A cross-sectional analysis of the short-term outcomes of patients receiving prehospital treatment for symptomatic hypoglycaemia in Cape Town

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Introduction: There has been a growing prevalence of patients with chronic medical conditions in South Africa, diabetes mellitus being one of them. Acute symptomatic hypoglycaemia (SH) refers to decreased level of plasma glucose < 3.5 mmol/L accompanied by an altered level of consciousness. Pre-hospital management of such episodes includes reversal by oral and/or intravenous glucose administration, or intramuscular glucagon administration. Post-reversal, patients may refuse transport to hospital, which may result in recurrent episodes of acute SH. The aim of this study was to retrospectively determine the outcomes of adult SH patients who were treated and discharged pre-hospital.

Methods: A retrospective cross-sectional study design was used. Patient report forms from patients with SH managed in the pre-hospital setting between May 2012 and September 2012 in the greater Cape Town area were extracted from the Emergency Medical Services (EMS) database. A follow-up survey using a closed-ended questionnaire was administered to these same patients within seven days post-reversal to evaluate the efficacy of pre-hospital discharge of SH patients.

Results: A total of 110 eligible patients were identified and telephonically interviewed. It was found that 21 (19%) of cases had subsequently died. Of the 89 remaining cases, 30 (34%) reactivated EMS within seven days of discharge, independent of SH being the chief complaint. In total, 48 (54%) had recurrent episodes of SH within seven days of discharge by EMS. In 47 (53%) of cases discharged by EMS, no follow-up instructions were provided to mitigate recurrent SH episodes or complications.

Conclusion: More than half of patients who received pre-hospital treatment and discharge for SH had recurrent symptoms post-reversal by EMS staff, with a third needing to reactivate EMS. This would suggest that the current strategy of dealing with such cases needs careful re-evaluation to improve the quality of management of this patient population.

African relevance

- In Africa, pre-hospital symptomatic hypoglycaemia is common in diabetics and is often coupled with resource-confined environments for the required treatment.
Within the Western Cape EMS. Furthermore, no formal "treat and discharge" protocols exist in the pre-hospital environment is limited in terms of diagnostic capabilities. Consequently, the practitioner is not in a position to necessarily identify the cause of the SH they are treating. Furthermore, no formal "treat and discharge" protocols exist within the Western Cape EMS.

Methods

The patients for this study were selected from the Northern, Southern, and Western districts of Cape Town, South Africa, in alignment with the Western Cape EMS districts. These patients were identified from the Western Cape EMS district database system. This database is updated daily by data captures from patient care report forms. Data fields include case types, response and mission times, clinical assessment, and interventions with disposition methods.

A retrospective cross-sectional study design was used. Patient report forms for patients with a primary or secondary diagnosis of SH between May 2012 and September 2012 were extracted from the EMS database, yielding a convenience sample of 110 consecutive eligible SH cases. A telephonic follow-up survey based on a closed-ended questionnaire was conducted within seven days of the initial reversal to evaluate the outcome of the pre-hospital discharge.

This study included all adult (over 18 years of age) SH patients with a documented blood glucose level less than 3.5 mmol/L and a reduced level of consciousness. Study participants were matched to these criteria using a check sheet, which also served as a quality assurance intervention to the study. Blood glucose levels were determined by glucose monitors (i.e., no colorimetric visualization methods allowed). Patients must have been discharged in the pre-hospital environment post-reversal using oral and/or intravenous and/or intramuscular hyperglycaemic agents. SH patients outside the Western, Southern, and Northern Districts were excluded, as were Cape Town Fire and Rescue Service cases, private sector EMS cases, and inter-facility transfers. During the telephonic interview, patients unable to speak and understand English, Afrikaans, or Xhosa were excluded, as these represent the most common languages spoken in the Western Cape. Patient report forms with illegible or absent patient and/or contact information were regarded as non-contactable.

A protocol existed for contacting patients and/or their next of kin in a systematic manner for up to three tries, after which they were regarded as non-contactable. The telephonic surveys were conducted by the principal investigator and a trained secondary reviewer in English, Afrikaans, or Xhosa, dependent on the patient's language preference. The interviews were conducted off a script that was available in all three languages following forwards and backwards translation for accuracy. Fig. 1 outlines the sampling process.

Results

110 SH patients were eligible for a telephonic interview. Of note, speaking to third parties, 21 (19%) of the original cases were subsequently found to have died following the initial EMS activation and were therefore unavailable for the survey. The scope of this survey did not allow for the investigation of the presumed causes of death in these patients. The breakdown of cases is shown in Table 1. Of specific interest is the mean age of 56 years (SD = 13) for this cohort and that cases were almost equally distributed between males and females.

Of the contactable 89 cases, 54 (61%) had subsequent recurrent episode/s of SH within seven days of discharge by
EMS, with 30 (34%) of these cases re-activating EMS in the same time period (Fig. 2). This was independent of SH being the chief complaint and of motivation for re-activation of EMS.

Cases with a recurrent episode of SH were noted to use the following chronic diabetic medications: 12 (23%) oral diabetic agents only, 26 (50%) insulin only, and 14 (27%) both oral agents and insulin, with 36 (41%) of the 89 eligible patients not using any medication at the time of the incident.

Hospital admission within seven days post EMS discharge was required for 46 of the 89 SH cases (52%). The reasons for admission included infections (21%), hypoglycaemia (9%), uncontrolled hypertension (6%), cerebrovascular accidents (6%), and hyperglycaemia (10%), all of which may be linked to underlying diabetes mellitus.

Prior to discharge following SH reversal, 35 (39%) of patients recall receiving follow-up or other patient information. Seven (8%) of patients were either unable to recall the information or whether this information was even provided.

Fig. 3 stratifies recurrent SH episodes and provision of follow-up instructions by the levels of provided pre-hospital care. Notably, there were recurrent SH episodes amongst all levels of care, despite the provision of instructions. Of the 35 BLS, 45 ILS, and 13 ALS managed cases, 21 (60%), 24 (53%), and 9 (75%) had recurrent episodes, respectively, and thus required further intervention. Across all 89 cases, 59 (66%) reactivated EMS within seven days of the index pre-hospital discharge.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographics and characteristics of cases studied.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Value</td>
</tr>
<tr>
<td>N</td>
<td>110</td>
</tr>
<tr>
<td>Age (years)</td>
<td>56 (30–83)</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>59 (54%)/51 (46%)</td>
</tr>
<tr>
<td>Deceased</td>
<td>21 (19%)</td>
</tr>
<tr>
<td>Level of prehospital care provided (including deceased cases):</td>
<td></td>
</tr>
<tr>
<td>BLS</td>
<td>39 (35%)</td>
</tr>
<tr>
<td>ILS</td>
<td>56 (51%)</td>
</tr>
<tr>
<td>ALS</td>
<td>15 (14%)</td>
</tr>
</tbody>
</table>

* Median (range) values.
It was also found that post-discharge after SH reversal, patients had experienced the following abnormal signs and symptoms: headaches with or without dizziness 30 (27%), increased levels of sweating 15 (14%), abdominal discomfort 14 (13%), nausea and vomiting 12 (11%), and weakness and confusion 9 (8%). These symptoms are highly suggestive of recurrent SH episodes.

Discussion

Symptomatic hypoglycaemia is considered a serious complication of diabetes mellitus. SH may be disease-induced or precipitated by single or multiple medications used in combination. The treatment of pre-hospital SH is often limited to short term management strategies, with minimal capacity for the detection or treatment of underlying pathologies contributing to the index event.

This study suggests that recurrent SH episodes are associated with the reactivation of EMS resources. The decision to discharge a patient immediately after reversal in the pre-hospital environment is often motivated by patient refusal of hospital admission and further care. These requests cannot be denied on the basis of patient autonomy and legal rights. However, a large number of cases eventually reactivated EMS within the study period. Although the precise triggers for the second calls were not ascertained, several patients had signs and symptoms suggestive of repeat SH episodes.

The outcomes of this study may be compared to a 1998 prospective descriptive study from the USA evaluating the short-term outcomes of acute SH patients after discharge. That study showed that 91% of cases had recurrent episodes within 72 h, with 9% of these cases reactivating EMS. Though the recurrence rate was higher in the US study, reactivation of EMS was higher in our local cohort. Within our context, this could be attributed to poor socio-economic circumstances and reduced access to definitive care.

Within the Western Cape EMS, providers utilise blood glucose monitors as part of their scope of practice. These monitors have inherent limitations as they usually require calibration, a quality assurance step that is often not performed. Test strip accuracy may be influenced by expiration, extreme temperature fluctuations, and humidity. These factors may lead to under- or over-detected blood glucose levels, which influence treatment and discharge strategies.

In BLS cases or in cases where intravenous access cannot be established, oral hyperglycaemic agents are administered. These agents are short acting and may require a longer period of time to achieve the desired blood glucose level, thus potentiating neurological fallout. This effect may be partly responsible for data seen in this study, where 60% of the BLS cases experienced recurrent episodes, as oral glucose may have resulted in premature discharge. Current South African pre-hospital ILS and ALS protocols for the management of acute SH patients include the administration of intravenous dextrose 50%, intramuscular or intravenous glucagon, and oral anti-hypoglycaemic agents. The current dextrose dosage results in a faster time to achieve normoglycaemia. However, high concentration dextrose may induce hyperglycaemia in the short term and/or result in renewed hypoglycaemia in the longer term. This phenomenon may also have played a role in this study, in which 53% of ILS cases and 75% of ALS cases experienced recurrent episodes of SH. An additional treatment is the biosynthetic form of glucagon, which increases blood glucose by stimulating its release from the liver by the process of glycogenolysis. However, this method is dependent upon adequate endogenous glucose stores, which may already be exhausted due to repeated episodes of hypoglycaemia, starvation, extensive liver damage, or adrenal insufficiency. These factors are often unknown to pre-hospital providers.

Within the Western Cape EMS system, SH patients are primarily discharged if they refuse further care or show normalization of blood glucose levels and a return to their normal level.
of consciousness on scene. Current pre-hospital discharge practices are not sensitive to risk mitigation, as they are not tempered by underlying causative factors. Recurrent SH episodes may also be linked to medication usage, with specific emphasis on self-administered insulin and dose related errors. Common oral agents such as the sulfonylureas, metformin, and antibiotics have also been shown to potentiate SH. The increased rates of subsequent SH episodes and EMS reactivation shown in this study may have been linked to inadequate dosing of these agents and concomitant medication usage. In support of this, recurrent SH was especially evident in patients using insulin when compared to oral diabetic agent use only. This pattern is supported by a recent systematic review stating that 47% of a group of 267 patients treated with insulin presented with recurrent SH episodes.

Current levels of prehospital care with the Western Cape EMS include BLS, ILS, and ALS, with the vast majority of practitioners only having BLS and ILS training. BLS and ILS practitioners primarily treated patients included in this study. This may have posed a significant risk to patients due to the limited capabilities of these practitioners. This study showed that only 29% of BLS patients, 42% of ILS patients, and 33% of ALS patients were given information and follow-up instructions, potentially contributing to the findings of recurrent SH episodes in 60% of BLS patients, 53% of ILS patients, and 75% of ALS patients. Patient outcomes may also have been independent of information provided. It is noted that in some cases where instructions were known to be verbally provided, patients were unable to recall such information. The manner in which providers provided any information, or whether it was influenced by poor cognitive states post-SH reversal remains uncertain. Decreased levels of plasma glucose result in sympatho-adrenal nervous system stimulation, and subsequent further drops in glucose may result in an increase in mortality and morbidity. Consequently, multiple recurrent SH episodes increase the risk for neurological deficits with resultant long term local and systemic morbidities. Furthermore, these neurological deficits may affect cognitive function and thus the patient’s ability to reason and make adequate decisions around further care strategies. This is not usually considered in the pre-hospital discharge process, and thus becomes a concern in this study population.

Follow-up care instructions play a key role in the safe discharge and discharge of patients, particularly in the pre-hospital context. These instructions should ideally be in writing, evidence-based, and vetted against patient outcomes (as demonstrated in Appendix A). They should also include standardised information cards for the patient or bystanders to identify early signs and symptoms of recurrent SH. Criteria may also be linked to differential underlying pathologies upon which the patient, bystanders, or practitioners may act appropriately. However, a disadvantage of this may be the inability of some patients to interpret this information, in some cases due to the chronic complications of diabetes mellitus such as inadequate vision.

Subsequent to repeat activation of EMS after initial discharge, 52% of the study patients required hospitalisation. In a similar study conducted in 2008, 199 acute SH patients were followed after pre-hospital discharge after reversal of hypoglycaemia. In this group, 16% required hospital admission. It was also noted that severe cases of hypoglycaemia were shown to have an 18% recurrence rate within a 48-h period. In another recent cohort study it was shown that patients with recurrent SH had extended hospital stays, increased morbidity, and an increased need for specialised nursing. A recent review of cost impact per patient presenting with hypoglycaemia in Spain described that a single episode may cost in excess of €3500 (≈ZAR 52,500 at current exchange rates). Thus, repeat SH episodes may prove to be very costly for patients and funders. A major compounding factor is that of quality of life for patients experiencing long-term effects from recurrent SH episodes.

Though this study was not designed to further explore the causative factors leading up to death, a high proportion of SH cases initially discharged were found to have died upon telephonic follow-up. Further, it may be that a number of the patients who did not respond to the telephonic challenge might also have died. The contribution of SH disposition strategy to overall mortality remains speculative. There may be a link between misdiagnoses or inabilitys to detect underlying causes of SH and mortality in this cohort. Furthermore, medication administration and interactions may have increased mortality in this group.

This study population was limited to three Metropole EMS divisions, so data cannot necessarily be extrapolated to the remainder of the Western Cape population. However, as detailed, these divisions are fairly typical and major differences at least within the Western Cape are not expected. A major difficulty encountered in data collection was the identification of pure SH cases, often due to ambivalent data. A further limitation was the exclusion of data from Fire Services, private EMS agencies, inter-hospital transfers, and other first responders. There was likely also a degree of recall bias during the telephonic interview, though this was hopefully limited by using the seven-day time limit for interviews to be done. A detailed analysis of time sequences in both prior and post- index SH episodes relative to underlying co-morbidities was not possible. With reference to the need for hospital admission post-SH reversal, the diagnosis provided by patients or relatives may not have been on the causal pathway from the index SH episode. For deceased cases, a detailed analysis of causal pathways and associations with the index SH episode was not possible with the study methodology employed. This study also lacked a control group measuring the rate of recurrent visits to Emergency Centres and EMS callouts.

Conclusion

A determination of underlying causative factors is a vital part of the treatment of SH. Even in this small study, 52% of patients required hospitalisation following initial treatment and pre-hospital discharge for an episode of SH. More effective “treat and discharge” protocols should be developed to reduce repeat episodes, repeat EMS calls, and mitigate risks. These protocols should use a systematic approach to the management of acute SH for all levels of pre-hospital care providers. Risk stratification tools should be included. These mitigation strategies may also reduce the development and progression of co-morbidities and should be developed in conjunction with hospital-based Emergency Centres that also treat these patients. Currently, no evidence exists on the long and short-term outcomes of the implementation of such strategies.
This is of importance in the Western Cape and South Africa as a whole. Comprehensive and understandable education is an important treatment component when considering pre-hospital discharge of any patient, though a consistent relationship between providing information and recurrent SH episodes was not seen in this particular study. Effective patient and relative information cards should be developed and implemented to enable the patient and their family to make informed choices regarding follow-up and emergency care.

Conflicts of interest

The author declares no conflicts of interest.

Dissemination of results

Results from this study were shared with the Cape Town Medical Emergency Transport and Rescue Emergency Medical Services (METRO EMS) through an informal presentation.

Author contribution

M.R.B. conceived the original idea, designed the experiments, carried out analysis of data and prepared the manuscript.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.afjem.2015.03.003.

References