

## HIV management by nurse prescribers compared with doctors at a paediatric centre in Gaborone, Botswana

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**Objectives.** To compare compliance with national paediatric HIV treatment guidelines between nurse prescribers and doctors at a paediatric referral centre in Gaborone, Botswana.

**Methods.** A cross-sectional study was conducted in 2009 at the Botswana-Baylor Children's Clinical Centre of Excellence (COE), Gaborone, Botswana, comparing the performance of nurse prescribers and physicians caring for HIV-infected paediatric patients. Selected by stratified random sampling, 100 physician and 97 nurse prescriber encounters were retrospectively reviewed for successful documentation of eight separate clinically relevant variables: pill count charted; chief complaint listed; social history updated; disclosure reviewed; physical exam; laboratory testing; World Health Organization (WHO) staging documented; paediatric dosing.

**Results.** Nurse prescribers and physicians correctly documented 96.0% and 94.9% of the time, respectively. There was a trend

towards a higher proportion of social history documentation by the nurses, but no significant difference in any other documentation items.

**Conclusions.** Our findings support the continued investment in programmes employing properly trained nurses in southern Africa to provide quality care and ART services to HIV-infected children who are stable on therapy. Task shifting remains a promising strategy to scale up and sustain adult and paediatric ART more effectively, particularly where provider shortages threaten ART rollout. Policies guiding ART services in southern Africa should avoid restricting the delivery of crucial services to doctors, especially where their numbers are limited.

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In areas where HIV prevalence is high and resources are limited, models of care that rely exclusively on doctors to provide patient management are not always feasible. Doctor shortages are expected to continue worsening in high-prevalence settings in coming years, further exacerbating these difficulties.<sup>1,2</sup> This is particularly true where the availability of paediatric HIV care is concerned, as global shortages of doctors with paediatric experience are well documented,<sup>3-5</sup> and nearly 7 of every 10 children who need antiretroviral therapy (ART) do not currently receive it.<sup>6</sup> A distinct challenge to the global goal of universal access to ART is therefore the under-representation of children, as opposed to adults, in ART programmes.<sup>6,7</sup>

Programmes are therefore increasingly turning to task-shifting strategies to address human resource limitations and to facilitate

both decentralisation and scale-up of health care services.<sup>8</sup> The African experience with task-shifting of HIV care and treatment by non-doctor clinicians has so far increased the number of patients on ART and improved the decentralisation of services.<sup>9-14</sup> While there are legitimate concerns about the quality of task-shifted care,<sup>13,15</sup> good outcomes have been documented in the context of appropriate training and support for task-shifted personnel.<sup>16,17</sup> Many developing countries have few options other than task-shifting for the rapid scale-up of HIV care and treatment programmes.<sup>3,6,9,13</sup>

Even in the context of conflicting data regarding the reliability of task-shifting, nurses are an attractive target for task-shifting of ART management, given their ubiquitous role in health systems and their availability in most high HIV prevalence settings. In Botswana there is approximately 1 doctor per 3 500 people,<sup>18</sup> but they tend to work in large urban facilities, beyond the reach of Botswana's largely rural population. Indeed, many rural clinics are currently staffed entirely by nurses. Compared with other countries in southern Africa, Botswana's nurse-to-patient ratio is relatively high,<sup>18</sup> and this robust cadre is well positioned to catalyse ART rollout in the country.<sup>10,18</sup>

In response to Botswana's limited supply of doctors able to provide HIV management, the Botswana Ministry of Health's nurse-prescriber training programme commenced in 2008, extending access to an estimated 20 000 clients in rural Botswana.<sup>19</sup> Nurses are trained to become nurse prescribers to provide routine ART management for stable patients, including children, as defined by standardised criteria.

We investigated the performance of this new cadre of providers of paediatric ART, using charting documentation to compare the rate of compliance with national HIV guidelines by doctors and certified nurse prescribers in a single government-affiliated clinic in Botswana. The nature of the pre-service training received by the nurse prescribers reviewed is as follows:

**Training components.** Four weeks of training on management of ART for stable paediatric patients, including didactics and practicum;

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an additional month of clinical mentorship attached to a licensed physician with paediatric HIV experience.

**Training objectives.** Correctly prescribing ART; monitoring therapeutic outcomes; identifying and managing appropriately adverse reactions related to ART; addressing adherence issues; understanding when referral to an HIV-experienced physician is required (including ART failure and severe ART toxicity); providing other aspects of HIV care; monitoring laboratory results; isoniazid preventive therapy; and co-trimoxazole prophylaxis.

We are not aware of any studies that compare this metric in resource-limited settings, and this is the first published study from Botswana that compares compliance with national HIV guidelines of doctors and nurses in the management of HIV-infected children. We hypothesised that there would be no difference in guideline compliance between physicians and nurse prescribers.

## Methods

### Study design

We compared the performance of nurse prescribers and doctors caring for HIV-infected paediatric patients using chart documentation as the metric of performance. The medical records of paediatric patients aged 1 - 16 years who had been seen at the Botswana-Baylor Children's Clinical Centre of Excellence (COE), a large and busy government-affiliated clinic in Gaborone, Botswana, between 5 January 2009 and 31 March 2009 were retrospectively reviewed.

### Sampling

Patient visits ('encounters') were selected by stratified random sampling conducted via review of patient records for January - March 2009. From the patient visits to the COE during this period, we identified encounters which met our inclusion/exclusion criteria below - a total of 800 doctor-patient encounters and 776 nurse-prescriber-patient encounters. Based on the randomly ordered patient identification numbers, we then numbered the encounters. Using a random number table and by spinning a pencil, we randomly picked a starting point between 1 and 800 for the doctor encounters and between 1 and 776 for the nurse prescriber encounters. With this random starting point, our selection of encounters for review was every 7th encounter down the list until 100 doctor encounters and 97 nurse prescriber encounters had been selected for the study. These patient encounters were then audited by one of the study authors (GM) for successful documentation of eight separate clinically relevant variables: (i) adherence - pill count performed and charted; (ii) chief complaint - patient complaints documented and attended to in the plan; if no chief complaint was given by the patient, this was stated in the chart; (iii) social history - social history with any changes documented; (iv) disclosure - if full or partial disclosure was reviewed with the patient and/or caregiver; (v) physical examination - adequate physical examination of at least six body systems; (vi) laboratory tests ordering (LTO) - monitoring laboratory tests ordered correctly according to national ART guidelines; (vii) staging - WHO staging performed; and (viii) dosing - paediatric dosing performed according to national ART guidelines.

### Inclusion/exclusion criteria

All encounters met the criteria for standard, routine paediatric ART management, defined by the Botswana Ministry of Health as an otherwise well-appearing child, aged 1 - 16 years, on first-line ART for at least 1 year with the following characteristics: (i) viral load undetectable (<400 copies/ml) for at least 6 months after full suppression (<400 copies/ml); (ii) CD4 cell count ( $\geq 25\%$  for children

aged <13 years; >150 cells/ $\mu$ l for children aged  $\geq 13$  years); (iii) weight and height for age within two Z-scores of 50th percentile; (iv) developmental milestones within normal limits; and (v) on first-line ART regimen as defined by the Botswana National HIV/AIDS Treatment Guidelines: (stavudine or zidovudine) + lamivudine + (nevirapine or efavirenz).

On the basis of these criteria, encounters with any non-stable patients or patients on second-line or salvage ART were excluded. Also excluded were acute visits for ill children, ART initiation visits, and visits dedicated to counselling support.

### Data collection methods

Encounters for review were selected based on stratified random sampling as described above. The COE's electronic medical record (EMR) was used to generate reports for each encounter that detailed the successful documentation of completion of each of eight clinical variables.

We estimated that doctors would accurately document 90% of the charted items, which is consistent with approximate upper limits in the literature.<sup>20</sup> We predetermined that a documentation difference of more than 5% between doctors and nurses would be considered clinically significant. A two-group chi-square test with 80% power to detect a difference between an overall doctor documentation rate of 90% and an overall nursing documentation rate of 85% would require a sample size in each group of at least 686 documentation items for our primary outcome. Sample size was calculated with nQuery Advisor<sup>®</sup> 6.02 (Statistical Solutions, Saugus, Massachusetts, USA).

### Data analysis

Data were entered into an Excel database (Microsoft 2003, Seattle, Washington, USA) and analysed using Minitab<sup>®</sup> 15 (State College, Pennsylvania, USA). Quantitative data were analysed for the eight clinical variables individually and for combined values. Mean compliance scores were calculated for both nurse and doctor encounters. The two-sample test for binomial proportions was used to calculate *p*-values; a *p*-value of less than 0.05 was considered statistically significant for our primary outcome. For our secondary outcomes (the eight individual documentation items), a *p*-value of less than 0.00625 using Fisher's exact test was considered statistically significant. This reduction from a *p*-value of 0.05 was due to the number of categories under evaluation, in an effort to minimise the chance of a type I error by applying the Bonferroni principle.

### Ethical approval

This study was approved by the Health Research and Development Committee (HRDC), Ministry of Health, Botswana, and the Institutional Review Board, Baylor College of Medicine, USA.

## Results

### Participants

During the study period, there were 3 eligible nurse prescribers and 10 eligible doctors. One hundred doctor-patient encounters and 97 nurse prescriber-patient encounters were reviewed, with 800 doctor and 776 nurse prescriber documentation items collected for analysis.

### Descriptive data

Two of the 3 nurse prescribers and 1 of the 10 doctors were female. The average number of years of working with the most recent Botswana National Guidelines at this time for the doctors and nurse prescribers was 17 months (95% confidence interval (CI) 10 - 24 months) and 3.7 months (95% CI 3.0 - 4.3 months), respectively.

**Table I. Percentage of appropriate documentation in the charts by nurse prescribers and doctors**

Documentation item	Appropriate nurse documentation (% (N)) of documentations)	Appropriate doctor documentation (% (N)) of documentations)	<i>p</i> -value
Pill count charted	100 (97)	97 (100)	0.246
Chief complaint listed	100 (97)	99 (100)	1.000
Social history updated	95.9 (97)	86 (100)	0.024
Disclosure reviewed	95.9 (97)	92 (100)	0.373
Physical exam	94.8 (97)	96 (100)	0.745
Laboratory testing	93.8 (97)	94 (100)	1.000
WHO staging documented	90.7 (97)	96 (100)	0.160
Paediatric dosing	96.9 (97)	99 (100)	0.362
Cumulative of 8 items	96.0 (776)	94.9 (800)	0.335

### Outcome data

Table I describes the percentage of appropriate documentation for nurse prescribers and doctors. Overall, nurses and doctors correctly documented 96.0% and 94.9% of the time, respectively. There was a trend towards a higher proportion of social history documentation by the nurse; however, using a *p*-value cut-off of 0.00625 according to the Bonferroni multiple comparison methods, this value of 0.024 was not a statistically significant difference between the two groups. There was no significant difference in any other documentation items included in the study.

### Discussion

This study, comparing certified nurse prescribers and doctors, successfully demonstrates comparable performance. All documented *p*-values above reflect the non-inferiority of nurse-provided services compared with doctors. The observed trend towards better attention towards children's social situations by nurses could be important in determining ART outcomes, given the association between complicated social situations and unsuccessful HIV care.<sup>21</sup>

Although published commentaries have discussed issues relating to task-shifting in Botswana,<sup>10,19,22</sup> we know of no studies that have compared the quality of services of nurse and doctor providers in Botswana. Additionally, the literature review uncovered no data from any country or region establishing the non-inferiority of nurses compared with doctors specifically in relation to paediatric ART management.

Nonetheless, our findings are broadly in agreement with those of the CIPRA-SA trial.<sup>16</sup> The CIPRA-SA randomised non-inferiority trial compared nurse versus doctor management of ART care, finding nurse-monitored ART non-inferior to doctor-monitored ART for a composite endpoint of treatment-limiting events, including mortality, treatment failure, ART toxicity and adherence with follow-up care.

A strength of our study is its reflection of routine clinical practice in a busy paediatric ART centre. However, it has some limitations, in addition to its retrospective design. The relationship between the metric we evaluated – compliance with national HIV management guidelines – and good paediatric patient outcomes is not currently reported in the literature and cannot be determined by our study. The need for further studies in this area is clear, including prospective non-inferiority studies of routine paediatric ART practice by nurse prescribers powered to explore differences in patient outcomes, as well as cost-effectiveness of nurse-directed models of paediatric ART care for specific clinical outcomes.

Care should be taken in broadly generalising our study results. Our setting in a paediatric-specialised centre in a large urban area is not necessarily typical of most settings in southern Africa or other

resource-limited settings where paediatric ART care is delivered. The training received by nurse prescribers in our setting may also not be typical of other paediatric ART settings. The latter is important, as southern African studies of task-shifted care suggest that the nature of pre-service training substantially influences provider practice and treatment outcomes in patient cohorts managed by non-doctors.<sup>16,17,23</sup>

The nurse prescribers in CIPRA-SA were experienced and well trained, all having undergone an additional year of clinical training in primary health care and specialised didactic and clinical training in HIV management, including ART.<sup>16</sup> However, where pre-service training is less comprehensive, results have been concerning.<sup>13,15,17</sup> In Mozambique, a nationwide evaluation of non-doctor clinicians managing patients on ART noted a high rate of ART management errors; correct management of all main aspects of patient care included in the evaluation (staging, co-trimoxazole, ART, opportunistic infections and adverse drug reactions) was observed in only 10.6% of reviewed encounters.<sup>17</sup> These clinicians (known as *tecnicos de medicina*) had all received 30 months of general pre-service training not including HIV/AIDS content, but only 2 weeks of HIV-specific didactic training, mostly emphasising ART, before beginning to manage ART. Subsequent to this evaluation, Mozambique's scope of practice and training for non-doctor cadres in HIV management was revised.<sup>17</sup>

### Conclusions

In southern Africa, there is an urgent need to broaden current doctor-directed models of HIV/AIDS care, particularly where children are concerned. Our findings further support the continued investment in programmes employing properly trained nurses in southern Africa to provide quality care and ART services to HIV-infected children who are stable on therapy. Task shifting is a promising strategy to scale up and sustain adult and paediatric ART more effectively, particularly where provider shortages threaten ART rollout. Policies guiding ART services in southern Africa should avoid restricting the delivery of crucial services to doctors, especially where their numbers are limited, while ensuring that cadres of health care workers to whom essential services are shifted are both well trained and properly supported longitudinally.

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## Traumatic rhabdomyolysis (crush syndrome) in the rural setting

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**Background.** Patients with traumatic rhabdomyolysis (crush syndrome)(CS) secondary to community beatings commonly present to a rural emergency department that has limited access to dialysis services. We describe a retrospective study of patients admitted with a diagnosis of CS to the emergency department of a government hospital in rural KwaZulu-Natal, between November 2008 and June 2009.

**Objectives.** We assessed identification and management of these patients, considering: (i) early adverse parameters used to identify poor prognosis, (ii) the importance of early recognition, and (iii) appropriate management with aggressive fluid therapy and alkaline diuresis to prevent progression to renal failure.

**Methods.** Diagnosis was based on clinical suspicion and haematuria. Exclusion criteria included a blood creatine kinase level <1 000 U/l on admission. Data captured included demographics,

the offending weapon, time of injury and presentation to hospital, and admission laboratory results. Outcome measures included length of time in the resuscitation unit, and subsequent movement to the main ward or dialysis unit, discharge from hospital, or death.

**Results.** Forty-four patients were included in the study (41 male, 3 female), all presenting within 24 hours of injury: 27 were assaulted with sjamboks or sticks, 43 were discharged to the ward with normal or improving renal function, and 1 patient died.

**Conclusions.** Serum potassium, creatinine, and creatine kinase levels were important early parameters for assessing CS severity; 43 patients (98%) had a favourable outcome, owing to early recognition and institution of appropriate therapy – vital in the absence of dialysis services.

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Inadequate policing in KwaZulu-Natal (KZN) and an overloaded judicial system has led to vigilante justice, where local community protection groups administer corporal punishment for criminal behaviour. Their intentions are to injure, but not

kill, to serve as a warning to potential perpetrators.<sup>1,2</sup> Beatings frequently result in traumatic rhabdomyolysis (crush syndrome) (CS), which can rapidly cause acute renal failure (ARF) and death. Early identification of CS involves recognition of characteristic signs, including 'tramline' bruising (distinctive lines suggestive of beating with a sjambok), ecchymosis over large muscle groups, and widespread blunt trauma.

Assault injuries are commonly presented to the emergency department of the Ngwelezane (NGW) Hospital – a tertiary referral centre for northern KZN. New departmental clinical guidelines were introduced, with a focus on early identification of patients with CS, their admission to the critical care/resuscitation area, and aggressive management of hypovolaemia and acidosis. We describe

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a retrospective study of CS patients admitted to the hospital between November 2008 and June 2009.

Myoglobin, potassium (K) and creatine kinase (CK) are released from damaged muscle cells. 'Coca Cola' urine discolouration caused by myoglobin is pathognomonic of CS. As an early prognostic marker, testing for the protein in urine is not always possible in a rural setting; however, the presence of blood (haematuria – determined with a dipstick test) serves as a positive indicator for myoglobin. Myoglobin is converted to ferrihaemate in acidotic conditions (urinary pH <5.6),<sup>3</sup> resulting in sludging and mechanical obstruction in the nephrons; urine alkalisation with sodium bicarbonate (maintaining pH >6.5) significantly reduces this conversion.<sup>4-10</sup> More than 3 times the normal upper limit of CK in the blood (>1 000 U/l) is essential for a diagnosis of CS.<sup>11</sup> Deteriorating renal function can be monitored with serum urea and creatinine measurements, which will rise with increased renal dysfunction.

Tissue damage also causes significant third-spacing and depletion of intravascular volume, requiring early aggressive fluid volume replacement. This is the cornerstone of treatment recommended by the International Society of Nephrology Renal Disaster Relief Taskforce, with a target urine output of >3 ml/kg/h.<sup>6-10,12</sup> Mannitol can be administered to patients who remain oliguric/anuric despite a central venous pressure (CVP) of 15 cm H<sub>2</sub>O.<sup>6</sup> A protocol developed in the early 1990s, suggesting aggressive fluids and diuresis, reduced CS-related mortality from 13 - 15% to 2.5%.<sup>13</sup>

## Methods

All patients admitted with a diagnosis of CS to the resuscitation unit of NGW Hospital between November 2008 and June 2009 were included in the study; admission medical records were retrospectively analysed. Research ethics approval was obtained from the NGW Hospital Ethics Committee. Diagnosis was based on clinical suspicion without laboratory tests, i.e. 'tramline' bruising, ecchymosis over large muscle groups and widespread blunt trauma, combined with micro- or macroscopic haematuria. Patients without these criteria, or with irretrievable admission notes, were excluded. Exclusion criteria also included CK levels <1 000 U/l in initial blood samples taken on hospital admission.

Data concerning age, sex, offending weapon, time of assault, and time of presentation to hospital were collected. Admission test results were recorded, including degree of haematuria, urinary pH, serum pH, and serum levels of CK, K, urea, creatinine and amylase. CVP line insertion and the amount of bicarbonate, mannitol and furosemide administered was also documented. Outcome measures included the length of time spent in the resuscitation unit, and subsequent movement to the main ward or dialysis unit, discharge from hospital, or death.

## Results and discussion

Forty-four patients were included in the study (41 male, 3 female); average age (mean) was 27 years (range 14 - 53). All patients presented within 24 hours of injury; 20 within 6 hours, 11 within 6 - 12 hours, 6 within 12 - 24 hours, and timing unknown in 7 patients. Similar numbers of patients had suffered beatings with sticks, metal bars, and sjamboks; 2 were beaten with fists, and 4 were injured with an unknown weapon. Recorded outcome measures are summarised in Table I.

Two patients had 'Coca Cola' urine pathognomonic of rhabdomyolysis, and 29 showed haemoglobin (Hb<sup>++</sup>) on urine dipsticks, indicative of myoglobinuria. A urinary pH of 5 was recorded in 37 patients on admission; intravenous sodium bicarbonate was administered.

A variety of studies give weight to different predictors of ARF development in initial blood tests; however, urea, creatinine, K, and CK are universally cited.<sup>14,15</sup> Three of the 5 patients who needed prolonged resuscitation (>48 hours) had raised serum creatinine, suggesting that this is a significant indicator of CS severity (Table II).

High urea concentrations were reported in initial blood samples of 8 patients, 1 of whom required prolonged resuscitation. Blood urea can be an indicator of intravascular depletion, but also of recent protein intake. Urea levels in initial samples of 18 patients were lower than the normal range, possibly indicating a poverty-related low-protein diet. Urea was therefore a weak prognostic marker of renal compromise.

All hyperkalaemic patients (5) had elevated CK (>1 725 U/l); a strong correlation between serum K and CK has been documented.<sup>12,15</sup> It may be significant that 3 of the hyperkalaemic patients had some degree of renal failure on admission. Presentation within 24 hours of injury coincides with the time when the risk of hyperkalaemia complications is highest. Hyperkalaemia is thought

**Table I. Outcome measures**

Outcome		Number of patients (N)
Time spent in resuscitation unit (h)	0 - 24	23
	24 - 48	16
	48+	5
Patient outcome	Discharged from hospital	4
	Main ward	38
	Dialysis unit	1
	Death	1

**Table II. Details of patients staying >48 hours in the resuscitation unit**

Patient	Urine dipstick test	Urine pH	CK nl (38 - 174 U/l)	K nl (3.6 - 5 mEq/l)	Creatinine nl (53 - 115 µmol/l)	Urea nl (3.5 - 6.4 mmol/l)	Patient outcome
1	Hb <sup>++</sup>	5	*	2.94	355	14.6	Ward
2	Coca-Cola	5	Too high	nl	nl	nl	Ward
3		5	*	5.9	nl	nl	Ward
4	Hb <sup>++</sup>	5	15 685	5.7	200	nl	Dialysis
5	Hb <sup>++</sup>	5	1 822	6.3	134	nl	Death

\*Not measured.  
nl = normal range.

to be the major cause of mortality in CS, and the most important indicator of the need for dialysis,<sup>12</sup> including a strong correlation with creatinine levels.<sup>16</sup>

Interestingly, 3 patients were hypokalaemic on admission; the patient with the lowest K level (2.94 mEq/l) remained in the resuscitation unit for more than 48 hours, and was admitted with a blood creatinine level of 355 µmol/l (Table II). A high rate of hypokalaemia (as opposed to hyperkalaemia) was documented after the Bingöl earthquake in Turkey in 2003: K replacement was necessary in resuscitation efforts; the reason for this is unknown.<sup>17</sup>

The lower limit of serum CK to exclude CS ranges in the literature from 520 - 1 000 U/l.<sup>16,18</sup> In a study of 2 083 ICU trauma admissions, the lowest CK level linked to renal failure was 5 000 U/l; 19% of those with CK above this concentration developed renal failure.<sup>18</sup> Elevated CK levels consistently relate to the need for dialysis.<sup>15,18</sup>

The main cause of morbidity in this study was ARF secondary to CS, and the subsequent need for dialysis. Of 44 patients at risk of CS, 43 (98%) were discharged from the resuscitation unit with normal or improving renal function. In contrast to studies describing earthquake victims where prolonged entrapment is characteristic, all patients presented within 24 hours of injury, which gives the advantage of early intervention, provided that the condition has manifested. This emphasises that clinical suspicion is of key importance in a busy casualty department run by junior staff. Simple tests with urine dipsticks should not be underestimated; this useful bedside test is widely available and easy to use.

## Conclusion

Traumatic CS has previously been related to a high incidence of ARF and mortality, especially when dialysis is not readily available. Favourable outcomes of CS cases in this study can be attributed to early recognition by simple means, and skilful management in the ordinary casualty department described.

Clinical signs and screening with urine dipsticks aid identification of at-risk patients. Blood tests to determine K, creatinine and CK concentrations are important for prognostication, alerting the clinician to the severity of rhabdomyolysis and guiding appropriate

treatment. Measuring CK is a cheap and reliable means of aiding CS diagnosis, and must be encouraged in all suspected cases. Elevated K and creatinine may suggest impending renal compromise, while urea may be less indicative in a population with a low-protein diet. In all cases, forced alkaline diuresis is indicated.

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*Faithful companion  
Knows every mountain path  
Taking her last walk?*

*Haiku: Peter Folb*