



Original Article

Vaso-occlusive crises in patients with sickle cell disease: Parents' perspectives and association with disease outcomes

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المخلص

أهداف البحث: لقد تم تسجيل ارتفاع في نسبة انتشار الإصابة بمرض الخلايا المنجلية في المملكة العربية السعودية. ويعتبر أكثر المضاعفات شيوعاً لدى الأطفال الذين يعانون من مرض الخلايا المنجلية هو الألام الناتجة عن أزمات انسداد الأوعية الدموية، التي تحدث عندما تتجمع خلايا الدم الحمراء المصابة وتسبب احتشاءات في الأوعية الدموية الصغيرة. تهدف هذه الدراسة إلى تقييم مستوى الوعي حول أزمة انسداد الأوعية الدموية بين آباء مرضى الأنيميا المنجلية في منطقة المدينة المنورة وتأثير ذلك على أعراض المرض.

طرق البحث: دراسة مقطعية، أجريت باستخدام استبانة منظمة ومحقة. شملت العينة 123 مشاركاً، من آباء أطفال مصابين بالأنيميا المنجلية تتراوح أعمارهم بين 2 إلى 18 عاماً يعيشون في منطقة المدينة المنورة.

النتائج: متوسط درجة المعرفة الكلية كان 30 ± 4 . حيث يتمتع غالبية الآباء (74%) بمستوى جيد من المعرفة. كان هناك ارتباط كبير بين مجموع نقاط المعرفة ونتائج المرض خلال العام الماضي للدراسة كما أظهر التحليل الإحصائي نتائج غير معتبرة بعد ربط المعرفة الكلية بتعليم الأب والأم وكذلك دخل الأسرة. يعتقد أولياء الأمور أن أفضل طريقة لزيادة الوعي بأزمة انسداد الأوعية الدموية هي اجتماعات التثقيف الصحي المباشرة بنسبة 60.97%، بينما يعتقد 21.13% أن المعلومات المكتوبة أفضل، ويعتقد 13.9% أن الإنترنت سيكون خياراً جيداً لزيادة الوعي.

الاستنتاجات: أظهرت الدراسة وجود وعي جيد عند آباء مرضى الأنيميا المنجلية عن أزمات انسداد الأوعية الدموية. ولقد أثرت معرفة الآباء بطبيعة المرض على نتائج أزمة انسداد الأوعية الدموية في أطفالهم بشكل إيجابي.

الكلمات المفتاحية: أزمة انسداد الأوعية الدموية؛ فقر الدم المنجلي؛ الاحتشاء؛ معرفة الوالدين؛ الأطفال

Abstract

Objectives: KSA has been reported to have a high prevalence of sickle cell disease (SCD). The most common complication of SCD in children is pain due to vaso-occlusion crises (VOCs) that ensue when sickle-shaped red blood cells are entrapped in small vessels, leading to infarcts. This study aimed to determine the level of awareness about VOCs among parents of patients with SCD and its correlation with the disease outcomes.

Methods: A cross-sectional study was conducted including 123 parents of children with SCD, aged 2–18 years old. All recruited participants were residents of Almadinah Almunawwarah. A structured and validated questionnaire was used for data collection.

Results: The mean total knowledge score was 30 ± 4 . The majority of parents (74%) had a good level of knowledge about SCD. There was a significant association between the total knowledge score and the outcome of VOCs during the year prior ($p < 0.05$). There was no association between the total knowledge score and the parents' education and family income. Regarding methods of increasing awareness of VOCs, 60.97% of parents thought that the best method was by direct meetings about health education, while 30.89% preferred to have written information about the disease. Only 21.13% argued that the internet was a better choice for raising awareness.

Conclusion: In this study, the parents of SCD patients had a good level of knowledge about VOCs. There was a significant association between the parents' awareness of

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VOCs and a better disease outcome in their children, as they had fewer attacks and hospital admissions.

Keywords: Children; Infarction; Parents' awareness; Sick cell disease; Vaso-occlusive crisis

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Introduction

Sickle cell disease (SCD) is a common autosomal recessive disorder affecting red blood cells. It is characterised by the production of an abnormal type of haemoglobin, haemoglobin S (Hgb S).¹ The prevalence of sickle cell disease in children and adolescents in KSA is estimated to be 24 per 10,000.²

The most common complication of sickle cell anaemia in children is painful vaso-occlusion crises (VOCs).³ Painful crises happen when red blood cells become sickle-shaped and are trapped in small vessels,^{4,5} causing infarcts of various organs, including the lungs, spleen, bones, and brain.^{6,7} The first episode of painful crises in patients before 2 years of age is usually called dactylitis, which affects the small bones of the hands and feet.⁸ As the patient gets older, the crises are widely distributed over the body but occur more commonly in the lower back, legs, and arms.^{9,10} These crises can be acute or chronic. Acute crises are caused by blockages in the small blood vessels, and chronic crises are defined as repeated attacks of crises.¹¹ Chronic pain usually leads to tissue damage in the bones, joints, and visceral organs.¹² The risk factors of painful crises include exposure to cold, hypoxia, acidosis, infection, dehydration, physically demanding activity, and emotional stress.¹¹ Painful crises are the cause of 50–60% of emergency visits and 60–80% of hospitalisations in children with SCD.⁸ It is proven that hospitalisation owing to VOCs adversely affects school attendance and performance.¹⁰ There are many effective treatment modalities that improve the outcome of SCD such as hydroxyurea and blood transfusion.^{13,14} However, blood transfusions have restricted indications in SCD.^{15,16}

Different international studies in countries with high incidences of SCD have discussed awareness of sickle cell anaemia, including a study in Nigeria, which assessed the knowledge and attitudes of SCD among 137 selected secondary school students. They found that the majority (83.2%) of the respondents were aware of SCD, 80.0% were aware it was an inherited disorder, and 83.0% that it affected the red blood cells, but only half (54%) knew that the disease can only be diagnosed through a blood test.⁴ Another study was conducted in Bahrain about SCD awareness in the general population and it was reported that public awareness of this disease among Bahraini people is very

good in general. They illustrated that almost 93% had heard of SCD, 89% knew that it can be diagnosed by a blood test, but 51% did not know the prevalence of SCD in Bahrain.¹⁷ In KSA, which is also known to have a high incidence of SCD, we found a recent study published in 2018 conducted in the Albaha region that studied the perceptions among the general population about SCD. The results showed that the majority (68.8%) were aware of the basics of SCD. Those who had less awareness of SCD (31.2%) were mainly young males, businessmen, and housewives.¹⁸

We are not aware of any local study that discussed the awareness of vaso-occlusive crisis risk factors among parents of patients with SCD and we assume that increasing awareness will have a positive impact on the outcome of the disease.

Objectives of the study

To determine the level of awareness of VOC among parents of patients with SCD in the Almadinah Almunawwarah region and its association with the outcome of the disease, measured by the number of attacks and number of admissions due to VOCs in the year before the study period.

Materials and Methods

A cross-sectional study was conducted via telephone calls from researchers using a questionnaire. The questionnaire was structured with questions covering the epidemiological data of the patient and his/her parents; the parents' knowledge about the disease, its risk factors, and ways to prevent attacks of VOCs; and determining the parents' preferred way to improve their knowledge. The number of VOCs and the number of hospital admissions in the year before the study was also obtained. The patients' contact information was obtained from the Almadinah Almunawwarah Hereditary Blood Disorders Charity Society (AAHBDCS) after receiving the parents' consent. The questionnaire was reviewed by three haematology consultants who are experts in the field and was tested on a pilot sample of 30 parents. The study population consisted of 583 individuals, and were all parents of children and adults with SCD who are registered in the AAHBDCS.

Parents of children aged 2–18 years living in Almadinah Almunawwarah and who speak either Arabic or English were included in the study. A total of 249 individuals were initially included. Patients with sickle-thalassemia disorder and/or other co-inherited haemoglobinopathies were excluded. Patients who received regular blood transfusion (transfusion-dependent patients) and those who were not followed up in a Almadinah Almunawwarah regional hospital were also excluded. In total, 76 participants were excluded owing to outdated contact details, and 2 patients died due to VOC complications before the study period. Finally, a total of 123 individuals were included in the study sample and answered the questionnaires.

Data analysis

SPSS (version 24; IBM, Armonk, NY) was used for statistical analysis. Means and standard deviations were used for continuous variables, and proportions and confidence intervals were used for categorical variables. To find an association between awareness of VOC and disease outcome, Student's *t*-tests and chi-squared tests were used.

Results

A total of 123 participants who completed the questionnaire. There were 57.7% fathers, 39.8% mothers, 0.8% brothers and 1.6% sisters who completed the questionnaire and were included in the study. The description of their level of education and the family income is shown in [Table 1](#).

Approximately half (50.4%) of patients' family incomes were less than 5000 SR per month. The patient characteristics including age, nationality, and residency are described in [Table 2](#).

Caretaking for the patient's medical condition was done most frequently by both parents (54.5%). Most patients were regularly followed up (82.9%). Almost 15% had difficulties continuing their follow up regularly: of these, 55.56% claimed transportation issues, 22.22% financial problems, 16.67% travelling long distances, and 5.56% were unable to attend during a parent's working hours ([Table 3](#)).

Most participants (68.3%) had not heard of VOCs as the medical term for the crisis. Approximately 69% heard of it from their doctors, and 15% had come across it on the internet. It was good to find that while most parents were aware of possible triggers for VOCs in their child, few had

Table 1: Patients' family profile.

Patients' family profile		Count	Percentage
Relation to the patient:	Father	71	57.7%
	Mother	49	39.8%
	Brother	1	0.8%
	Sister	2	1.6%
Fathers' educational level:	Illiterate	13	10.6%
	Primary	22	17.9%
	Intermediate	21	17.1%
	Secondary	32	26.0%
Mothers' educational level:	University graduate	35	28.5%
	Illiterate	16	13.0%
	Primary	31	25.2%
	Intermediate	20	16.3%
Family income:	Secondary	24	19.5%
	University graduate	32	26.0%
	Less than 5000 SR	62	50.4%
	5000 to 10000 SR	32	26.0%
10000 to 15000 SR	10	8.1%	
More than 15000 SR	19	15.4%	

Table 2: Patients Profile.

Patients' profile		Count	Percentage
Age (Mean ± SD) (12 ± 4)			
Nationality:	Saudi	84	68.3%
	Yemeni	19	15.4%
	Nigerian	12	9.8%
	Chadian	3	2.4%
	Sudanese	2	1.6%
	Iraqi	1	0.8%
	Pakistani	1	0.8%
Residency:	Mali	1	0.8%
	Almadinah	94	76.4%
	Almunawwarah		
	Khaibar	17	13.8%
	Al-Ola	9	7.3%
	Yanbu	2	1.6%
Badr	1	0.8%	

Table 3: Patients status and follow-up condition with SCD.

Parameter		Count	%
Who is taking care of the child and his/her medical condition?	Father	6	4.87%
	Mother	49	39.8%
	Both parents	67	54.5%
	The patient	1	0.81%
Is the access to hospital easy?	Yes	105	85.4%
	No	18	14.6%
If "No", mention the cause: (n = 18)	Financial problems	4	22.22%
	Transportation	10	55.56%
	Difficult to attend during work time	1	5.55%
	Travelling long distance	3	16.66%
Is the patient on regular follow-up?	Yes	102	82.9%
	No	21	17.1%
If "Yes", mention the hospital name:	Maternity & Children Hospital	80	78.43%
	King Fahad Hospital	15	14.70%
	Ohud Hospital	1	0.98%
	Prince Sultan Armed Forces Hospital	7	6.86%
	National Guard Hospital	1	0.98%
	Khaibar General Hospital	2	1.96%
	Yanbu General Hospital	1	0.98%
	Prince Abdul Mohsen Hospital (Al-Ola)	2	1.96%

wrong beliefs of possible triggers. Again, this was obvious when they were asked about possible preventative measures of VOCs, possible best treatment options, and possible complications. It was found that 21% of parents thought that VOCs did not impact their child's school performance (Table 4).

The average number of VOCs during the year before the study was 4 ± 5 , while the number of attacks requiring admissions during that year were 1 ± 2 .

Only 50.4% of patients received the recommended vaccinations for SCD. The comparison between the number of VOCs and the number of admissions in those who were vaccinated and those who were not was insignificant, with a mean of 3.76 and 3.64 attacks respectively (Table 5).

Analysis of results showed a correlation between the total knowledge score and the number of VOCs ($P < 0.05$). However, the correlation between the total knowledge score and the number of admissions was insignificant.

We found no correlation between the father's and mother's educational level and the total knowledge score, nor there was a correlation between family income and the total knowledge score ($P > 0.05$).

Comparing the results of residents of the city of Almadinah Almunawwarah to those in the outskirts, there was no significant statistical difference in the total knowledge score and number of admissions. However, there was a significant statistical difference in the number of VOCs in the year prior ($P < 0.05$) (Table 6).

Table 4: Parents' knowledge about vaso-occlusive crisis.

Parameter		Count	%
Have you ever heard of vaso-occlusive crisis?	Yes	39	31.7%
	No	84	68.3%
If yes from where? (parent can choose more than one answer) (n = 46)	Your doctor	27	69.23%
	Written information	7	17.94%
	Internet	6	15.38%
	Family and friends	6	15.38%
What conditions may trigger vaso-occlusive crisis? (parent can choose more than one answer) (n = 734)	Cold weather	121	98.37%
	Hot weather	67	54.47%
	Going to sea	40	32.52%
	Fatigue	117	95.12%
	Fever	111	90.24%
	Eat frozen vegetables	14	11.38%
	Vomiting and diarrhea	77	62.60%
	Lack of air	86	69.91%
	Drink fresh juice	1	0.81%
	Taking vaccine	6	4.87%
	Infection	94	76.42%
	What factors can prevent the vaso-occlusive crisis? (parent can choose more than one answer) (n = 1333)	Drinking plenty of fluids	123
Avoiding getting very cold		120	97.56%
Having fluids on hand, both at home and away		117	95.12%
Avoiding known sources of infection		114	92.68%
Avoiding sitting with smokers		113	91.86%
Vaccinations		110	89.43%
Practicing good hand hygiene		110	89.43%
Seeking emergency medical attention for any temperature of 38.5 C or higher		110	89.43%
Avoiding environments with low oxygen like high altitudes		103	83.73%
Avoiding emotional stress		96	78.04%
Avoiding demanding physical activity		83	67.47%
Avoiding very tight clothes		73	59.34%
What of the following treatment modalities can help during the vaso-occlusive crisis? (parent can choose more than one answer) (n = 643)	Avoiding getting over-heated	61	49.59%
	Bed rest	117	95.21%
	Oral fluids	121	98.37%
	IV saline	105	85.36%
	Oral analgesia	107	86.99%
	Injected analgesia	105	85.36%
Do you think children with vaso-occlusive crisis are more likely to develop the following complications? (parent can choose more than one answer) (n = 431)	Blood transfusion	88	71.54%
	Severe pain such as pain in the bones and abdomen	122	99.18%
	Infection that threatens the patient's life: high temperature to 38 °C	81	65.85%
	Kidney failure	38	30.89%
	Clots	87	70.73%
	Respiratory complications: Dyspnea, chest pain	103	83.73%
Do you think vaso-occlusive crisis can impact a child's school performance?	Yes	97	78.9%
	No	26	21.1%

Table 5: Comparison of number of vaso-occlusive crises during the last year and number of admissions during the last year regarding the patient vaccination as recommended in SCD.

	Yes (n = 62) 50.4%		No (n = 61) 49.6%		p-value
	Mean	S.D	Mean	S.D	
How many vaso-occlusive crises during the last year?	3.76	4.367	3.64	5.231	>0.05
How many admissions during the last year?	1.29	1.885	1.38	2.382	>0.05

Table 6: Comparison of Total Knowledge score and place of residency.

	Almadinah Almunawwarah (n = 94)		Outside Almadinah Almunawwarah (n = 29)		p-value
	Mean	S.D	Mean	S.D	
Total knowledge	29.94	3.666	30.86	3.292	>0.05
How many vaso-occlusive crises during the last year?	3.89	4.662	3.07	5.244	<0.05
How many admissions during the last year?	1.53	2.336	0.69	1.105	>0.05

Table 7: Ways to increase awareness.

What do you think the best way to increase awareness of vaso-occlusive crisis? (parent can choose more than one answer) (n = 139)	Health education meetings	75	60.97%
	Written information	38	30.89%
	Internet	26	21.13%

The parents' knowledge score was on average 30 out of 38 with a standard deviation of 4, ranging from 19 to 37. As a percentage, the average knowledge score was 79% for all parents; 74.0% of parents had a good level of knowledge (above 66.6%) and 26% had a fair level of knowledge (33.3–66.6%). No one had a very poor level of knowledge (below 33.3%).

The majority of parents (60.97%) stated that they thought the best way to increase awareness of VOCs was by direct health education meetings, while 30.89% selected written information as a better tool, and 21.13% thought that the internet was best (Table 7).

Discussion

Although VOCs are the most common complication of SCD, we found that 68.3% of parents had not heard the term “vaso-occlusive crisis” before, but they realised it as a painful crisis despite not knowing the pathophysiology causing the pain, as it was translated to Arabic when we asked. Of those who had heard the term before, 69.23% knew about it from their doctors, while 17.94% knew it from written information, and 15.38% had seen it on the internet or heard of it from family and/or friends. We expected a larger number claiming education from the internet due to its wide availability, but it seems low educational levels and low family income might have played a role in limiting their access to this excellent source of information. We did not find studies discussing VOC awareness online to compare with our results.

While the majority of parents did not know “VOC” as a medical term, they were actually aware of many important triggering factors leading to VOCs, as most of the parents listed cold weather, fatigue, and fever as risk factors. Most respondents in other studies were aware of those factors as well.^{17,18} We found that a lower percentage of parents were less aware of common and important factors such as infection, low oxygen, vomiting, diarrhoea, and hot weather. The last two triggering factors also had a low percentage as demonstrated in Al-Bahrain's study.¹⁷ That percentage was similar with our result regarding low oxygen concentration due to high altitude as a triggering factor in Albaha's study, but in comparison with Al-Bahrain's study their respondents were well-aware of this factor.^{17,18}

Several parents had wrong beliefs, as they stated that going to the sea, eating frozen vegetables, vaccinations, and drinking fresh juices could trigger a VOC. Other studies discussed this point and they found that some of their population had wrong beliefs regarding fava beans, veganism, and nuts as triggering factors of VOC crises.^{17,18} Such wrong beliefs should be explored more and corrected when talking to patients and parents.

Regarding the awareness of VOC prevention, it was an excellent finding that 100% of parents knew that drinking plenty of fluids is an effective preventative measure. They were also aware of other preventative measures, such as having fluids on hand both at home and away, avoiding known sources of infection, avoiding sitting with smokers, receiving recommended vaccinations, practising good hand

hygiene, seeking emergency medical attention for any temperature of 38.5 °C degrees or higher, avoiding environments with low oxygen (like high altitudes), avoiding emotional stress, and avoiding physically demanding activities. In contrast, 40–50% of parents did not think that wearing tight clothes and overheating were risk factors. This again needs more attention from educators to correct parents' misconceptions. We believe that this finding has contributed to the general belief that parents keeping their children warm in winter is always good to prevent VOCs. However, they were not aware that this action itself could precipitate VOC if they used very tight clothes or if they overheated SCD patients, causing dehydration.

It was good to find that more than two-thirds of parents were familiar with all VOC treatment modalities. The same was proved in other studies.^{17,18} However, again, this demands more education of parents as special consideration should be paid to involve them in the management of their affected children.

Almost all parents (99.2%) were aware and appreciated that severe pain is a complication of VOC, which was observed in other studies as well.^{17,18} In contrast, the parents who knew about life-threatening complications of SCD raised a concern of the importance of education and the efforts which should be put toward improving it. For example, 76.1% did not know kidney failure is a possible complication, 34.15% did not realise that serious infections could happen, 29.27% were unaware that clots in the central nervous system and other places could occur, and 16.27% lacked knowledge about acute chest syndrome and other chest complications that their children are at high risk of developing.

Although there were no statistically significant correlations between receiving vaccinations and the number of VOCs or the number of admissions during the year prior, it was concerning that almost half of the patients studied did not receive the recommended vaccines. In fact, it was documented in different studies that SCD patients' adherence to the recommended vaccinations had low rates, but they could not explain the cause, which appeared to be multifactorial.^{19,20} In another study trying to improve the influenza vaccination rate, which was less than 50% in the study population, they were able to increase it up to 90% after using quality improvement methods.²⁰ It would be of great value to apply a similar method with our SCD patients and their parents with the hope of improving the outcome of the disease and the quality of their lives.

Another focus of our study was on school performance, which was covered by asking parents if they believe that SCD has an effect on their child's performance in school. Our results were consistent with others, who showed that up to 50% of SCD patients failed at least one time in school.¹⁰ It was obvious in our results that the majority of parents agreed that VOCs have a negative impact on their child's school performance, which indicates their high level of awareness and demands special care of those patients to improve their performance in school and the importance of involving their teachers in our management plans.

More than two-thirds of our sample parents had a good level of knowledge and the rest had a fair level of knowledge. Fortunately, none of the parents had a poor level of knowledge. The mean of the total knowledge score was 30 ± 4 out of 38. There were no significant correlations between the total knowledge score and family income, educational level of the father or mother, and residency.

As we proposed in our research question, we found that there is a correlation between the total knowledge score and the number of VOCs during the year prior. We could not find similar studies to compare our results with, but we know that this was proved in many other studies of different chronic diseases. The relation between knowledge level and outcome of other chronic diseases has been documented, and it has been found that a low level of knowledge about diabetes was directly proportional with its outcome.^{21,22} Another study found that using a structured interdisciplinary education programme had a positive impact on decreasing blood pressure level.²³

We also found that the knowledge score was not correlated with the number of hospital admissions in SCD patients. This might be explained by the fact that severe VOCs requiring admission will still happen even if the awareness of the disease pathophysiology among parents was high, which is affected by the type of mutation present in SCD patients. This can be also viewed as a good practice if these parents were bringing their children to the hospital when they have severe symptoms and not managing them at home. Other factors that could have played a role affecting the number of admissions of those patients are limitations owing to accessibility to medical services, particularly in low-income families, non-Saudi patients, and those living outside the main city. We found that 50.4% of participants had low incomes (less than 5000 SR), 31.7% were non-Saudi, and 23.6% lived outside the main city.

In addition to the suspected difficulties in accessing medical facilities that faces patients living outside Almadinah Almunawwarah, it was observed in a separate study that rural residents were using coping strategies rather than seeking care at hospitals.²⁴

Limitations

The limitations of our study were mainly the limited sample size and the limited literature found about the role of awareness of VOCs and its effect on disease course.

Conclusion

There was a good level of awareness among parents of SCD patients about VOCs in general. Although they had a good level, much still needs to be done to improve their knowledge as it is expected to improve the outcome of VOCs in their children.

Recommendations

According to our findings, we suggest increasing awareness of VOCs through organising regular health education

meetings with parents and their affected children, as it was the most preferred choice by the parents. We assume they preferred this method because they can understand better, interact directly, and explore their concerns more. It will be important to encourage them to access trusted internet sites while seeking medical information to improve their knowledge and level of awareness of the disease. In addition, it is crucial for treating physicians and other medical team members to explore a parent's wrong beliefs, paying more attention to educating them about triggering factors and preventative measures against VOCs.

A nationwide programme is recommended to raise awareness of sickle cell anaemia and its complications and to investigate the role of premarital screening in KSA. Further studies in this field will aid the medical community and patients with sickle cell anaemia.

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We do not have a funding source.

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

This study was approved by the Institutional Review Board of Taibah University and the General Directorate of Health Affairs in Almadinah Almunawwarah. All data were handled with high confidentiality and privacy.

Authors contributions

MAZ conceived and designed the study and contributed in writing and revising the results and the final version of the paper. GSM analysed and prepared the data. GKS collected the data and wrote the final draft. DHQ collected the data and provided logistic support to the team. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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