



The "HOSPITAL" Score to identify patients at high risk for readmission

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Atelier ANQ - Januar 26, 2017

Goals of this talk

- 1) Introduction
- 2) How to identify high-risk patients
- 3) The HOSPITAL score: development
- 4) The HOSPITAL score: validation
- 5) Strengths and limitations of the HOSPITAL score
- 6) Other scores
- 7) Intervention study using the HOSPITAL score

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How to reduce readmissions

- 30% of readmissions being considered as truly preventable. [van Walraven, CMAJ 2011]
 - Interventions that have been shown to reduce readmission: telephone follow-up, education program, home visit.
 - The most efficient interventions are the most demanding and complex. But on the other hand, limited resources, pressure on the costs. [Leppin JAMA int med 2014]
- need to target the patients who are not likely to benefit, i.e. those who are at high-risk for readmission.

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How can we identify these high-risk patients?



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Ask the patient

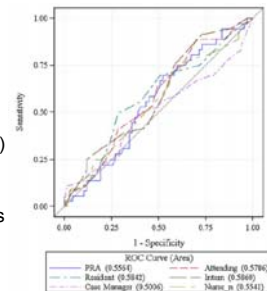
- Little evidence.
- Prospective cohort study in 7 general internal medicine wards in Canada, 495 patients.
- Patient-reported discharge readiness was measured with an 11-point Likert response scale, with scores < 7 indicating subjective unreadiness.
- Patients who reported being unready at the time of discharge did not experience any higher risk of readmission or death in the first 30 days post-discharge, compared with patients who felt ready for discharge.

Lau, AJM 2016

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Ask the clinical providers

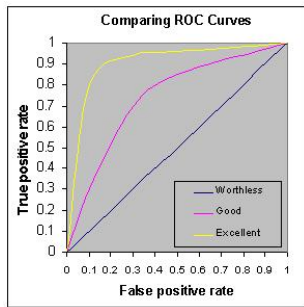
- Patients aged ≥ 65 discharged from the general medical service at University of California.
- Prediction of the chance of readmission with a 0–100% scale.
- Of 159 patients, 52 patients (32.7%) were readmitted.
- The ability to discriminate between readmissions and non-readmissions was poor for all provider groups



Allaudeen, J Gen Intern Med 2011 (26):771–6

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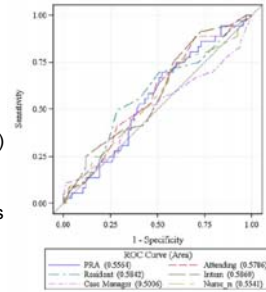
C-statistic = area under the receiver operating curve



- 0.90-1 = excellent
- 0.80-0.90 = very good
- 0.70-0.80 = fair-good
- 0.60-0.70 = poor
- 0.50-0.60 = fail

Ask the clinical providers

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- The ability to discriminate between readmissions and non-readmissions was poor for all provider groups



Allaudeen, J Gen Intern Med 2011 (26):771–6

Prediction model to identify patients at high-risk for readmission

ORIGINAL INVESTIGATION

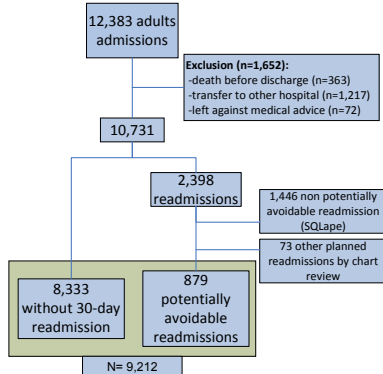
HEALTH CARE REFORM

Potentially Avoidable 30-Day Hospital Readmissions in Medical Patients

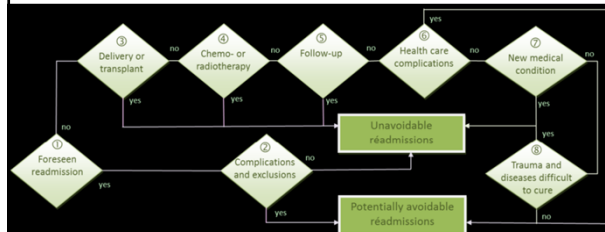
Derivation and Validation of a Prediction Model

Jacques Dongé, MD, MSc; Drahomir Aujesky, MD, MSc; Deborah Williams, MHA; Jeffrey L. Schnipper, MD, MPH

JAMA Intern Med. 2013;173(8):632-638.



SQLape



Dr Yves Egli, Institute of Social and Preventive Medicine (IUMSP), Lausanne

Methods

- Candidate predictor categories from the index admission:
 - demographics
 - health-care utilization measures
 - comorbidities
 - hospital stay characteristics
 - laboratory values
- Split-sample approach (derivation 2/3 – validation 1/3)
- Multiple logistic regression with backward elimination

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Effect	OR	95%CI
Low hemoglobin level (<12)	1.3	1.1-1.6
Low sodium level (<135)	1.4	1.1-1.7
Any procedure performed	1.4	1.2-1.7
Urgent admission	1.4	1.0-1.8
Length of stay ≥ 5 days	1.5	1.3-1.8
Discharge from oncology	1.8	1.5-2.2
1-5 admissions in the past year	1.7	1.4-2.1
>5 admissions in the past year	3.8	2.8-5.3

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The «HOSPITAL» score

H	Low Hemoglobin level at discharge (< 120 g/L)	1
O	Discharge from an Oncology service	2
S	Low Sodium level at discharge (< 135 mmol/l)	1
P	Procedure during hospital stay (any ICD-9 coded)	1
IT	Index admission Type : urgent or emergent (non-elective)	1
A	Number of hospital Admission(s) in the previous year:	
	0	0
	1-5	2
	>5	5
L	Length of stay ≥ 5 days	2

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Calibration

Agreement between observed outcomes and predicted probabilities

Points	Risk category	Patients in each category, n (%)	Predicted risk of readmission, % (HOSPITAL score)	Actual risk of readmission, %
0-4	Low	1,428 (47%)	4.7	4.6
5-6	Inter-mediate	875 (28%)	9.6	9.6
≥ 7	High	768 (25%)	18.2	18.5

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Discrimination power

	Derivation set (n=6,141)	Validation set (n=3,071)
C-statistic	0.69	0.71

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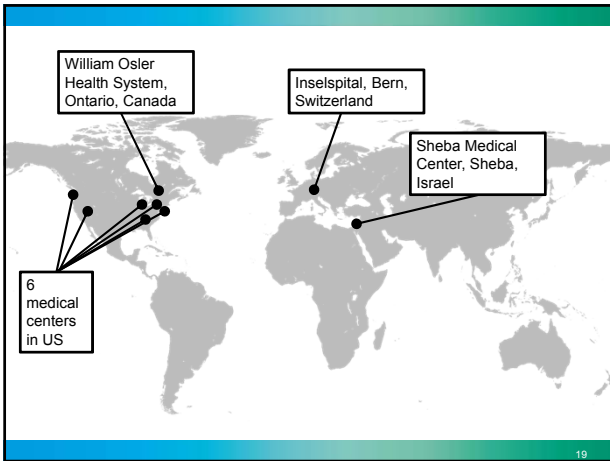
INTERNATIONAL MULTICENTER VALIDATION OF THE “HOSPITAL” SCORE TO PREDICT 30-DAY POTENTIALLY AVOIDABLE READMISSIONS IN MEDICAL PATIENTS

Jacques D. Donzé, MD, MSc; Mark V. Williams, MD; Edmondo J. Robinson, MD, MBA, MSHP; Eyal Zimlichman, MD, MSc; Drahomir Aujesky, MD, MSc; Eduard E. Vasilevskis, MD MPH; Sunil Kripalani, MD, MSc; Joshua P. Metlay, MD, PhD; Tamara Wallington, MD; Grant S. Fletcher, MD, MPH; Andrew D. Auerbach, MD, MPH; Jeffrey L. Schnipper, MD, MPH.

JAMA Intern Med. doi:10.1001/jamainternmed.2015.8462
Published online March 7, 2016

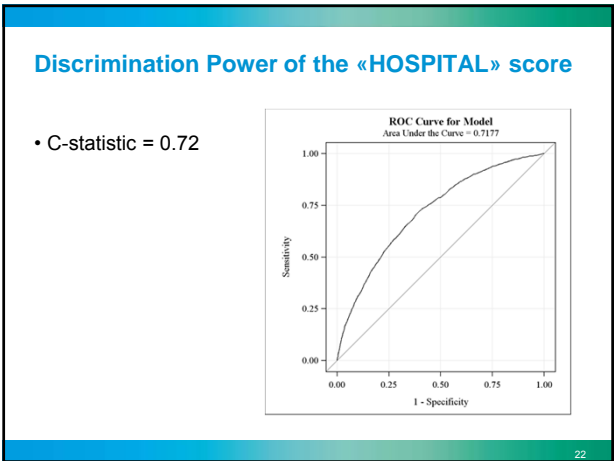
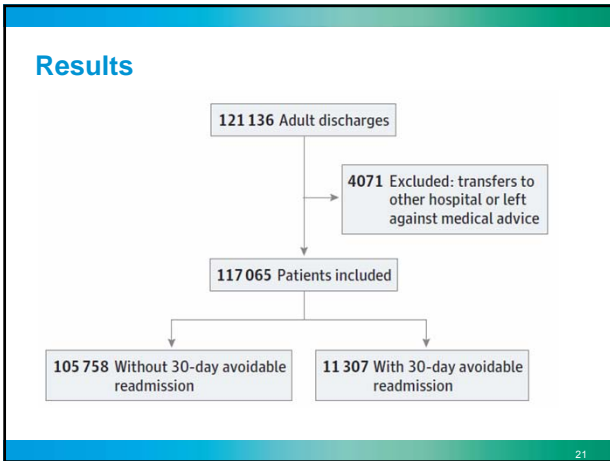


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Methods

- All adult medical patients consecutively discharged alive from these 9 medical centers, between January and December, 2011
- Primary outcome was any 30-day readmission that was classified as potentially avoidable using the previously validated SQLape algorithm
- The performance of the score was evaluated according to its discrimination (C-statistic) and its calibration.

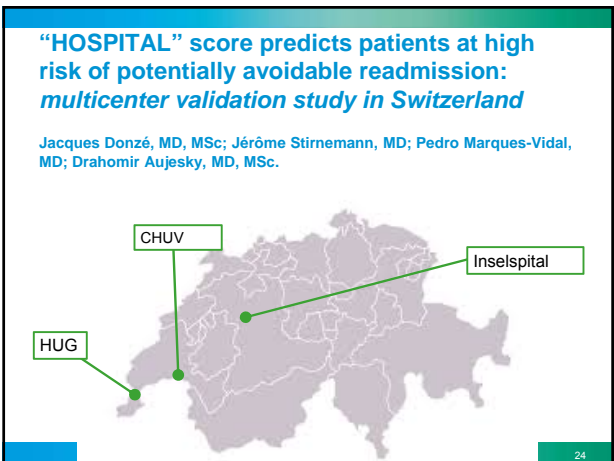


Calibration

Observed vs. Predicted 30-day Potentially Avoidable Readmissions (PAR)

Points	Risk category	Patients in each category, n (%)	Observed proportion of PAR in the validation study, %	Estimated risk of PAR in the validation study, %
0-4	Low	77,896 (63%)	5.8	5.8
5-6	Intermediate	29,239 (23%)	11.8	11.8
≥ 7	High	17,077 (14%)	22.4	22.4

Pearson goodness-of-fit statistic : excellent calibration P=0.97



Methods

- All adult patients consecutively discharged alive from the medical departments of 3 tertiary care hospitals in Switzerland between January 2011 and December, 2012.
- Outcome = any potentially avoidable 30-day readmission according to the validated SQLape algorithm

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Results

- 43,058 discharges
- 12.3% (n=5,309) had a 30-day readmission
- 5.2% (n=2,219) a 30-day readmission deemed potentially avoidable.
- Median length of stay was 7 days (IQR 3-12) -> threshold for LOS in the HOSPITAL score changed from 5 days to 8

Original score	Median LOS 4	LOS >= 5	43.8%
Swiss validation	Median LOS 7	LOS >=8	43.8%

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The «HOSPITAL» score

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S	Low Sodium level at discharge (< 135 mmol/l)	1
P	Procedure during hospital stay (any ICD-9 coded)	1
IT	Index admission Type : urgent or emergent (non-elective)	1
A	Number of hospital Admission(s) in the previous year:	
	0	0
	1-5	2
	>5	5
L	Length of stay >= 5 8 days	2

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C-statistic of 0.67 (95% CI 0.66-0.68)

Categories	Proportion	Observed	Predicted
Low risk (0-4)	62%	3.9%	4.0%
Intermediate (5-6)	25%	7.4%	6.7%
High risk (>=7 points)	13%	10.4%	11.1%

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Prospective validation of the "HOSPITAL" score

Aim: to prospectively demonstrate the HOSPITAL score accuracy to predict 30-day unplanned readmission and death.

Methods: Prospective cohort study. Medical inpatients ≥50 y.o., discharge between April and September 2013 from the Fribourg Cantonal Hospital.

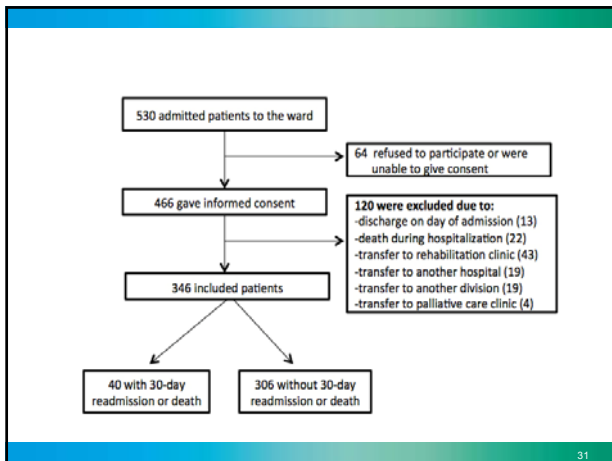
[Aubert, Swiss Med Wkly. 2016;146:w14335]

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HOSPITAL score

	Points
Low Hemoglobin level at discharge < 12.0 g/dl	1
Discharge from an Oncology service or cancer	2
Low Sodium level at discharge (< 135 mmol/l)	1
Procedure during hospital stay (any ICD10 coded)	1
Index admission Type : non-elective	1
Number of hospital Admission(s) <1 year	
0	0
1-5	2
>5	5
Length of stay >= 5 8 days (originally 5 days in US)	2

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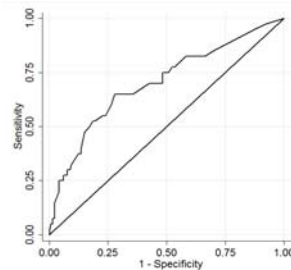
Results

- Among the 346 included patients, 40 (12%) had a 30-day unplanned readmission or death.
- Mean age of the patients was 73.4 years (SD 11.5) and median length of stay 7 days (IQR 4-12).

Points	Risk category	Number of patients in each category, n (%)	Observed proportion with readmission or death in the validation study, %	Estimated risk of readmission or death in the validation study using the HOSPITAL score, %
0-4	Low	204 (59.0)	9.8	8.2
5-6	Inter-mediate	72 (20.8)	8.3	11.3
≥ 7	High	70 (20.2)	20.0	21.6

Calibration: P=0.77 (Hosmer-Lemeshow goodness-of-fit test)

Power discrimination:
C-statistic 0.70 (95%CI 0.62-0.79)



Validation for frequent diseases

9181 medical patients from 6 US medical centers with a diagnosis of either:

- acute myocardial infarction
- COPD
- pneumonia
- heart failure

C-statistic 0.68

[Burke, Donzé, Med Care 2016]

Other external validation studies in different populations

-Validation study in 19,277 medical patients in Denmark: C-statistic 0.66 [Cooksey QJM 2016]

-Validation study in 931 patients discharged from the hospital service of a moderate sized university hospital in the midwestern US. C-statistic 0.77 [Robinson, PeerJ 2016]

-Validation study in primary care patients (Mayo Clinic). 26,278 admission to any department (only 30% to a general medical service). C-statistic 0.68 [Garrison, J Eval Clin Pract 2016]

Validation Studies – Summary

Design	Setting	Performance
Derivation study	Academic hospital in Boston, MA	0.71
Internal validation study	N=10,701 medical patients	
International external validation study	9 medical centers, 4 countries, N=124,212 medical patients	0.72
Geographical and time transportability		
External validation in CH Restrospective design	3 academic hospitals in Switzerland, N=43,058 medical patients	0.67
External validation in CH Prospective design	1 large community hospital in Switzerland, N=436	0.70
External validation in specific diseases	6 US medical centers N= 9,181	0.68
External validation in Denmark	N= 19,277 medical patients	0.66
External validation in a US moderate sized university hospital	N= 931	0.77
External validation in primary care patients, admitted to any department	N=26,278	0.68

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HOSPITAL score

Strengths

- Easy to use
- Assessment before discharge
- Does not include non-avoidable readmissions
- All medical patients regardless of their main cause of admission
- International validation with good performance
- Retrospective and prospective validation

Limitations

- The variables included in the score are not modifiable
- The score is not mean to be calculated at admission
- The HOSPITAL Score does not give a specific intervention target

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Can the score be even more simplified?

We simplified the score as follow:

Variable	Original score (number of point) if positive	Simplified score (number of points)
Hemoglobin level at discharge <120g/l	1	1
Cancer diagnosis or discharge from an Oncology division ^a	2	2
Sodium level at discharge <135mmol/l	1	1
Any ICD-9 or ICD-10 Procedure during hospitalization ^b	1	NA
Index Type of admission: nonelective ^c	1	1
Number of hospital Admissions during the previous 12 months	0	0
0-1	2	2
2-5	5	5
≥5		
Length of stay ≥5 days	2	2
Total	13	12

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Can the score be even more simplified?

C-statistic 0.72

Observed proportions versus estimated risk of 30-day potentially avoidable readmission (PAR).

Points	Risk of 30-day readmission	Patients in each category, n (%)	Observed proportion with PAR (%)	Estimated risk of PAR using the simplified HOSPITAL score (%)
0-4	unlikely	82,383 (70.4)	6.4	6.4
≥ 5	likely	34,682 (29.6)	17.3	17.3

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Is there alternative to the HOSPITAL score?

Risk Prediction Models for Hospital Readmission

A Systematic Review

JAMA. 2011;306(15):1688-1698

Conclusions:

-Most readmission risk prediction models perform poorly.

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LACE score

Attribute	Value	Points
a. LACE index for the risk of 30 day readmissions		
L Length of Stay (Days)	<1	0
	1	1
	2	2
	3	3
	4-6	4
	7-13	5
	>14	7
A Acute Admission	Yes	3
	No	0
C Comorbidity score (Charlson)	0	0
	1	1
	2	2
	3	3
	>4	5
E Emergency Department attendances in last 6 months	0	0
	1	1
	2	2
	3	3
	>4	4

van Walraven. CMAJ. 2010;182(6):551-557.

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Charlson score

Comorbidity	Relative weight assignment
Metastatic solid tumor	6
AIDS	6
Moderate-to-severe liver disease	3
Hemiplegia	2
Moderate-to-severe renal disease	2
Diabetes w/end organ damage	2
Neoplasia	2
Leukemia/lymphoma	2
Myocardial infarct	1
Congestive heart disease	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Dementia	1
Chronic pulmonary disease	1
Connective tissue disease	1
Ulcer disease	1
Mild liver disease	1
Diabetes	1

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LACE vs HOSPITAL score

- LACE not validated outside Canada and Singapore.
- LACE more complicated to calculate: need Charlson score (i.e. all ICD codes, available after discharge).
- Poor performance in older patients in the UK (C-stat 0.56).
- HOSPITAL score overperform the LACE score in Denmark and Switzerland.

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Comparison with the LACE score

Design	Setting	HOSPITAL score	LACE score
Derivation study Internal validation study	Academic hospital in Boston, MA N=10,701 medical patients	0.71	-
International external validation study Geographical and time transportability	9 medical centers, 4 countries, N=124,212 medical patients	0.72	-
External validation in CH Retrospective design	3 academic hospitals in Switzerland, N=43,058 medical patients	0.67	-
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External validation in a US moderate sized university hospital	N= 931	0.77	-
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How valid are the score currently used in clinical practice?

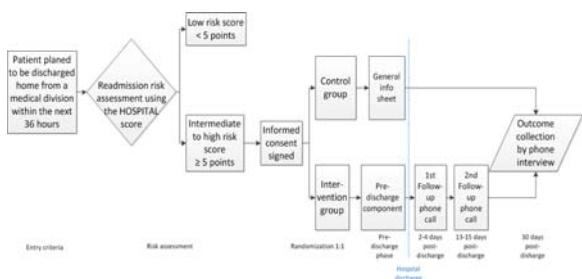
- Many prediction models, but...
 - Systematic review of the 6 highest IF general medical journals 2008-11: 71 articles.
 - Only 3 studies were external validation studies, 50% had a too small sample size, performance reported correctly in 12%.
- Study site, reliability, and clinical prediction rule was adequately described in 10.1%, 9.4%, and 7.0% of validation studies respectively.

-Bouwmeester W, (2012) Reporting and Methods in Clinical Prediction Research: A Systematic Review. PLoS Med 9(5): e1001221. doi:10.1371
-Ban J-W, (2016) Design Characteristics Influence Performance of Clinical Prediction Rules in Validation: A Meta-Epidemiological Study. PLoS ONE 11(1): e0145779. doi:10.1371/journal.pone.0145779

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Next step with the HOSPITAL score

RCT to test intervention targeted to the patients with higher risk for readmission.



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Take home message

- HOSPITAL score is the best validated prediction model for 30-day readmission.
- The HOSPITAL score is easy to use and can be calculated before discharge.
- Many prediction models are developed, but very are well validated, and how many are really used appropriately?

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Thank you for your attention

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