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Selecting ambulatory emergency care (AEC) patients from the medical emergency in-take: the derivation and validation of the *Amb* score

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ABSTRACT – Accurate prediction of the likelihood of same-day discharge could make it possible to direct one-third of the medical in-take to an ambulatory care unit, thereby facilitating bed management. In Phase 1 of this study, we identified seven independent factors that contribute to an ambulatory care score (*Amb* score) that can potentially be used as a tool to select ambulatory emergency care (AEC) patients from the medical emergency in-take. A high score was associated with discharge within 12 hours of assessment and treatment in hospital. In Phase 2, we verified and internally validated the performance of the *Amb* score in a different cohort of patients, finding that it functioned well in identifying early discharges (ie AEC patients), with an area under the receiver operator curve (AUROC) of 0.91 (95% CI 0.88–0.94). An *Amb* score of ⩾5 has a sensitivity of 96% (95% CI 90–98) and a specificity of 62% (95% CI 55–68) in identifying potential AEC patients.

KEY WORDS: *Amb* score, ambulatory emergency care, admission, medical in-take

Background

The number of emergency hospital admissions and their costs continue to increase annually.[1] It is appropriate that all emergency referrals from primary care should be assessed in hospital, but admission is not always necessary. Acute medical units (AMU) help to reduce length of stay and prevent unnecessary admissions.[2] In addition, ambulatory care units contribute to admission-avoidance: many medical emergencies can be managed in the ambulatory care setting provided diagnostic services and assessment facilities are readily available.[3,4]

Notwithstanding the diagnosis, some conditions do not warrant in-patient management; indeed, up to a third of referrals seen in AMU are discharged on the same day.[5,6] This constitutes a significant proportion of patients that could potentially be assessed within the ambulatory emergency care setting.

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The RCP Acute Medicine Task Force[7] defines ambulatory emergency care (AEC) as 'the clinical care which may include diagnosis, observation, treatment and rehabilitation, not provided within the traditional hospital bed base or within the traditional outpatient services that can be provided across the primary–secondary care interface. In the context of acute medicine, it is the care of a condition that is perceived either by the patient or by the referring practitioner as urgent, and that requires prompt clinical assessment undertaken by a competent clinical decision maker.' AEC patients tend to fall into one of four categories: a diagnostic exclusion group in which certain conditions, such as a possible deep venous thrombosis, must be ruled out; a low-risk group, such as those with community-acquired pneumonia with a low CURB65 score; a specific diagnostic group, who require a procedure such as pleural effusion; and finally, the group that requires a treatment that has traditionally been provided in an inpatient department, such as those with low-risk pulmonary embolism.

In hospitals where AEC patients are managed in a geographically separate unit from the general emergency medical in-take, it can be difficult for the GP or the primary care nurse to identify patients who should be referred directly to the AEC unit without a full clinical assessment and further investigation. Clinical scoring systems are currently used to gauge illness severity and mortality risks[8–11] when assessing acutely unwell patients, but they are not used to assess the suitability of an emergency-referred patient for ambulatory care management.

A simple scoring system that can predict the likelihood of same-day discharge after assessment would be useful in selecting patients who fall into the AEC category. The referring primary care clinician, or the emergency medicine (EM) and AMU triage staff, should be able to calculate this score before a full clinical assessment and subsequent investigations. Hence, the score must be based on the patient's clinical, demographic and social parameters.

Being able to give the patient information on the likelihood that they will be admitted is of benefit, allowing them to make appropriate arrangements for their home life, for their work commitments or with care agencies. For the hospital, this information could be useful for bed-management purposes.

This study was undertaken in two phases — Phase 1 (derivation) and Phase 2 (validation). Factors that would be useful in predicting the likelihood of early discharge (within 12 hours) were identified in Phase 1; these were then used to derive a simple

ambulatory care score, the *Amb* Score.[12] In Phase 2, which involved a different cohort of patients, this score was verified, and its ability to identify early discharges from the unselected general medical emergency in-take was internally validated.

Methods

This study was undertaken at The Royal Glamorgan Hospital, a 570-bed district general hospital serving a largely rural population in the South Wales valleys. With a 28-bed AMU, it admits between 30 and 50 patients each day, although more than a third of these are discharged within 12 hours. Written consent was obtained from all patients who took part in this study prior to data collection. The NHS Research Ethics Committee (REC) advised that this service-development project did not require ethical approval. A total of 625 patients were recruited, of whom 282 (45%) were studied in the derivation phase (Phase 1) and 343 (55%) in the validation phase (Phase 2).

Phase 1: derivation

This phase identified factors that might be useful in assisting the referring doctor or the hospital triage staff in determining the likelihood that a emergency medical patient would be discharged from hospital within 12 hours of assessment.

Out of 612 medical emergencies who were referred by their GP, 282 were randomly selected to be studied retrospectively. The study sample was divided into patients who were discharged within 12 hours of hospital assessment (the ambulatory group) and those who were admitted for ⩾48 hours (the admission group). A patient who was discharged within 12 hours of assessment was assumed to have a condition that could potentially be treated in an AEC unit. Social, demographical and clinical variables that could be associated with an early discharge (⩽12 hours) were identified. A hospital stay of 48 hours or longer was arbitrarily counted as an admission, so follow up was for 48 hours. Those who died or who discharged themselves against medical advice, and those who stayed in hospital for 12–48 hours were excluded. In this phase, referrals from the EM department were excluded.

This phase was undertaken over a four-week period in May and June 2010. We used the earliest full set of recordings, be they from the accompanying GP letter, the ambulance notes, or the first set of observations after arrival in hospital, to calculate the Modified Early Warning Score (MEWS). Table 1 shows the MEWS scoring parameters used in following our local trust protocol. Information on other variables was extracted from the medical and nursing notes and by talking directly with the patients or relatives.

Analysis was performed using Epi Info Version 3.5.1 (CDC Atlanta 2008). Continuous variables were presented as means with standard deviation (SD) and chi-square was used in 2X2 tables to compare categorical data. Odds ratios with 95% confidence interval (CI) are given. Logistics regression was used to identify independent variables, and the adjusted odds ratios are quoted. We regarded a $p<0.05$ as statistically significant.

The seven independent factors that were associated with an early discharge (⩽12 hours) were then used to formulate an ambulatory care score, termed the *Amb* score; it was postulated that a high *Amb* score might be useful in identifying potential AEC patients from amongst the unselected general medical emergency in-take.

Phase 2: internal validation

This phase was undertaken prospectively over a three-week period in June and July 2011. The main aims were to verify factors used to calculate the *Amb* score that were derived in Phase 1, and to validate the score in a different cohort of patients by comparing the *Amb* scores for patients who were discharged within 12 hours (the ambulatory group) with those of patients who were admitted for ⩾ 48 hours (the admission group). The Phase 2 study cohort included both GP and EM referrals, but the other criteria for exclusion remain the same as in Phase 1.

A sample size of 103 patients in each group was suggested (STATCALC) as adequate to identify differences between the two groups powered at 80% at a 95% level of confidence. In fact, a total of 343 patients who fulfilled the criteria were randomly selected from 1,015 emergency referrals in the three-week period. An *Amb* score was calculated for each patient on the basis of information obtained from the patient or their relatives, and from the clinical notes (GP letters, ambulance sheets, EM notes, and nursing and medical records).

Table 1. Modified early warning score (MEWS) used by Cwm Taf local health board.

	3	2	1	0	1	2	3
RR (per min)	⩾36	31–35	21–30	9–20			⩽8
Sp02 (%)				⩾93	90–92	85–89	<85
HR (per min)	⩾130	110–129	91–109	60–90	50–59	40–49	<40
SBP (mmHg)	<80	80–89	90–109	110–190		191–199	⩾200
AVPU				Alert	Voice	Pain	Unresp
Temp (˚C)		⩾38.5	37.6–38.4	35.6–37.5	35–35.5	34.5–34.9	⩽34.4

RR = respiratory rate; SpO2 = peripheral oxygen saturation; HR = heart rate; SBP = systolic blood pressure; AVPU = alert, voice or pain responsive, or unresponsive; Temp = temperature

Table 2. Variables studied in the derivation study (Phase 1).

Variable	Admission group n=139	Ambulatory group n=143	Odds Ratio (95% CI)	P value	Adjusted OR (95%CI)
Mean age (SD)	71.2 (16.2)	57.2 (17.5)		<0.01	
Age 30–39(%)	5 (3.6)	16 (11.2)	0.3 (0.1–0.8)	<0.01	
Age 40–49(%)	6 (4.3)	20 (14.0)	0.3 (0.1–0.7)	<0.01	
Age 50–59(%)	11 (7.9)	23 (16.1)	0.4 (0.2–0.9)	<0.05	
Age ⩾ 80(%)	52 (37.4)	13 (9.1)	6 (3.1–11.6)	<0.01	2.4 (1.1–5.2)
Male sex(%)	61 (43.9)	41 (28.7)	1.9 (1.2–3.2)	<0.01	1.9 (1.1–1.5)
Can eat/drink normally(%)	132 (95)	143 (100)	Undefined		
Ambulant(%)	124 (89.2)	143 (100)	Undefined		
Access to transportation(%)	54 (38.8)	127 (88.8)	0.07 (0.04–0.2)	<0.01	0.1 (0.05–02)
Family support or carers available(%)	102 (73.4)	128 (89.5)	0.3 (0.1–0.6)	<0.01	
IV treatment not anticipated(%)	74 (53.2)	139 (97.9)	0.02 (0.007–0.1)	<0.01	0.1 (0.009–0.08)
Not acutely confused(%)	121 (87.1)	141 (98.6)	0.05 (0.006–0.4)	<0.01	0.1 (0.02–0.6)
No new sphincter problems(%)	131 (94.2)	143 (100)	Undefined		
If chest pains, ACS not suspected(%)	128 (92)	131 (91.6)	1.07 (0.4–2.6)	0.44	
Significant bleed not suspected(%)	136 (97.8)	131 (98.6)	0.5 (0.04–5.4)	0.05	
No new neurological deficit(%)	119 (85.6)	134 (93.7)	0.4 (0.16–0.9)	<0.05	
Normal temperature(%)	118 (84.9)	129 (90.2)	0.1 (0.02–0.5)	<0.01	
Normal respiratory rate(%)	128 (92.0)	103 (72.0)	0.9 (0.3–2.8)	<0.05	
Normal oxygen saturation (≥93%)(%)	112 (80.6)	126 (88.1)	0.15 (0.05–0.5)	<0.01	
Heart rate 50–140 bpm(%)	135 (97.1)	133 (93.0)	0.5 (0.05–5.7)	0.50	
Systolic BP 100-200 mmHg(%)	121 (87.1)	139 (97.21	0.2 (0.04–0.5)	<0.01	
MEWS 0(%)	70 (50.4)	104 (72.7)	0.4 (0.2–0.6)	<0.01	0.5 (02–0.0)
MEWS 2(%)	17 (12.2)	5 (3.5)	3.8 (1.4–10.7)	<0.01	
MEWS 3(%)	12 (8.6)	4 (2.8)	3.3 (1.03–10.4)	<0.05	
MEWS ⩾4(%)	11 (7.9)	2 (1.4)	6 (1.3–27.9)	<0.01	
GCS 15(%)	129 (92.8)	143 (100)	Undefined		
No past history coronary artery disease(%)	74 (53.2)	85 (59.4)	0.8 (0.3–1.7)	0.25	
No past history of heart failure(%)	87 (62.6)	97 (67.8)	0.6 (0.1–3.7)	0.45	
No past history of arrhythmia(%)	77 (55.4)	91 (63.6.)	0.6 (0.2–1.5)	0.12	
No past history of diabetes (%)	74 (53.2)	89 (62.2)	0.5 (0.2–1.2)	0.07	
No past history of stroke or TIA(%)	82 (59.0)	93 (65.0)	04 (0.1–1.4)	0.08	
No past history of renal disease(%)	79 (56.8)	94 (65.8)	0.5 (0.2–1.3)	0.07	
No past history of chromic lung disease(%)	65 (46.8)	79 (55.2)	0.6 (0.3–1.2)	0.07	
Not discharged within previous 30 days (%)	101 (72.7)	125 (87.4)	0.2 (0.07–0.5)	<0.01	0.3 (02–0.7)

CI = confidence interval; OR = odds ratio; SD = standard deviation; IV = intravascular; ACS = acute coronary syndrome; bpm = beats per minute; BP = blood pressure; MEWS: Modified Early Warning Score; GCS = Glasgow coma scale; TIA = transient ischaemic attack

Validation was carried out by applying the *Amb* score to the data from this phase. Chi-square analysis was used to verify the *Amb* score variables, and the area under the receiver operator curve (AUROC) was used to assess the effectiveness of the score in identifying those who were discharged within 12 hours (ie the potential AEC patients). An appropriate cut-off level for the optimal *Amb* score sensitivity and specificity was identified from the AUROC analysis.

Results

Phase 1: derivation

Data were collected on 282 patients who fulfilled the criteria. On average, the males (36.2%) were older (mean age 67, SD 16) than the females (mean age 63, SD 19), but not significantly so. About half of those in the study sample (50.7%) were discharged within 12 hours of assessment (the ambulatory group). Of those who remained for ⩾48 hours (the admission group), 42.2% were not assigned to a specialty team, 24.3% stayed under the care of the elderly team and 11.2% went to the respiratory team.

The significant factors identified by bivariate analysis that were associated with patients who had an early discharge (ie potential AEC patients) are listed in Table 2. Access to transportation, having good family support, being female and being younger than 80 years old were significantly associated with discharge within 12 hours. A previous history of common medical problems, such as coronary artery disease or chronic lung diseases, was not shown to affect length of stay, neither was a possible diagnosis of significant bleeding or acute coronary syndrome. If intravenous treatment was anticipated, however, the patient was more likely to be admitted for ⩾ 48 hours.

A normal temperature (35–37.5°C), a systolic blood pressure of 100–200 mmHg and a peripheral oxygen saturation of ⩾93% on air (or on oxygen if the patient was on home oxygen) were significantly associated with an early discharge (⩽12 hours). A MEWS score of ⩾2 was significantly associated with admission for ⩾48 hours. Conversely, a MEWS score of zero was significantly associated with a discharge within 12 hours.

A hospital discharge within the previous seven days had no effect on the length of stay but those who had been discharged within the previous 30 days were more likely to stay for ⩾48 hours.

Multiple logistics regression analysis returned seven independent variables that determine whether a patient was discharged within 12 hours or admitted for ⩾48 hours (Table 3). These seven variables were used to formulate the *Amb* score (Table 4). The weighting of each parameter was chosen to reflect the odds ratio (OR) of being discharged within 12 hours from the derivation data, such that those with an OR in favour of early discharge were given a higher value. The two parameters with an OR in favour of admission for ⩾48 hours (male gender and age >80) were given negative values. Having access to transportation, not being acutely confused and not requiring IV treatment were associated with the greatest odds of being discharged within 12 hours, so these were given a higher weighting in the *Amb* score calculation. This gave a total *Amb* score out of 8. Patients with a high *Amb* score were more likely to be discharged within 12 hours following assessment, so these could be treated as potential AEC patients. When the score was

Table 4. Calculating the *Amb* score.

Sex	**Female**	**0**
	Male	**−0.5**
Age	<80	0
	⩾80	−0.5
Access to personal transport/can take public transport	Agree	+2
	Disagree	0
IV treatment NOT anticipated	Agree	+2
	Disagree	0
NOT acutely confused	Agree	+2
	Disagree	0
MEWS = 0	Agree	+1
	Disagree	0
NOT been discharged from hospital in the last 30 days	Agree	+1
	Disagree	0
TOTAL *Amb* score (max 8)		

IV = intravascular; MEWS = modified early warning score; *Amb* score = ambulatory care score

Table 3. Independent variables in derivation study (Phase 1).

Variable	Admission group (%) n=139	Ambulatory group (%) n=143	P value	Adjusted OR (95%CI)
Age ⩾ 80	52 (37.4)	13 (9.1)	<0.01	2.4 (1.1–5.2)
Male sex	61 (43.9)	41 (28.7)	<0.01	1.9 (1.1–3.5)
Access to transportation	54 (38.8)	127 (88.8)	<0.01	0.1 (0.05–0.2)
IV treatment not anticipated	74 (53.2)	139 (97.9)	<0.01	0.1 (0.009–0.08)
Not acutely confused	121 (87.1)	141 (98.6)	<0.01	0.1 (0.02–0.6)
MEWS 0	70 (50.4)	104 (72.7)	<0.01	0.5 (0.2–0.9)
Not discharged within previous 30 days	101 (72.7)	125 (87.4)	<0.01	0.3 (0.2–0.7)

OR = odds ratio; IV = intravascular; MEWS = modified early warning score

Table 5. Verification of *Amb* score parameters in the validation study (Phase 2).

	Admission group (%) n=228	Ambulatory group (%) n=115	OR (95% CI)	
Female sex	97 (42.5)	75 (65.2)	0.4 (0.2–0.6)	p<0.01
Age < 80	136 (59.6)	108 (93.9)	0.2 (0.1–0.3)	p<0.01
Access to personal/public transport	132 (57.9)	109 (94.8)	0.1 (0.03–0.2)	p<0.01
IV treatment NOT anticipated	82 (40.0)	106 (92.2)	0.1 (0.03–0.1)	p<0.01
NOT acutely confused	198 (86.8)	113 (98.3)	0.1 (0.03–0.5)	p<0.01
MEWS score = 0	72 (31.6)	77 (67.0)	0.2 (0.1–0.4)	p<0.01
NOT discharged within last 30 days	187 (82.0)	106 (92.2)	0.5 (0.2–0.8)	p<0.01
Mean *Amb* Score (SD)	**4.2 (1.8)**	**7.1 (1.1)**		**p<0.01**

OR = odds ratio; IV = intravascular; MEWS = modified early warning score; SD = standard deviation; Amb score = ambulatory care score

Table 6. Top five diagnoses in the validation cohort (Phase 2).

Admission group (n=228)		Ambulatory group (n=115)	
COPD	13%	DVT	12%
UTI	12%	Non-cardiac chest pains	9%
LRTI (no consolidation)	9%	LRTI (no consolidation)	9%
Pneumonia	8%	TIA	6%
Stroke	4%	Musculoskeletal problem	5%

COPD = chronic obstructive pulmonary disease; DVT = deep venous thrombosis; UTI = urinary tract infection; LRTI = lower respiratory tract infection; TIA = transient ischaemic attack

applied to the derivation data, a score of 6 or above corresponded to an increased likelihood of being discharged within 12 hours (OR 0.3).

Phase 2: internal validation

In this phase, 40% of the referrals were from GPs; sexes were equally represented equally (50.4% females). There were no significant gender differences in age (mean age 66, SD 20).

Approximately one-third (35.5%) of the total study sample in this phase was discharged within 12 hours. This group had a mean *Amb* score of 7.1 (SD 1.1), compared with a mean *Amb* score of 4.2 (SD 1.8) in the admission group (p<0.01) (Table 5).

Bivariate analysis comparing each of seven *Amb* score parameters in the two groups showed a high level of statistical significance, confirming the discriminatory ability of these variables (Table 5). The area under the receiver operator curve (AUROC) for the *Amb* score was 0.91 (95% CI, 0.88–0.94) (Fig 1). A cut-off point between an *Amb* score 4 and 5 was chosen as this gave the most favourable sensitivity of 96% (95% CI, 90–98) without compromising much of the 62% specificity (95% CI, 55-68). The specificity reflects the proportion of patients that the score had correctly predicted would be admitted for ⩾48 hours. It is lower than the sensitivity because some of these patients were discharged within 12 hours. The score would have been less specific if the cut-off threshold were reduced and it would lose sensitivity at a higher cut-off.

Table 6 shows the top five diagnoses in each group in the Phase 2 cohort. Deep venous thrombosis (DVT) was the most frequent diagnosis in the ambulatory group, whereas exacerbation of chronic obstructive pulmonary disease (COPD) was the most frequent reason for admission for ⩾48 hours.

Discussion

This was a single-centred study aiming to identify factors that might be useful in predicting discharges within 12 hours of hospital assessment (ie potential AEC patients). These factors were then used to derive a simple scoring system (*Amb* score) that could be used to select out these potential AEC patients from the general medical emergency in-take. It is postulated that the score would be helpful to patients by informing the likelihood of same-day discharge, and for the hospital front-door assessment and bed management teams by facilitating in-take management. Patients who were discharged within 12 hours were chosen as surrogates for potential ambulatory care patients because specialised AEC units tend to stay open for 8–12 hours each day, and because most AEC patients who are incorporated into the general medical emergency in-take are discharged within 12 hours of arrival in hospital.

Being younger (<80 years) and female were factors that were associated with being discharged within 12 hours of assessment. In this semi-rural setting with a significant coal mining legacy, the women probably enjoy a better state of physical health than the men. Whether this gender difference in the length of stay is similar in other areas in the UK remains to be seen, although gender differences in healthcare-seeking behaviour have been reported previously in other countries,[13,14] although which gender utilises healthcare systems more depends on where the studies were undertaken.

Public transport services in the South Wales valleys can be variable,[15] so if a patient had no access to personal or public

transport, they had to rely on the Welsh Ambulance Service. This might have delayed their discharge. Access to personal transport is a more crucial factor in determining early discharge than having good family support. In areas in the UK with better-resourced public transport services, transportation might not be such a significant factor in early discharges.

Intravenous (IV) treatments, such as antibiotics for cellulitis, is mostly an in-patient service in this region, so the need or otherwise for IV treatment is a significant factor in determining length of hospital stay. Many other trusts have a well-established outpatient IV antibiotic service, so this factor might not be significant in other regions, although patients who require other IV fluids or emergency blood transfusion might still need to be admitted.

Often, the cause of acute onset confusion is not initially apparent, and it is good clinical practice to treat any possible precipitating factors while closely monitoring the patient. Such patients tended to be kept in for ⩾48 hours.

A MEWS score of 0 can be useful in deciding that a patient should be managed in an ambulatory care setting. In keeping with previous studies,[8,9] we have shown that a high MEWS score is associated with a longer hospital stay of at least 48 hours.

Patients who had been discharged within the previous 30 days tended to be readmitted for ⩾48 hours, although not necessarily with the same diagnosis. Anecdotally, these readmissions were mostly due to difficulties in the social support services rather than a deterioration in the patient's clinical condition, so in areas with excellent community support services, this might not be such a significant factor.

In this study, we have identified some factors that can assist the referring doctor, those that receive the calls, and the EM and AMU triage staff in considering the suitability of ambulatory care management for some patients who would normally have been incorporated into the unselected general medical emergency in-take. The resulting *Amb* score is simple and can be calculated prior to a full clinical assessment or investigations (other than the measurements required calculate the MEWS score). The validation data show that the score performs well when an appropriate cut-off level, which has a high sensitivity at identifying potential AEC patients without significantly compromising its specificity, is selected.

Clinical factors often affect decisions to refer emergency cases to hospital but not all such cases require admission. Provided these patients are assessed as clinically stable after initial treatment in hospital, and provided they have appropriate social support, they can be discharged for further management within the ambulatory care setting. In the correct context, the *Amb* Score could be a useful guide to such patient management. It can help GPs to predict the likelihood of same-day discharge and it could help bed managers in planning the daily general medical emergency in-take and in avoiding over-crowding in the AMU or EM unit. Potential AEC patients could be re-directed to a designated ambulatory care unit if one exists or to a specialty-based rapid access out-patient clinic. The *Amb* Score could also be useful to identify general medical in-take patients who need early review by a senior doctor (specialty doctor or consultant), thereby preventing admission and unnecessary investigation on the AMU.

With bed shortages and increasing emergency referrals to hospital on the one hand and more accessible diagnostic facilities and specialty-based rapid access clinics[16,17] on the other, there is an opportunity for the expansion of AEC services. Tools such as the *Amb* score could assist in these developments.

There are of course pitfalls in using such a score: for example, a patient with cardiac-risk factors, presenting with cardiac sounding chest pains and an abnormal electrocardiogram, should normally be admitted, although he might have an *Amb* score of 8; conversely, a 90-year-old male with a MEWS score of 1, a recent hospital discharge and no access to transportation might have an *Amb* score of 4 but could still be suitable for early discharge if he had a minor problem such a urinary tract infection. Ultimately, a decision that is based on a quick initial clinical assessment by a competent healthcare professional takes precedence over the score, which should only be used as a guide.

Conclusions

The *Amb* score is a novel and simple test that is sensitive in predicting discharge within 12 hours of hospital assessment, and thus might select out potential AEC patients from the unselected general medical emergency in-take before full assessment and further investigations are undertaken. The score was derived from a small study, from one hospital in a semi-rural setting. Further studies are required to validate the usefulness of the *Amb* score in other regions and in both primary and secondary care.

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