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Supplemental Methods: methodology of chart reviews in subgroup analysis

Chart reviews in the subgroup analysis were performed by 5 clinicians (AEL, KSR, NMB, EWR, JDR), who were blinded to patients' ICD-10 codes and DRG assignment. Clinical information was collected from the electronic health record (EHR) and study data were collected and managed using REDCap electronic data capture tools hosted at the University of Colorado Clinical and Translational Sciences Institute (CCTSI).[31-32] Health information that was reviewed included the discharge summary, clinician notes, test reports, procedure reports and laboratory studies.

The goal of chart reviews was to categorize each UCH patient encounter into one of three categories based on the Fourth Universal Definition of MI[6]: Type 1 MI (T1MI), Type 2 MI (T2MI) or non-ischemic myocardial injury (NIMI). The following criteria were used:

T1MI encounters met the following three criteria: 1) biomarker evidence of acute myocardial injury, defined as an elevated troponin level (per cohort definition above) and evidence of at least a twenty percent difference between peak and trough troponin levels, using the peak as the reference; 2) signs or symptoms of acute myocardial ischemia were present (see **Supplemental Methods 1** for further details); and 3) clinical suspicion or procedural confirmation of intracoronary atherothrombotic plaque rupture as the etiologic cause of AMI.

T2MI encounters met the following three criteria: 1) biomarker evidence of acute myocardial injury per the T1MI definition; 2) AMI signs or symptoms per the T1MI definition; 3) clinical suspicion of mismatch between myocardial oxygen supply and demand caused by a "severe illness" unrelated to acute coronary atherothrombosis. Cases in which coronary disease was obstructive (>70%) were categorized as T1MI unless a preponderance of evidence in the chart, and the treating clinicians' notes, suggested T2MI.

NIMI encounters met the following criteria: 1) lack of biomarker evidence of acute myocardial injury or 2) lack of signs or symptoms of ischemia as defined above.

In order to maximize agreement between reviewers, methods for chart reviews in the subgroup analysis were discussed and agreed upon by all reviewers. This included instructions on the specific criteria for each of the signs and symptoms of AMI, as well as regarding the criteria for "severe illness" that might qualify as a cause of T2MI (see pages 2-3). Agreement between reviewers regarding the diagnosis of T1MI versus non-T1MI was assessed based on independent review of twenty randomly selected cases by each of the five reviewers: dual-comparison kappa scores revealed perfect agreement between all reviewer pairs.

Supplemental Methods: agreement in chart review diagnosis by 5 reviewers

Test Patient	EWR	JDR	NMB	AEL	KSR
1	1	1	1	1	1
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	1	1	1	1	1
8	0	0	0	0	0
9	0	0	0	0	0
10	1	1	1	1	1
11	0	0	0	0	0
12	1	1	1	1	1
13	1	1	1	1	1
14	1	1	1	1	1
15	0	0	0	0	0
16	0	0	0	0	0
17	1	1	1	1	1
18	0	0	0	0	0
19	1	1	1	1	1
20	1	1	1	1	1
20 test patients	1 = Type 1 MI, 0 = not Type 1 MI				

Rater A	Rater B	Cohen's Kappa	Agreement
EWR	JDR	1.00	100%
EWR	NMB	1.00	100%
EWR	AEL	1.00	100%
EWR	KSR	1.00	100%
JDR	NMB	1.00	100%
JDR	AEL	1.00	100%
JDR	KSR	1.00	100%
NMB	AEL	1.00	100%
NMB	KSR	1.00	100%
AEL	KSR	1.00	100%
Group		**1.00**	**100%**

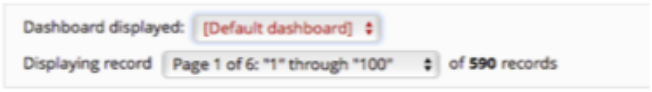
*Part of a subgroup analysis of all patients cared for at the University of Colorado Hospital (UCH).

Supplemental Methods: chart reviewer instructions, page 1.

Knowin Troponin: Guide to RedCap & Chart Reviews

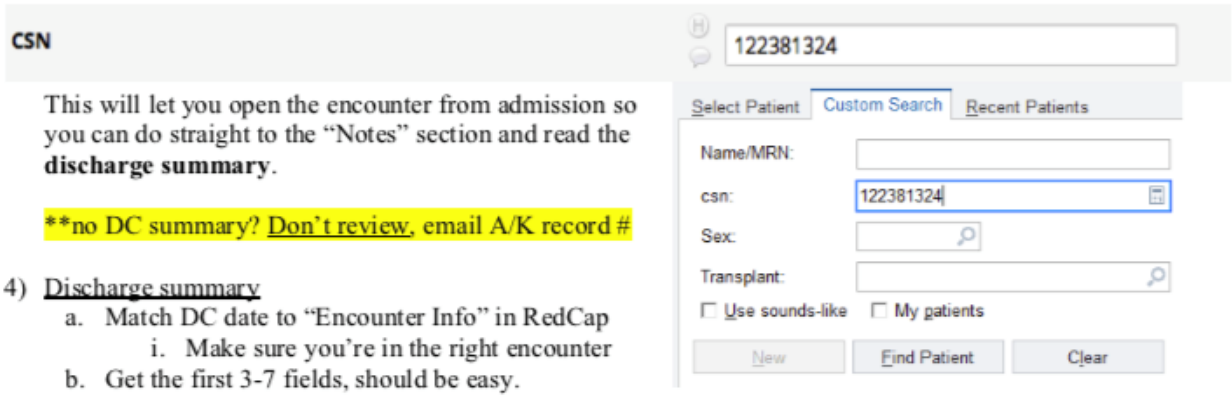
After logging into the Knowin Troponin RedCap & Epic EHR …

1) "Record Status Dashboard" (left toolbar)
   a. Click "default dashboard"
   b. Select your name
   c. This is your random list.



2) Click "Patient station" to pull up the appropriate Encounter

3) Custom search based on the CSN listed in the RedCap.



This will let you open the encounter from admission so you can do straight to the "Notes" section and read the **discharge summary**.

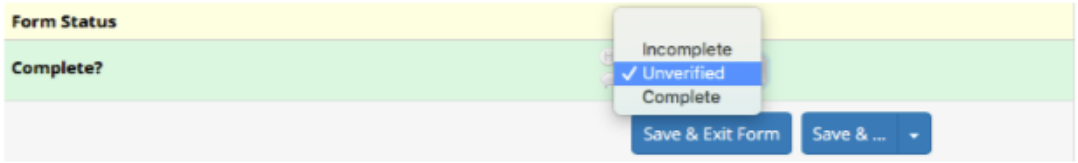
**no DC summary? Don't review, email A/K record #

4) Discharge summary
   a. Match DC date to "Encounter Info" in RedCap
      i. Make sure you're in the right encounter
   b. Get the first 3-7 fields, should be easy.
   c. MI diagnosis: check all things described even if not verified.
   d. Note of any "severe" illnesses

5) Examine data: EKG, Stress, Echo, Cath, etc. as well as other notes/data prn.
   a. In general, you should only have to **review the above if** the DC summary:
      i. **mentions ≤ 1 MI criterion**. e.g. TWI mentioned but nothing else.
      ii. **documents poorly so unclear if "severe illness"** e.g. no mention of troponin elevation
   b. Make sure you're reviewing data from **appropriate date/encounter**!
   c. Use criteria on **page 2** for MI diagnostic criteria
      i. if you're spending >10 mins per record on average, let us know!
      ii. if you're stuck, don't spin your wheels, email questions to A/K **(we expect this)**

6) Make any additional comments as needed.

7) Scroll to very bottom of the form, change "Incomplete" status to "Unverified"



8) "Save and Exit Form"

9) Click "Record Status Dashboard" → this will take you back to your individual dashboard/record list

Supplemental Methods: chart reviewer instructions, page 2.

Chart Reviews: Criteria for Diagnosis

First, a word about **"intracoronary thrombus"** and **"severe illness."**

- If a stent was placed, assume intracoronary thrombus was present, unless:
  - Notes suspicious for supply-demand mismatch → be sure to document the "severe illness"
  - **Dissection (SCAD)**, **Spasm** & **Emboli** all count as "severe illness" ~ these are Type 2's
- If you're unsure whether something is really a "severe illness", email A/K the record number.
  - e.g. a **post-op** patient with ***intracoronary thrombus***, I would **not** document a "severe illness"
    - you can say in "Other notes" that the patient was post-op.
  - e.g. a **post-op** patient with no cath or imaging changes → call it a "severe illness"
  - *If this seems like a form of bias, it is! But it's not our bias, it's the clinicians'/ reporters' bias.*

acute/subacute **Ischemic symptoms**

- Classic: acute (mins-hours) or subacute (days) onset **Chest pain** or **dyspnea** or **SOB**
  - +/- diaphoresis, nausea, jaw pain, arm pain
  - AND *absence of an obvious cause* (PE, COPD exacerbation, etc.)
- Atypical: Epigastric pain/burning, Nausea, Diaphoresis, or Unexplained syncope
  - AND *absence of a more likely cause*

new **Ischemic ECG changes**

- Remember, must be **new** or **dynamic (changing)**
  - ST-elevation at the J-point (40 ms after R) in **≥ 2 contiguous leads**
    - V2–V3
      - ≥ 2mm in men ≥ 40 years
      - ≥ 2.5 mm in men < 40 years
      - ≥1.5 mm in women regardless of age
    - **All other leads: ≥1 mm**
  - ST-depression and T wave changes in **≥ 2 contiguous leads**
    - New horizontal or downsloping ST-depression **≥ 0.5 mm**
    - T-wave inversion **> 1 mm** with prominent R wave or R/S ratio > 1.
      - **Exclude TWI** if criteria for LVH met.
- Email A/K to adjudicate if…
    - new LBBB and prior ECG without LBBB
    - new pathologic q waves (precordial only) and prior ECG without q waves
    - Ventricular arrhythmia or Cardiac arrest without other changes.

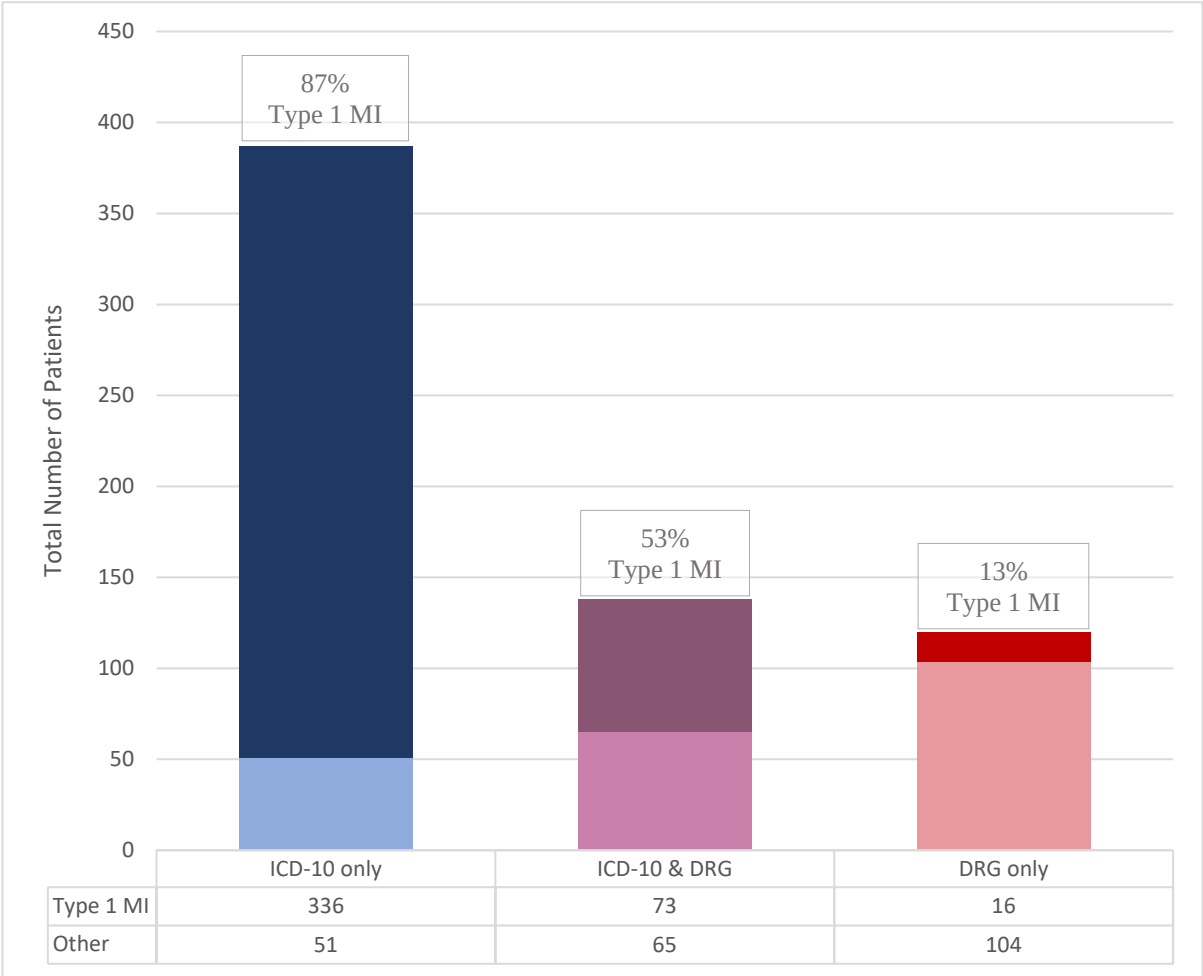
new **Ischemic imaging changes:**

- Try to **correlate anatomically** e.g. RCA lesion should cause → inferior WMA/defect
- It's **NEW** if no prior documentation
  - **Echo/MRI**: wall motion abnormality, not on prior imaging if we have any.
    - can't be re: asynchrony/bundle branch block or other rhythm issue (will say in report).
  - **New** loss of "viable" myocardium
    - **NEW infarct** (with old for comparison) or **Reversible** defect (not due to artifact)

Intracoronary thrombus on angiography

- If a stent was placed, assume intracoronary thrombus was present, unless:
  - Notes suspicious for supply-demand mismatch → be sure to document the "severe illness"
  - **Dissection (SCAD)**, **Spasm** & **Emboli** all count as "severe illness" ~ these are Type 2's
- If a stent wasn't placed, but report/notes mention "acute lesion" or similar → count as thrombus
- If MI criteria met, but no coronary disease and no "severe illness" → write **MINOCA** in "Other Notes"
  - send number to A/K

Supplemental Figure I: Proportion of Type 1 MI among UCH subgroup patients (n=645) in ICD10 cohort only (left), DRG cohort only (right) and both DRG and ICD10 cohorts (middle).



	ICD-10 only	ICD-10 & DRG	DRG only
Type 1 MI	336	73	16
Other	51	65	104

*Part of a subgroup analysis of all patients cared for at the University of Colorado Hospital (UCH).

Abbreviations: UCH = University of Colorado Hospital, DRG = diagnosis related group; ICD-10 = international classification of diseases, 10th revision; Type 1 MI = Type 1 myocardial infarction.

Supplemental Table I. Diagnosis related groups (DRG) and international classification of diseases, 10th revision (ICD-10) codes used for inclusion in the AMI DRG and AMI ICD-10 cohorts, respectively. Of note, principal discharge diagnosis codes were used. Inclusion in each AMI cohort was designed to simulate a value-based payment program for AMI. DRG classes for AMI were chosen to align with inclusion criteria for the BPCI Advanced program.[3] Principal discharge ICD-10 codes for AMI were chosen to align with inclusion criteria for the VBP and HRRP programs. [4,5]

DRGs included in DRG cohort		ICD-10 Codes included in ICD-10 cohort*	
Number	Description	Number	Description
280	Acute Myocardial Infarction without CC or MCC, discharged alive.	I21.01	ST elevation (STEMI) myocardial infarction involving left main coronary artery
281	Acute Myocardial Infarction with CC, discharged alive.	I21.02	ST elevation (STEMI) myocardial infarction involving left anterior descending coronary artery
282	Acute Myocardial Infarction with MCC, discharged alive.	I21.09	ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall
		I21.11	ST elevation (STEMI) myocardial infarction involving right coronary artery
		I21.19	ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall
		I21.21	ST elevation (STEMI) myocardial infarction involving left circumflex coronary artery
		I21.29	ST elevation (STEMI) myocardial infarction involving other sites
		I21.3	ST elevation (STEMI) myocardial infarction of unspecified site
		I21.4	Non-ST elevation (NSTEMI) myocardial infarction

*A March 2019 update to the ICD-10 codes used for the VBP and HRRP programs includes one additional code (I21.9) for "Acute Myocardial Infarction, unspecified" that was not used for our inclusion criteria.

Abbreviations: CC refers to Comorbid Condition; MCC refers to Major Comorbid Condition.

Supplemental Table II: Baseline characteristics in UCHealth (entire study cohort) compared to the UCH Subgroup

	UCHealth excluding UCH	UCH	p value
Total n	1531 (100%)	645 (100%)	
Demographics			
Age (median)	66.23 (sd = 13.43)	64.38 (sd = 14.39)	0.001
Female	469 (30.63%)	232 (35.97%)	0.111
White or Caucasian	1323 (86.41%)	345 (53.49%)	<0.001
Cardiology Team	1240 (80.99%)	309 (47.91%)	<0.001
Medical History			
Diabetes Mellitus	550 (35.92%)	266 (41.24%)	0.007
Hypertension	1213 (79.23%)	503 (77.98%)	0.703
Hyperlipidemia	1148 (74.98%)	304 (47.13%)	<0.001
Heart Failure	512 (33.44%)	288 (44.65%)	<0.001
Peripheral Artery Disease	69 (4.51%)	15 (2.33%)	0.019
Prior Stroke	261 (17.05%)	133 (20.62%)	0.089
COPD	227 (14.83%)	116 (17.98%)	0.064
Chronic Kidney Disease	375 (24.49%)	235 (36.43%)	<0.001
Dementia	63 (4.11%)	31 (4.81%)	0.737
Cancer	298 (19.46%)	107 (16.59%)	0.063
Home Medications			
Aspirin	118 (7.71%)	81 (12.56%)	0.001
P2Y12 Inhibitor	68 (4.44%)	48 (7.44%)	0.024
Beta Blocker	128 (8.36%)	97 (15.04%)	<0.001
Any Statin	132 (8.62%)	91 (14.11%)	<0.001
ACEi, ARB, ARNI	109 (7.12%)	83 (12.87%)	<0.001
Oral Anticoagulaton	28 (1.83%)	24 (3.72%)	0.033

Abbreviations: ACEi=angiotensin-converting enzyme inhibitor; ARB=angiotensin-receptor blocker; ARNI = angiotensin-receptor neprilysin inhibitor; COPD = chronic obstructice pulmonary disease; DOAC = direct oral anticoagulant; DRG = Diagnosis Related Group; ICD-10 = international classification of diseases, 10^{th} revision; T1MI = Type 1 MI; UCH = University of Colorado Hospital.

Supplemental Table III. Multivariate comparison of quality measures and rates of resource utilization among different AMI cohorts (sensitivity analysis)

	ICD-10	DRG	*T1MI-UCH	*ICD10-UCH	*DRG-UCH
Total n	1935	662	425	525	258
Outcome measures					
1 year mortality	168 (8.7%) ref	147 (22.2%) p<0.001	44 (10.4%) ref	53 (10.1%) p=0.169	61 (23.6%) p=0.004
30 day mortality	51 (2.64%) ref	47 (7.1%) p=0.034	7 (1.7%) ref	8 (1.5%) p=0.158	13 (5.0%) **p=0.089**
90 day readmission	365 (18.9%) ref	171 (25.8%) **p=0.753**	93 (21.9%) ref	114 (21.7%) p=0.233	68 (26.4%) p=0.589
30 day readmission	269 (13.9%) ref	123 (18.6%) p=0.689	62 (14.6%) ref	76 (14.5%) p=0.462	45 (17.4%) p=0.540
Medications administered					
Aspirin	1916 (99.0%) ref	622 (94.0%) p<0.001	424 (99.8%) ref	519 (98.9%) p=0.992	235 (91.1%) **p=0.098**
P2Y12 inhibitors	1579 (81.6%) Ref	295 (44.6%) p<0.001	340 (80.0%) ref	393 (74.9%) p=0.680	98 (38.0%) p<0.001
High-dose Statin	1790 (92.5%) ref	531 (80.2%) p<0.001	407 (95.8%) ref	500 (95.2%) p=0.993	219 (84.9%) p<0.001
Beta Blocker	1804 (93.2%) ref	553 (82.5%) p<0.001	401 (94.4%) ref	477 (90.9%) p=0.668	197 (76.4%) p<0.001
Process measures					
Length of Stay	4.03 days ref	3.88 days **p=0.006**	5.81 days ref	5.79 days p=0.555	4.88 days **p<0.001**
Echocardiography	1294 (66.9%) ref	421 (63.6%) p=0.055	218 (51.3%) ref	271 (51.6%) p=0.552	122 (47.3%) p=0.247
Stress Test	24 (1.2%) ref	33 (5.0%) p<0.001	9 (2.1%) ref	20 (3.8%) p=0.977	30 (11.6%) p<0.001
Cardiac CT	7 (0.4%) ref	11 (1.7%) p=0.001	3 (0.7%) ref	4 (0.8%) p=0.288	8 (3.1%) p=0.991
Cardiac MRI	11 (0.6%) ref	8 (1.2%) **p=0.999**	8 (1.9%) ref	11 (2.1%) p=0.999	7 (2.7%) p=0.999
Cardiac Catheterization	1262 (65.2%) ref	217 (32.8%) p<0.001	282 (66.4%) ref	323 (61.5%) p=0.924	81 (31.4%) p<0.001
Cardiac rehabilitation referral	1118 (57.8%) ref	148 (22.4%) p<0.001	68 (16.0%) ref	79 (15.0%) p=0.981	17 (6.6%) P<0.001

*Part of a subgroup analysis of all patients cared for at the University of Colorado Hospital (UCH).
Bolded p values represent a change in statistical significance (using an alpha of 0.05) with multivariate analysis.

Abbreviations: CT = computed tomography; MRI = magnetic resonance imaging; DRG = diagnosis related group; ICD-10 = international classification of diseases, 10th revision; T1MI = Type 1 MI

Supplemental Table IV: Top 10 ICD-10 diagnoses in the DRG cohort (n = 662).

ICD-10 discharge	n	Description of ICD-10 code
I21.4	377	Non-ST elevation (NSTEMI) myocardial infarction
I21.A1	60	Myocardial infarction type 2
I13.0	22	Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease
I11.0	16	Hypertensive heart disease with heart failure
I21.19	16	ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall
I21.09	12	ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall
I13.2	10	Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease
I16.1	10	Hypertensive emergency
I50.23	10	Acute on chronic systolic (congestive) heart failure
I21.3	8	ST elevation (STEMI) myocardial infarction of unspecified site
Other	121	

Supplemental Table V: Top 10 DRG assignments in the ICD-10 cohort (n=1935).

DRG discharge	n	Description of DRG
247	655	Percutaneous cardiovascular procedures with drug-eluting stent without MCC
246	201	Percutaneous cardiovascular procedures with drug-eluting stent with MCC
280	180	Acute myocardial infarction, discharged alive with MCC
281	157	Acute myocardial infarction, discharged alive without MCC
174	155	Percutaneous coronary intervention w AMI
249	91	Percutaneous cardiovascular procedures with non-drug-eluting stent without MCC
282	85	Acute myocardial infarction, discharged alive without CC/MCC
234	60	Coronary artery bypass with cardiac catheterization without MCC
233	44	Coronary artery bypass with cardiac catheterization with MCC
190	42	Chronic obstructive pulmonary disease with MCC
Other	265	

Supplemental Table VI: DRG group assigned to patients in subgroup analysis by chart review diagnosis.

DRG Group	*UCH Type 1 MI n=425*	*UCH Type 2 MI n=101*	*UCH NIMI n=119*
AMI	89 (21%)	84 (83%)	85 (71%)
PCI	189 (44%)	5 (5%)	14 (12%)
CABG	47 (11%)	1 (1%)	4 (3%)
Other	100 (24%)	11 (11%)	16 (14%)

*Part of a subgroup analysis of all patients cared for at the University of Colorado Hospital (UCH).

Abbreviations: AMI = acute myocardial infarction; CABG = coronary artery bypass grafting (CABG); DRG = diagnosis related group; PCI = percutaneous coronary intervention

Supplemental Table VII: Tables for Cohen's Kappa calculations for UCH subgroup analysis*

Chart review	DRG	ICD-10 – Y	ICD-10 – N
Type 1 MI	AMI	73	16
Type 1 MI	PCI	189	0
Type 1 MI	CABG	47	0
Type 1 MI	None	100	0
Type 2 MI	AMI	34	50
Type 2 MI	PCI	5	0
Type 2 MI	CABG	1	0
Type 2 MI	None	11	0
Non-ischemic	AMI	31	54
Non-ischemic	PCI	14	0
Non-ischemic	CABG	4	0
Non-ischemic	None	16	0

Comparison	*Both*	*Neither*	*(DRG or ICD-10) only*	*T1MI only*	*Total*	*% Agree*	*Kappa (95% CI)*
T1MI vs. ICD-10	409	104	116	16	645	79.5%	0.49 (0.42,0.56)
T1MI vs. DRG	89	51	169	336	645	21.7%	-0.47 (-0.54,-0.4)

*Part of a subgroup analysis of all patients cared for at the University of Colorado Hospital (UCH).

Abbreviations: DRG = diagnosis related groups; ICD-10 = international classification of diseases, 10th revision; Non-ischemic = non-ischemic myocardial injury; T1MI = Type 1 myocardial infarction.