soon after, they call back with a similar complaint. This delays definitive medical care.

WHAT THIS STUDY ADDS
⇒ We demonstrated that providing adequate health education could reduce transport refusals, ambulance callbacks, and save resources. Thereby increasing the number of ambulances available to respond to other emergency calls.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY
⇒ Governmental (Hamad Medical Corporation Ambulance Service (HMCAS) and Hamad Medical Corporation Diabetes Center (HMC-DC)) and non-governmental (Qatar Diabetes Association (QDA)) organisations can complement each other in promoting better health, screening and disease prevention. This multisectoral approach is essential and creates a holistic patient experience.

the US National Emergency Medical Services Information System database, in 2015, 13.9% of diabetes admissions in emergency departments were made by EMS.[7] In Glasgow, Scotland, in 2019, around 40% of patients with diabetes attended to by ambulance services were referred to the hospital, and the callback rate was less than 5%.[8] In another study in Scotland, 49.8% of patients with diabetes reported having had hyperglycaemic emergencies; further, treatment by paramedics in prehospital settings significantly helped manage it, reducing the conveyance to the hospital to around 39%.[9] So far, no study has

explored the non-conveyance of diabetes emergencies in prehospital settings in the Middle East and North Africa (MENA) region.

By 2050, diabetes prevalence is predicted to increase to 24% among individuals aged between 45 and 54 years in Qatar.[10][11] The HMCAS delivers prehospital emergency medical care when individuals in Qatar call 999. Once patients are medically stabilised, paramedics must transport them to an appropriate healthcare facility.[12][13] The HMCAS' ambulance response times are short and consistent with international standards.[14] Thus, some patients refuse transport to the hospital after receiving on-scene emergency treatment but call back 999 with a similar complaint soon after. This could delay definitive medical care. Patients and paramedics in Qatar might not speak the same first language, creating a specific gap in providing concise and accurate advice about diabetes education. Additionally, the patient may fear the long waiting hours in the emergency department,[15] of which increase the odds of patients refusing transport to the hospital.

Effective communication with patients in prehospital settings is challenging for prehospital healthcare providers, primarily because they are unable to provide proper and consistent medical advice.[16] In 2016, 43.37% (N=504) of patients with diabetes treated by HMCAS refused hospital transport after receiving initial emergency medical treatment.[17]

Health education provided by prehospital medical staff to patients with diabetes needed to be enhanced.[18] Diabetes education is essential for self-management and positive health-related outcomes.[19] Therefore, training HMCAS paramedics to provide appropriate diabetes education could reduce the patients' 999 callback rates, thereby reducing the demand on HMCAS resources.

We conducted a quality improvement (QI) study aimed at reducing callbacks to 999 by patients with diabetes who refused transport to the hospital within 72 hours after receiving emergency treatment by HMCAS paramedics. We hypothesised that if HMCAS paramedics could provide appropriate diabetes education to patients, it would reduce the occurrence of diabetes-related emergencies and consequently reduce their callback rates within 72 hours. This study used Quality Control Tools (QCT) to demonstrate the implemented interventions' impact, understand process behaviour and identify potential solutions.[20]

METHODS
Context
This QI study was part of the Clinical Care Improvement Training Programme (CCITP)[21] organised by the Hamad Healthcare Quality Institute. The CCITP is a 4-month programme that builds knowledge among the healthcare staff about healthcare QI tools. Participants from different departments attended workshop sessions with online assignments alongside the CCITP improvement coaches and faculty, who guided the participants in conducting a basic QI project in their respective departments.

The HMCAS Clinical Practice Guidelines (CPG) define hypoglycaemia as a random blood sugar level (RBS) <4 mmol/L. The maximum level of acceptable postprandial hyperglycaemia is 10 mmol/L.[22][23] Thus, we excluded patients with RBS levels between four and 11 mmol/L. During the study period, 437 individuals with diabetes met the inclusion criteria. They received prehospital emergency care, declined hospital transport, but called back emergency services within 72 hours. Each patient was assigned a unique code in the online record system to conceal their personal information and protect their privacy.

This project hypothesised that delivering a good quality of health education to patients with diabetes who called 999 and were not conveyed to hospital helps reduce the incidence of callbacks made to 999 within a short period for the same issue. Further, four Plan–Do–Study–Act (PDSA) cycles were tested from 2017 to 2021. The PDSA approach is frequently used in healthcare as it helps conduct improvement projects in a structured manner to test the changes before implementation.[24]

The Standards for Quality Improvement Reporting Excellence checklist was used for preparing this article.[18] Minitab software V.17 was used for data analysis.

Interventions
We implemented several interventions for the paramedics working in Ambulance Service to equip them to deliver concise diabetic education in the prehospital setting. A future-state process map was produced (online supplemental appendix 1).

In the brainstorming sessions, multidisciplinary team members captured these ideas and developed an Ishikawa diagram, a standard Quality Tool (QT) used to record a problem's causes.[25]

PDSA cycles were used to test the implemented interventions. The key goal was to reduce callbacks to 999 patients with diabetes who refused transport to the hospital within 72 hours after receiving emergency treatment by teaching HMCAS paramedics how to provide concise and consistent health education to all patients with diabetes. It was hypothesised that adequate knowledge given by HMCAS paramedics to such patients would reduce the onset of diabetes-related emergencies and thus reduce callbacks.

These implemented improvement interventions were spread over the following four phases:

PDSA 1
Plan
► Improve the prerequisite paramedics' knowledge to provide concise and consistent health education to patients with diabetes in prehospital settings.

► Emphasise that the health education they provide is necessary to prevent life-threatening diabetic complications in patients who refuse transport to the hospital. As paramedics focus on attending to life-threatening situations, they may be unaware that providing appropriate health education also helps prevent life-threatening diabetes emergencies.

The interventions were conducted in HMCAS hubs 1, 2 and 4 in 2017.[14] They represent 37.5% of HMCAS hubs and cover about 70% of Qatar's population.

Do

► A knowledge assessment survey was conducted to measure all HMCAS paramedics' knowledge about diabetes health education.
► Cognitive Aid Cards (CAC) (figure 1) with educational content were prepared and attached to all portable patient monitors of the vehicles in these hubs (figure 1). The CAC contained educational content that was easy to understand and implement daily. For example, 'Use stairs instead of elevators', 'Help with house chores, as a type of physical activity', 'Park their cars in distant locations at malls', and 'Eat their preferred food but in moderate quantity followed by exercise'. The HMC diabetes educators were consulted to determine the appropriateness of the content.
► Between 21 April 2017 and 30 April 2017, in addition to the CAC pieces of advice, paramedics from the concerned hubs also distributed informative leaflets to all patients with diabetes who called 999 (figure 1). Governmental (HMC-DC) and non-governmental (QDA) organisations in Qatar supplied these leaflets (N=300).
► Further, at least one improvement team member was present in the hubs included in this phase of the study at the change shift time at 5:00 and 17:00 hours each day between 13 April 2017 and 20 April 2017, to brief each staff about the interventions.
► On 4 May 2017, a staff circular was disseminated to encourage paramedics to provide consistent and concise health education to all patients with diabetes treated in prehospital settings using the CAC and the leaflets.
► Nine days later, another survey was conducted to determine whether the paramedics' knowledge about diabetes education had improved.
► The responses to both surveys were analysed. The daily numbers of patients with diabetes who called 999 for diabetes-related emergencies and refused transport were collected, along with the numbers of patients with diabetes who called back within 72 hours of refusing transport.

Study

► The impact of the interventions on the paramedics' knowledge about education of patients with diabetes.

► The impact of the interventions on reducing the number of patients with diabetes who called 999 back within 72 hours of refusing transport.

Act

► Decide whether to sustain the interventions, adapt and retest or not.

PDSA 2
Plan

► Between July 2017 and December 2018, sustain and reinforce the same plan of PDSA1.

Do

► The CACs were attached to the portable patient monitors of all HMCAS emergency section ambulances.
► An educational poster was created and displayed in all HMCAS hubs. It contained diabetes health information to be given by paramedics to every patient with diabetes who called 999 and received emergency treatment regardless of the type of complaint they called for (figure 1).

Study

► The impact of the interventions on reducing the number of patients with diabetes who called back within 72 hours of refusing hospital transport initially.

Act

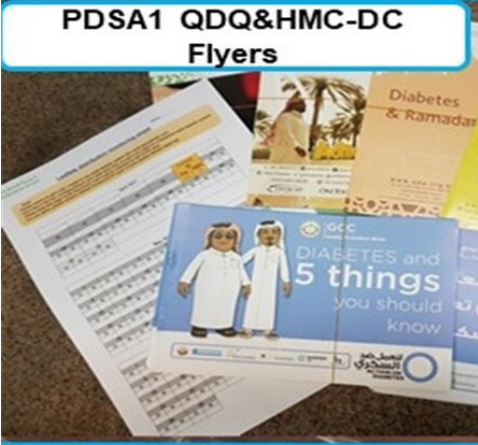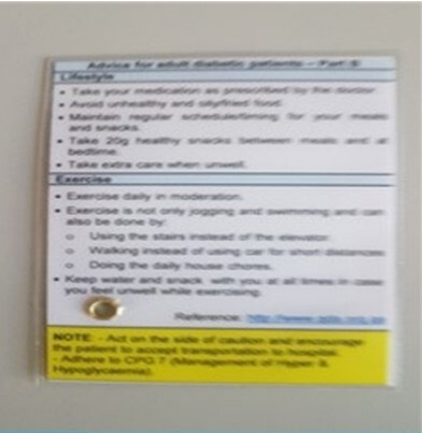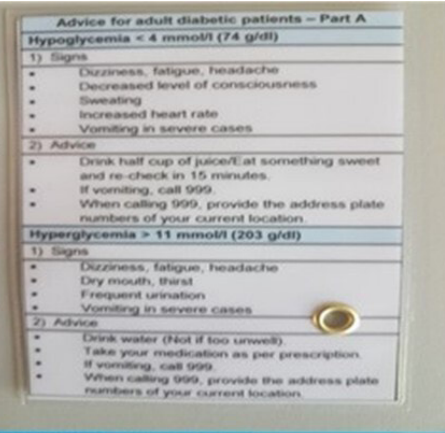► Decide whether to sustain the interventions, adapt and retest or not.

PDSA 3
Plan

► At the beginning of 2018, sustain the interventions implemented in phases 1 and 2 with minor modifications.

Do

► The project team suggested a modified version of the existing HMCAS diabetes CPG. It included motivational pieces of advice, health education information utilised in the CAC, and the staff educational poster from the previous PDSA cycles. They were suggested to be included as part of the emergency treatment the paramedics delivered.
► Based on the demographic information in the previous PDSA cycles and literature review,[26–29] the team suggested adding the Glucagon intramuscular injection as part of the emergency treatment of severe hypoglycaemia in the CPG. The rationale was to provide paramedics with more treatment options. Sometimes it might be difficult to find intravenous access for elderly patients, making it challenging to administer Dextrose 10% intravenously. Dextrose has been the emergency treatment for severe hypoglycaemia in the HMCAS and worldwide EMS.[28 30 31]
► These suggestions were approved in 2019.

Figure 1 PDSA phase 1 and 2 interventions. HMC-DC, Hamad Medical Corporation-Diabetes Center; PDSA, Plan–Do–Study–Act; QDA, Qatar Diabetes Association; RBS, random blood sugar.

Study
► The impact of the interventions on reducing the number of patients with diabetes who called back within 72 hours after refusing transport at first.

Act
► Decide whether to sustain the interventions, adapt and retest or not.

PDSA 4
Plan
► In 2020, sustain the outcome of the previous phases by refreshing the paramedics' knowledge about the importance of diabetes health education.

Do
► The team advised to include the outcome of this project in the 1-day continuous professional development (CPD) medical course delivered to HMCAS staff. All HMCAS paramedics (Ambulance Paramedics and Critical Care Paramedics) must attend the medical CPD course annually. It was conducted 49 times and was attended by 477 staff, despite an interruption between April and September 2020 during a peak of the COVID-19 pandemic.

Study
► The impact of the intervention on reducing the number of patients with diabetes who called back within 72 hours after refusing transport at first.

Act
► Decide whether to sustain the interventions, adapt and retest or not.

Measures and analysis
The weekly proportion of patients with diabetes who called back within 72 hours of receiving prehospital emergency treatment but refusing transport was monitored to measure the interventions' impact.

Shewhart or Statistical Process Control (SPC) charts were generated to understand variations in the collected data. This chart is a statistical tool that aids clinical and administrative decisions when monitoring a process. It has been effective in statistically measuring healthcare output.[32 33]

SPC P-charts (figure 3) were generated to display the weekly proportion of patients with diabetes who refused hospital transport and the proportion of callbacks within 72 hours for a similar complaint. SPC R-charts (figure 4) were produced to monitor the monthly number of patients with diabetes who refused transport and the monthly number of callbacks within 72 hours following transport refusal.

RESULTS
From 1 January 2017 to 30 April 2021, the 999 HMCAS call centre received 1163 diabetes-related emergency calls. Callbacks occurred within 72 hours in 37.58% of cases (n=437). 87.7% (n=565; 52.27% females) of hospital transport refusal calls were hyperglycaemic emergencies, and 12.3% (n=79) were cases of hyperglycaemia.

We created histograms of these data to investigate patients' age and RBS level distribution (figure 2). The mean age of patients with diabetes who refused transport to the hospital was 61.89 years, with an SD equal to±17.15 (figure 2). The histogram was skewed to the right compared with the Gaussian distribution. This indicated that most of them were older than 61.89 years. For the RBS level distribution: in the low RBS level group, the mean RBS level was 2.22 mmol/L, with an SD equal to±0.54. Hence, the histogram was skewed to the right compared with the Gaussian distribution. This indicated that the number of patients with RBS levels <2.22 mmol/L was less than those with RBS levels between 2.22 mmol/L and 4 mmol/L. In the high RBS group, the mean RBS level was 16.65 mmol/L, with an SD equal to±5, with the histogram skewed to the left, indicating the number of patients with RBS levels between 12 mmol and 16.65 mmol was higher than those with RBS level >16.65 mmol/L.

Figure 3 illustrates patient transport refusals. The process was stable before the interventions, which shifted before PDSA 2. In figure 3, callbacks were included, and a special cause was identified just before week 17 (below the lower control limit) with a significant drop in the proportion of patients with diabetes who called back 999 within 72 hours during the intervention. Between weeks 17 and 22, special causes were identified (above the upper control limit). Therefore, PDSA 1 and PDSA 2 were associated with a reduced proportion of weekly hospital transport refusals by patients with diabetes. The impact of PDSAs 1 and 2 on weekly callbacks by patients with diabetes within 72 hours of emergency medical attention was unclear, but a shift occurred shortly before PDSA 2 and was sustained during PDSA 2.

The project process was enhanced in PDSA 2 in 2017 and was sustained in 2018. After 2019, the transport refusal and callback rates increased proportionally (figure 4). Very few special cause variations were identified.

DISCUSSION
In the last decade, various countries, including the UK and the USA, acknowledged the importance of training paramedics in effective health education as they connect the healthcare system with the community.[34 35] In the MENA region, providing health education in prehospital settings has rarely been considered, primarily because of financial constraints.[36 37] In addition, social media has been identified as an essential resource to provide health education to patients with diabetes[38]; nonetheless, this was outside the scope of our study. Our collaboration with HMC-DC and QDA enabled us to use existing diabetic education leaflets that paramedics could distribute to the patients. We demonstrated the potential of improving cooperation between different healthcare agencies,[39]
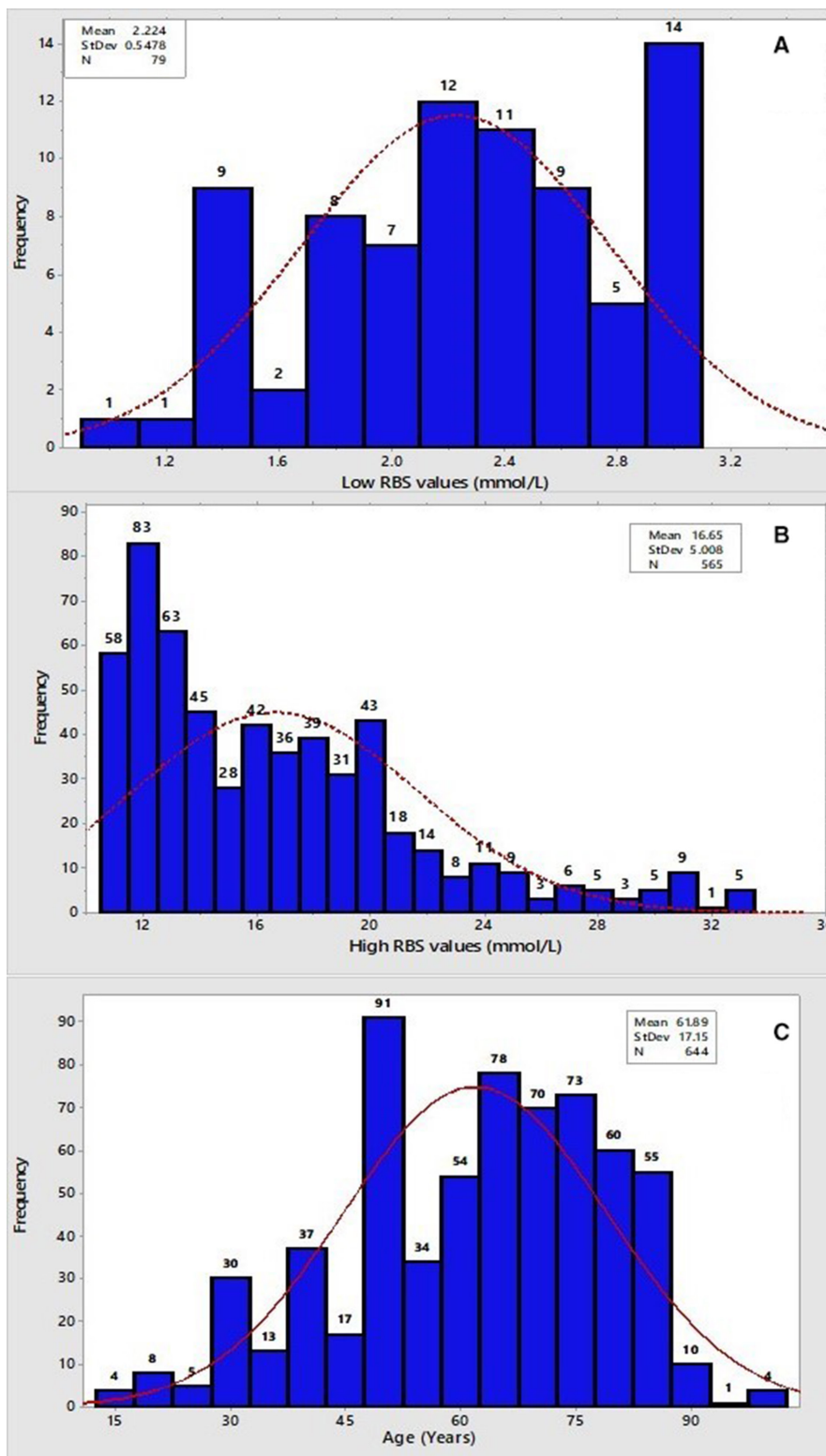
Figure 2 Random blood sugar (RBS: A and B) and age (C) histograms of patients who called 999 and refused transport to the hospital.

and even between various departments within the same organisation.[40 41]

Some studies in the MENA region and Asia have discussed the importance of prehospital health education in reducing out-of-hospital cardiac arrests.[42–44] However, to our knowledge, no study has examined prehospital

healthcare workers' ability to provide health education to patients with diabetes in prehospital emergency settings. Using the information provided to the paramedics in the CAC and the staff education poster, patients with diabetes were advised on how they could still eat their preferred foods while minimising their glycaemic index (GI) and
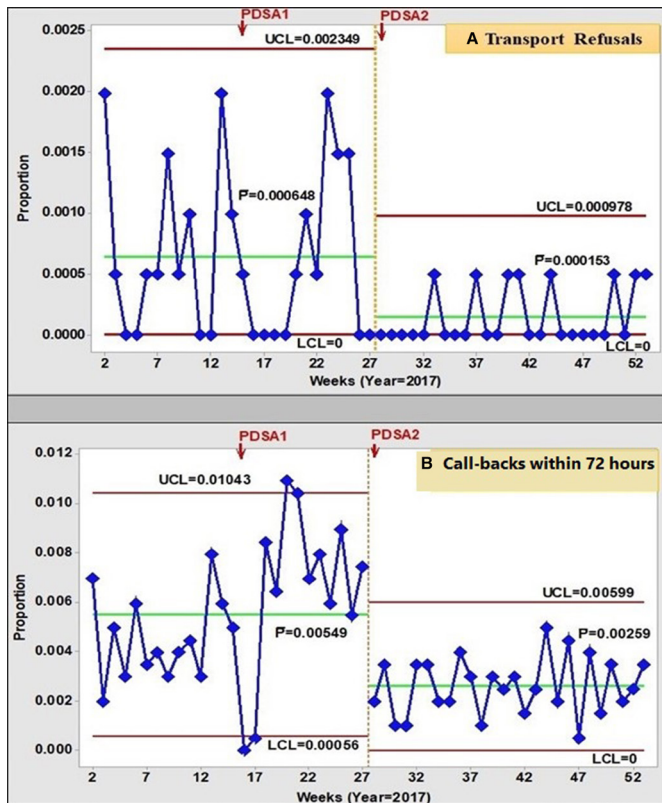
Figure 3 Shewhart P-charts of all patients with diabetes weekly (A) transport refusals and (B) callbacks within 72 hours after transport refusals in 2017. PDSA, Plan–Do–Study–Act; UCL, Upper Control Limit; LCL, Lower Control Limit.

food intake quantity. Paramedics were advised to use understandable terms to describe food quantity (eg, in 'handfuls' instead of grams) and their nutritional input according to patients' GI.[45] Additionally, recommending excessive physical activity could adversely affect the well-being of patients with diabetes[46]; thus, in this study, patients were advised to engage in moderate but regular physical activities.

Ethnicity is a contributing factor in type two diabetes.[47] In our study, demographic information was only available for 644 patients who dialled 999 and refused hospital transport after receiving treatment, representing 58.23% of the study sample. Of these, 42.82% (n=276) were Qatari, 11.02% (n=71) were other Arabic nationalities, and the rest belonged to nine different nationalities (from South Asia, East Asia, Europe and America). This diversity makes providing concise health education to multilingual patients with diabetes challenging.[48 49]

We used QCT, including SPC charts, to monitor the interventions' effects. Although SPC charts (figures 3 and 4) could not explain the variation in transport refusals and callbacks, histograms (figure 2) helped identify that most transport refusal patients were above 60 years of age. Diabetes self-management can be more challenging for this age group.[50] In this study, most patients with diabetes, had a very low RBS level, sometimes less than two mmol/L, while others had a very high RBS level, sometimes greater

than 20 mmol/L (figure 2). Therefore, suggesting adding in the CPG, the Glucagon intramuscular injection as part of the emergency treatment of severe hypoglycaemia was proven necessary. Using these histograms, decision-makers could conclude that prehospital education techniques for patients with diabetes should consider these factors. Further, SPC charts (figures 3 and 4) were used to monitor the interventions' impact on reducing calls-back by patients with diabetes within 72 hours of refusing transport.

SPC charts are helpful and effective for monitoring processes and improvement efforts. They can clarify the variation within a process and differentiate between normal variation and special causes.[51] We recalculated the control limits after 29 data points[51] for the P-control charts (figure 3) to map with the PDSAs, and found that the proportion of refusals and callbacks by patients with diabetes was significantly reduced after two PDSA cycles. Both processes were stable and predictable. The SPC R-bar charts (figure 4) were better for observing variation over a long period with many data points. They demonstrated that these processes (refusals and call-backs of patients with diabetes) were unstable and unpredictable with the appearance of a few special variation causes after implementing PDSA 3. After implementing PDSA 4, the number of transport refusals and callbacks within 72 hours increased, and special causes appeared
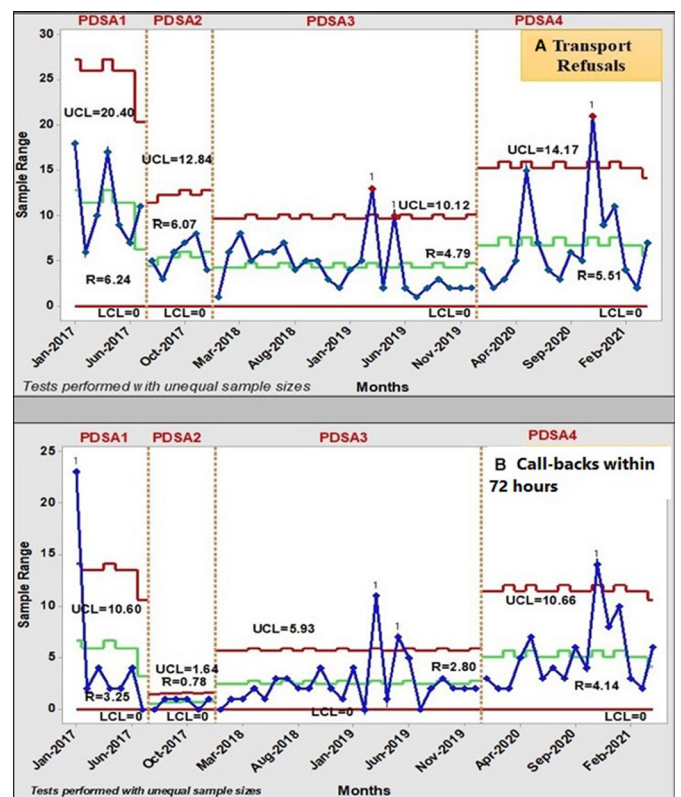

Figure 4 Full study Shewhart R-bars charts of all patients with diabetes monthly (A) transport refusals and (B) callbacks within 72 hours after transport refusals. PDSA, Plan–Do–Study–Act; UCL: Upper Control Limit; LCL: Lower Control Limit.

again, reflecting the unstable and unpredictable process. The COVID-19 pandemic significantly affected healthcare systems[52 53] and most likely affected the previously observed improvements, as patients feared COVID-19 exposure at hospitals.[54] The control charts in figure 4 indicate that the process started regaining stability in early 2021. Further monitoring is required to determine the current state and establish the need for another PDSA cycle.[33 54]

Limitations

First, most project team members were new to healthcare QI tools initially. CCITP training aimed to teach healthcare professionals how to use essential QI tools through small interventions in their departments in a subject they chose. Thus, this study's primary team was new to the QI field and was only later reinforced with QI experts at the start of PDSA 4. A more experienced team may have approached aspects of this project differently and collected more demographic data. Second, demographic diversity, representing multiple languages and levels of health education awareness, challenged the development of patient education material.[55] Third, the project relied on secondary data; hence some data were missing. Fourth, the pressure of the increased emergency calls managed by HMCAS (from 177 628 calls in 2016 to 268 953 in 2020) may have affected the quality of health education provided by the staff, which may explain why the improvement was seemingly not sustained. These limitations contributed to our inability to stratify the control charts by gender or blood sugar level groups and enable further process analysis.

CONCLUSION

Prehospital emergency medical services have a finite capacity; hence, patient callbacks put additional pressure on resources, may delay definitive care and could result in adverse health outcomes. Through this study, we reduced the callback rate of patients with diabetes who refused hospital transport but called back within 72 hours following two PDSA cycles. However, this was not sustained, as the analysis did not account for the gradual increase in emergency calls. This study demonstrated that providing adequate health education could reduce emergency callbacks and save resources to respond to other emergency calls. The multisectoral coordination between the HMCAS, the HMC-DC and the QDA was fruitful and helped create a holistic patient experience. Further cooperation between prehospital and in-hospital emergency medical services and other institutions may enhance health education and ensure access to effective patient care.

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