Systematic Review / Meta-analysis

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Differences in treatment and outcomes among patients with ST-segment elevation myocardial infarction with and without standard modifiable risk factors: a systematic review and meta-analysis

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Background: There are limited data available on outcomes and pathophysiology behind ST-segment elevation myocardial infarction (STEMI) in populations without standard modifiable risk factors (SMuRFs). The authors carried out this meta-analysis to understand the differences in treatment and outcomes of STEMI patients with and without SMuRFs.

Methods: A systematic database search was performed for relevant studies. Studies reporting desired outcomes among STEMI patients with and without SMuRFs were selected based on predefined criteria in the study protocol (PROSPERO: CRD42022341389). Two reviewers independently screened titles and abstracts using Covidence. Full texts of the selected studies were independently reviewed to confirm eligibility. Data were extracted from all eligible studies via a full-text review of the primary article for qualitative and quantitative analysis. In-hospital mortality following the first episode of STEMI was the primary outcome, with major adverse cardiovascular events (MACE), repeat myocardial infarction (MI), cardiogenic shock, heart failure, and stroke as secondary outcomes of interest. Odds ratio (OR) with a 95% CI was used to estimate the effect.

Results: A total of 2135 studies were identified from database search, six studies with 521 150 patients with the first STEMI episode were included in the analysis. The authors found higher in-hospital mortality (OR: 1.43; CI: 1.40–1.47) and cardiogenic shock (OR: 1.59; 95% CI: 1.55–1.63) in the SMuRF-less group with no differences in MACE, recurrent MI, major bleeding, heart failure, and stroke. There were lower prescriptions of statin (OR: 0.62; CI: 0.42–0.91) and Angiotensin converting enzyme inhibitor /Angiotensin II receptor blocker (OR: 0.49; CI: 0.28–0.87) at discharge in SMuRF-less patients. There was no difference in procedures like coronary artery bypass graft, percutaneous coronary intervention, and thrombolysis.

Conclusion: In the SMuRF-less STEMI patients, higher in-hospital mortality and treatment discrepancies were noted at discharge.

Keywords: diabetes, hypercholesterolemia, hypertension, mortality, smoking, standard modifiable risk factors (SMuRFs), ST-elevation myocardial infarction

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Introduction

According to WHO, ischemic heart disease is the leading cause of death globally, accounting for more than 8.9 million deaths in the year 2019[1]. Mortality due to ischemic heart disease has declined dramatically over the last decades in European and North American countries due to a greater focus on primary prevention[2]. However, there remains a significant number of patients presenting with acute myocardial infarction (MI) with no known standard modifiable risk factors (SMuRFs), including diabetes, hypertension, hypercholesterolemia, and smoking at the time of their event[3]. Despite representing a sizable portion of the first episode of ST-segment elevation myocardial infarction (STEMI) (4.1–26.2%), SMuRF-less groups of ischemic heart disease patients are not targets of standard preventative therapies and are often overlooked in clinical trial publications[4]. While some studies have noticed increased mortality and complications in these SMuRF-less patient groups[5–8], others have reported no differences in the outcomes[9,10].

At present, reperfusion with primary percutaneous coronary intervention (PCI) with guideline-directed medical therapy (GDMT) to avoid restenosis/thrombosis and cardiac remodeling is standard of care for STEMI[11]. For populations with SMuRFs, risk factor modification (e.g. control of high blood pressure, smoking cessation, and so on) has a significant role in preventing adverse outcomes[11]. In particular, in patients with diabetes, the risk of vascular restenosis after revascularization procedure is high due to several pathomechanisms like neointimal hyperplasia, chronic inflammation, and neo-atherosclerosis[12].

Studies have reported that the SMuRF-less groups of patients receive less GDMT[4,8] and invasive procedures[6], contributing to worse outcomes, while others have noticed no difference in GMDT[3] and invasive procedures[3,4,8]. The purpose of the study was to fully understand the differences in treatment and outcomes of STEMI in patients with and without SMuRFs; we performed a systematic review and meta-analysis of the available studies.

Methods

Database searches and sources

We performed this systematic review aligned with published protocol (PROSPERO ID: CRD42022341389)[13]. Our findings were reported according to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines[14], Supplemental Digital Content 1, http://links.lww.com/MS9/A94. This work has been reported in line with Assessing the methodological quality of systematic reviews (AMSTAR) guidelines (online supplement), Supplemental Digital Content 2, http://links.lww.com/MS9/A95. A systematic electronic search of PubMed, PubMed Central, Scopus, and Embase databases for studies reporting outcomes of the first episode of STEMI in patients with and without SMuRFs was performed, from inception until June 2022, using two broad search terms which were combined using Boolean operation 'AND'. For the search theme 'STEMI', the following search words were used: 'ST Elevation Myocardial Infarction', and for the theme SMuRFs, the terms used were: 'Risk Factors'. Our study was limited to the English language, case–control studies, cohort studies, and observational cross-sectional studies.

HIGHLIGHTS

- Limited data on treatment and outcomes in ST-segment elevation myocardial infarction (STEMI) patients without standard risk.
- The absence of standard modifiable risk factors (SMuRFs) was associated with increased in-hospital mortality.
- There were lower uses of statin and Angiotensin converting enzyme inhibitor/Angiotensin II receptor blocker at discharge among SMuRF-less patients.
- Additional research is required to redirect prevention and management among SMuRFs.

Study eligibility criteria

All comparative studies that reported incidence, baseline characteristics, treatment strategy, and clinical outcomes of first episode of STEMI in human adults (>18 years) with and without SMuRFs were eligible. Editorials, systematic reviews, viewpoints, dissertations, abstracts/presentations, and studies with incomplete data were excluded.

Data extraction

Two reviewers independently screened titles and abstracts using Covidence[15]. Full texts of the selected studies were uploaded and independently reviewed on Covidence to confirm eligibility. Data were extracted from all eligible studies via a full-text review of the primary article for qualitative and quantitative analysis. Discrepancies were resolved by consensus, and persisting conflicts were resolved by taking the opinion of the third reviewer. Finally, another independent reviewer assessed the risk of bias and cross-checked the selected studies.

Evaluation measure

Studies were evaluated using standardized inventories for assessing research quality using JBI critical appraisal checklist to determine the internal validity and the risk of bias in the included studies (eTable 1, Supplemental Digital Content 16, http://links.lww.com/MS9/A134)[16].

Assessment of reporting biases

Reporting bias was checked by prefixed reporting of the outcome.

Data synthesis and statistical analysis

RevMan 5.4 was used to perform statistical analysis with outcome estimation using odds ratio (OR) with a 95% CI[17]. Outcomes were measured using a fixed or random effect model for dichotomous variables and the mean difference for continuous variables.

Outcomes measured

The primary outcomes of interest were in-hospital all-cause mortality following the first episode of STEMI. Secondary outcomes of interest were major adverse cardiovascular events (MACE) (death, MI, heart failure, or stroke), repeat MI, cardiogenic shock, heart failure, major bleeding, and stroke. Apart from the clinical outcomes, baseline characteristics of patients

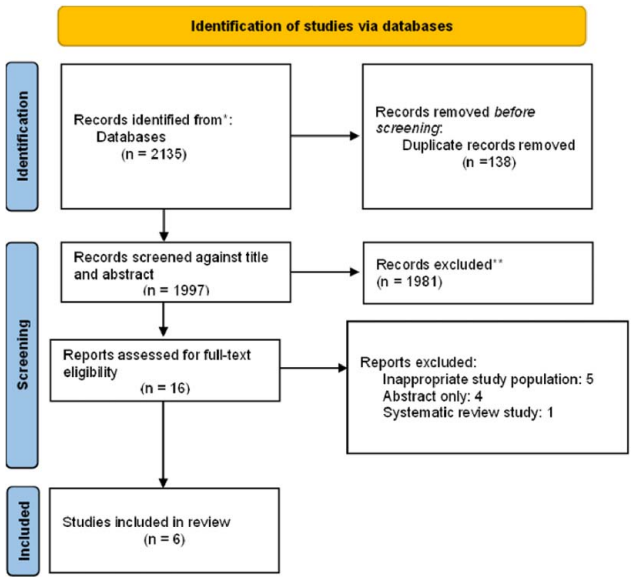

Figure 1. PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) 2020 flow diagram for the systematic review.

on admission, including age, sex, involved coronary vessels, discharge medications, and procedures: PCI, coronary artery bypass graft, and thrombolysis, were also included.

Results

Study characteristics

A total of 2135 studies were identified from the initial database search. After removing duplicates, the 1997 studies underwent title and abstract review. We then evaluated eligibility following inclusion criteria, and only 16 studies were selected for full-text review. Finally, we identified six studies for data extraction based on exclusion criteria. The PRISMA flow diagram for the review is shown in Figure 1.

Qualitative summary

A total of six retrospective observational studies were included for systematic review and meta-analysis. The total sample size (*N*) was 521 150 patients with the first episode of STEMI with a mean age of 64.23 ± 12.83 years and 358 071 (68.71%) were men. Out of the total, 11.24% were categorized into the SMuRF-less group ($n = 58\ 591$ patients) and 88.76% were classified into with SMuRF group ($n = 462\ 559$). The SMuRF-less group had an average of 1.25 kg/m^2 low BMI compared to SMuRF group using random effect model (MD −1.25; 95% CI: −1.69 to −0.82; $n = 86\ 964$; studies = 4; $I^2 = 93\%$) (eFigure1, Supplemental Digital Content 3, http://links.lww.com/MS9/A121). The baseline study characteristics and outcomes have been listed in Tables 1 and 2, respectively.

Quantitative analysis

In-hospital mortality

Pooled data from four included studies showed an in-hospital mortality of 14.59% (8381/57 446) in the SMuRF-less group, which was significantly higher in comparison to the in-hospital mortality of 10.93% (48 279/441 869) in the SMuRF group (OR: 1.43; 95% CI: 1.40–1.47; $n = 499\ 315$; $I^2 = 28\%$) (Fig. 2).

Major adverse cardiovascular events

Pooled data from three included studies did not show any significant difference in major adverse cardiovascular events (MACE) (death, MI, heart failure, or stroke) between the two groups (OR: 1.16; 95% CI: 0.84–1.60; $n = 498\ 779$; $I^2 = 99\%$) (eFigure2, Supplemental Digital Content 4, http://links.lww.com/MS9/A122).

Recurrent in-hospital MI

Pooled data from three included studies did not show any significant difference in repeat MI between the two groups (OR: 0.94; 95% CI: 0.74–1.19; $n = 498\ 779$; $I^2 = 51\%$) (eFigure 3, Supplemental Digital Content 5, http://links.lww.com/MS9/A123).

Cardiogenic shock

Cardiogenic shock was reported in three studies. Pooled data using a fixed effect model showed 59% higher odds of cardiogenic shock in the SMuRF-less group compared to the SMuRF group (OR: 1.59; 95% CI: 1.55–1.63; $n = 498\ 779$; $I^2 = 0\%$) [SMuRF-less: 15.42% (8837/57 314), SMuRF 10/65% (47 028/441 465)] (eFigure 4, Supplemental Digital Content 6, http://links.lww.com/MS9/A124).

Heart failure

Heart failure during hospitalization outcome was reported in three studies. Pooled data using a random effect model showed no statistically significant difference in in-hospital heart failure outcomes between the two groups (OR: 0.93: 95% CI: 0.86–1.01; $n = 496\ 147$; $I^2 = 76\%$) (eFigure 5, Supplemental Digital Content 7, http://links.lww.com/MS9/A125).

Major bleeding

Major bleeding was reported in three studies. Pooled data using a random effect model showed no statistically significant difference in in-hospital major bleeding between the two groups (OR: 1.10; 95% CI: 0.90–1.34; $n = 498\ 779$; $I^2 = 80\%$) (eFigure 6, Supplemental Digital Content 8, http://links.lww.com/MS9/A126).

Stroke

Stroke during the study was reported in three studies; pooling of the reported studies did not show statistically significant differences between the two groups (OR: 1.07; 95% CI: 0.64–1.79; $n = 498\ 779$; $I^2 = 88\%$) (eFigure 7, Supplemental Digital Content 9, http://links.lww.com/MS9/A127).

Treatment at discharge

Statin prescription at discharge

Pooled data from three studies that reported statin prescription at discharge showed that SMURF-less patients [8262/9902 (83.44%)] were less likely to prescribe statin at discharge compared to the SMURF group [53 442/62 245 (85.86%)] using the

Table 1

Baseline study details

Reference	Timeframe	Country	Type of study	No. of participants		Sex (%)		Mean BMI (kg/m^2)	Mean age (years)	SMuRFs (%)			
						Male	Female			DM	HTN	Dyslipidemia	Smoking
Vernon *et al.*, 2019[3]	1999–2017	Australia	Retrospective cross-sectional	$N=3081$	[SMuRF-less ($N=591$)]	80.54	19.45	27.0 ± 4.37	61.7 ± 12.39				
					> 0 SMuRFs ($N=2490$)	73.65	26.35	28.5 ± 5.43	60.4 ± 12.88	22.25	54.74	45.22	49.92
Yamamoto *et al.*, 2022[8]	January 2005 to December 2013	Japan	Retrospective study	$N=11$ 698	STEMI ($N=8312$) [SMuRF-less ($N=369$)]	62.33	37.67	21.8 ± 3.1	73.0 ± 12.1				
					> 0 SMuRF $N=7943$	73.90	26.10	23.7 ± 3.6	67.7 ± 12.4	34.87	81.58	58.39	41.31
Figtree *et al.*, 2021[4]	1 January 2005 and 25 May 2018	Sweden	Retrospective cross-sectional study	$N=62$ 048	SMuRF-less, $n=9228$	76.55	23.45	25.64 ± 3.26	69 (60–78)				
					> 0 SMuRF, $n=52$ 820	65.51	34.49	26.54 ± 3.93	68 (59–78)	21.30	70.41	48.43	32.55
Sia *et al.*, 2022[5]	January 2008 to June 2018	Singapore	Retrospective study	$N=22$ 160	STEMI SMuRF-less, $n=776$	76.29	23.71	24.07 ± 3.27	58.7 (51.6–67.1)				
					> 0 SMuRF, $n=12$ 747	85.16	14.84	24.88 ± 3.78	57.8 (50.8–65.9)	36.13	53.59	62.96	52.00
Vernon *et al.*, 2017[18]	January 2006 to December 2014	Australia	Retrospective study	$N=536$	SMuRF-less, $n=132$	78.03	21.97	26.5	64 (55–72)				
					> 0 SMuRF, $n=404$	74.75	25.25	26.9	64 (54–75)	11.39	58.91	54.46	37.62
Shrestha *et al.*, 2022[6]	2016–2019	USA	Retrospective observational study	$N=433$ 650	SMuRF-less, $n=47$ 495	73.18	26.82	62.22 (61.93–62.51)					
					SMuRFs, $n=386$ 155	67.69	32.31	63.07 (62.9–63.17)		3.33	78.00	6.75	27.20

DN, diabetes mellitus; HTN, hypertension; SMuRF, standard modifiable risk factor; STEMI, ST-segment elevation myocardial infarction.

Table 2

Outcomes of included studies

		Involved vessel (%)			Discharge medications (%)		In-hospital events (%)						
Reference	Left main	Left anterior descending	Circumflex artery	Right coronary	Statin	Acetylsalicylic acid	In-hospital MACE	In-hospital death	Myocardial infarction	Cardiogenic shock	Heart failure	Major bleeding	Stroke
Vernon *et al.*, 2019[3]													
SMuRF-less ($N=591$)		5.75	1.35	3.72	83.76	82.23	14.89	6.09	1.86	6.43	7.28	6.77	0.34
> 0 SMuRFs ($N=2490$)	0.20	5.78	1.89	6.06	86.43	85.22	16.30	4.30	2.17	4.70	11.12	5.98	0.64
Yamamoto *et al.*, 2021[8]													
Patients with STEMI ($N=8312$)													
[SMuRF-less ($N=369$)]	4.34	51.49	9.21	34.96	46.07	94.30							
> 0 SMuRF $N=7943$	3.00	47.48	10.02	39.35	68.16	98.45							
Figtree, *et al.*, 2021[4]													
SMuRF-less, $n=9228$	1.32	41.55	10.15	28.39	84.96 ($n=8942$)	95.20 ($n=8326$)	30.23	9.57	3.64	6.26	24.57 ($n=8794$)	2.04	1.10
> 0 SMuRF, $n=52$ 820	0.94	37.36	11.28	32.20	88.54 ($n=51$ 812)	94.97 ($n=49336$)	28.90	6.46	3.43	4.082	24.96 ($n=50$ 622)	2.16	1.27
Shrestha *et al.*, 2022[6]													
SMuRF-less, $n=47$ 495							23.58	15.71		17.31	9.99	5.65	0.28
> 0 SMuRFs, $n=386$ 155							16.51	7.17		11.59	10.65	4.69	0.19

MACE, major adverse cardiovascular events; SMuRF, standard modifiable risk factor; STEMI, ST-segment elevation myocardial infarction.

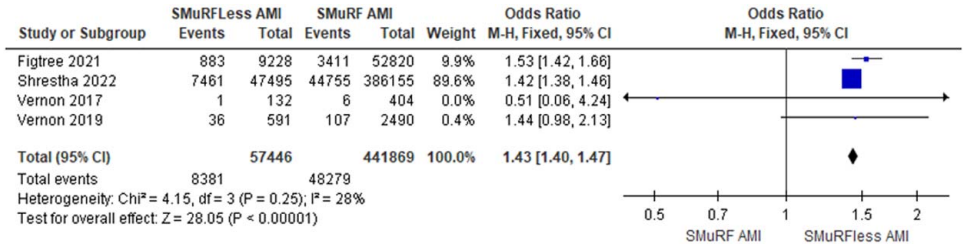

Figure 2. Forest plot showing in-hospital mortality using fixed effect model. AMI, acute myocardial infarction; SMuRF, standard modifiable risk factor.

random effect model (OR: 0.62; 95% CI: 0.42–0.91; $n = 72\ 147$; $I^2 = 93\%$) (Fig. 3).

Acetylsalicylic acid prescription at discharge

Pooled data from three studies that reported acetylsalicylic acid prescription at discharge showed no statistically significant difference in prescription of acetylsalicylic acid at discharge to SMURF-less patients [8760/9286 (94.34%)] compared to the SMURF group [56 797/59 769 (95.03%)] (OR: 0.64: 95% CI: 0.36–1.12; $n = 69\ 055$; $I^2 = 94\%$) (eFigure 8, Supplemental Digital Content 10, http://links.lww.com/MS9/A128).

P2Y12 inhibitor prescription at discharge

Pooled data from two studies that reported P2Y12 prescription at discharge showed no statistically significant difference in prescription of P2Y12 at discharge to SMURF-less group [7990-/8936 (89.41%)] compared to the SMURF group [46 727/51 823 (90.17%)] using fixed effect model (OR: 0.95; 95% CI: 0.89–1.03; $n = 60759$; $I^2 = 16\%$) (eFigure 9, Supplemental Digital Content 11, http://links.lww.com/MS9/A129).

ACEi/ARB and beta-blocker prescription at discharge

Pooled data from four studies that reported Angiotensin converting enzyme inhibitor (ACEi)/Angiotensin II receptor blocker (ARB) prescription at discharge showed that the SMuRF-less group [6814/9284 (73.40%)] was less likely to prescribe ACEi/ARB at discharge compared to the SMURF group [48 216/59 776 (80.66%)] using random effect model (OR: 0.49; 95% CI: 0.28–0.87; $n = 69060$; $I^2 = 98\%$) (Fig. 4).

However, pooled outcome on beta-blocker prescription at discharge showed 27% lower odds of beta-blocker prescription in the SMURF group [SMURF-less group {8525/10 140 (84.07%)}, SMURF group {58 121/71 052 (81.80%)} (OR: 0.73: 95% CI: 0.62–0.85; $I^2 = 75\%$)] (efigure 10, Supplemental Digital Content 12, http://links.lww.com/MS9/A130).

In-hospital treatment

Thrombolysis

Pooling data on thrombolysis from two studies showed no significant difference in thrombolysis between the two groups (OR: 0.90; 95% CI: 0.74–1.08; $n = 65\ 129$; $I^2 = 71\%$) (eFigure 11, Supplemental Digital Content 13, http://links.lww.com/MS9/A131).

PCI

Pooled data from four studies that reported PCI showed no difference in intervention between the SMuRF-less group [48 131/57 683 (83.44%)] and the SMURF group [397 468/449 408 (88.44%)] using random effect model (OR: 0.87; 95% CI: 0.60–1.26; $n = 507\ 091$; $I^2 = 99\%$) (eFigure 12, Supplemental Digital Content 14, http://links.lww.com/MS9/A132).

Coronary artery bypass graft

Pooled data from four studies that reported coronary artery bypass graft (CABG) showed no difference between the SMuRF-less group [2002/57 683 (3.47%)] and the SMURF group [23 926/449 408 (5.32%)] using random effect model (OR: 0.90; 95% CI: 0.54–1.49; $n = 507\ 091$; $I^2 = 96\%$) (eFigure 13, Supplemental Digital Content 15, http://links.lww.com/MS9/A133).

Discussion

Our meta-analysis focused on assessing clinical outcomes and differences in treatment between patients with and without modifiable risk factors following the first episode of STEMI. We found that amongst the 521 150 patients with the first episode of STEMI, one out of eight (11.24%) did not have any SMuRFs. SMuRF-less had higher rates of in-hospital mortality and cardiogenic shock, but no difference in the rates of MACE, recurrent MI, major bleeding, heart failure, and stroke. In addition, we

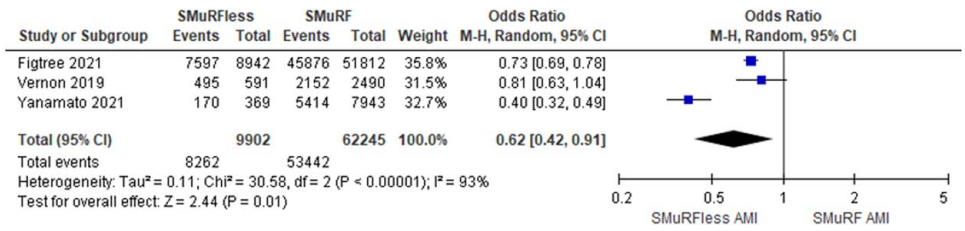

Figure 3. Forest plot showing statin prescribed at discharge using random effect model. AMI, acute myocardial infarction; SMuRF, standard modifiable risk factor.

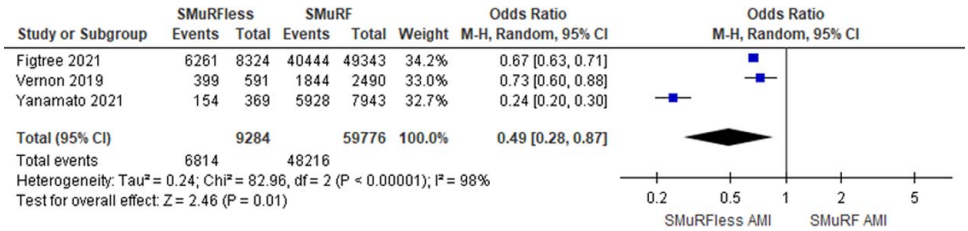

Figure 4. Forest plot showing the prescription of ACEi/ARB at discharge using random effect model. AMI, acute myocardial infarction; SMuRF, standard modifiable risk factor.

found no difference in procedures like CABG, PCI, and thrombolysis between the two groups. On discharge, patients without modifiable risk factors were getting less GDMT, especially with a statin and ACEi/ARB.

The underlying reason behind higher in-hospital mortality is not well-understood; however, several hypotheses have been stated, including reduced capacity in SMuRF-less patients to withstand sudden blood supply cuts due to a lack of ischemic preconditioning of heart muscle and coronary collateral[5,19,20]. Yamamoto *et al.*[8] found that SMuRF-less individuals also have delayed symptom onset to emergency department presentation and a longer door-to-balloon time, possibly due to the lack of perceived risk factors, ignoration of symptoms, and higher incidence of cardiogenic shock at presentation, resulting in less salvageable tissue at the intervention time. In our meta-analysis, the data on symptom onset to presentation or door-to-balloon are unavailable; however, there were higher odds of cardiogenic shock in SMuRF-less patients, which could either be caused by or a cause of increased door-to-balloon time[8]. Cardiogenic shock is a known poor prognostic marker in STEMI patients[21]. Further prospective studies are required to better understand the underlying prognostically related factors in SMuRF-less STEMI patients. Another hypothesis is that patients without modifiable risk factors are less likely to be initiated and discharged on GDMT, including statin, acetylsalicylic acid, and ACE/ARBs, possibly explaining the worse cardiovascular outcome[4,8]. The relationship of suboptimal GDMT prescription with increased mortality in SMuRF-less STEMI has been previously demonstrated by Figtree *et al.*[4]. Our meta-analysis found a similar finding that fewer SMuRF-less STEMI patients were discharged on GDMT medications. However, our analysis on beta-blocker prescription showed relatively more beta-blocker prescribed among the SMuRF-less group. The basis of this discrepancy in the prescription of prognostically critical medications is unclear; however, it could be related to the perception of low risk of poor outcomes due to a lack of modifiable risk factors in SMuRF-less STEMI patients[5]. Thus, this may indicate a need to generate awareness amongst patients and physicians about the paradoxical worst prognosis amongst SMuRF-less STEMI. These findings also stress the importance of starting GDMT early in the post-STEMI phase irrespective of perceived risk factor status to prevent the worst cardiovascular outcomes[4].

Many studies have also proposed that individuals without SMuRFs could have unidentified non-standard risk factors, including genetic factors, elevated lipoprotein A, active cancer, demographic, socioeconomic, ethnicity, and autoimmune disease, which can contribute to inflammatory atherosclerosis and ischemic heart disease, calling for a need of future research in this field[4,5,8,22]. In addition, there seems to be an apparent need for a screening tool that aids in the early identification of patients at risk of developing cardiovascular events without SMuRFs, perhaps a new biomarker or imaging tool[23]. Such tools will help establish medical therapy like statin early on, which has a plaque-stabilizing effect and results in a better outcome.

The strength of our study is its population size and generalizability across the study population, as we have combined studies across geographical locations, including Australia, Asia, and America with a good sample size. This study exhibits a paradoxical trend of worse outcomes in SMuRF-less STEMI patients and emphasizes the importance of further study needed in this domain. However, we do acknowledge several limitations to our study. First, we could only find a limited number of published studies that reported the outcomes of our interest; thus, pooled data for some of our desired results had to rely on fewer available data. The limited consistent data across studies do not directly suggest an alternative cause of such events. However, given that the incidence is over 10% of the population, this group may represent a variant that could benefit from alternative approaches. Unfortunately, no specific recommendations are identified. Secondly, although our analysis combined studies across geographical regions, data were still limited in terms of ethnicity, socioeconomic status, and geographic risk factors such as pollution, weather, etc. Third, we could only report in-hospital events due to a lack of data regarding long-term outcomes. Fourth, we found no difference in PCI, thrombolysis, or CABG procedures between the two groups; however, we could not comment on other important metrics such as the severity of CAD, the LV ejection fraction, or the door-to-balloon time, which is an essential determining factor in STEMI outcomes. The fifth limitation is that all studies were observational, so there is a risk of ascertainment and selection bias. Outcomes were not adjudicated in most of the studies. Each outcome was reported by only a small number of studies. Finally, we used unadjusted estimates since most of the studies did not report adjusted estimates for the outcomes.

Conclusion

SMuRF-less patients represent a sizable proportion of hospitalization with STEMI. We found higher complications, including in-hospital mortality and cardiogenic shock, in these patients with a lack of apparent traditional risk factors. Further studies are needed in this population to better understand non-traditional risk factors, screening tools to identify them early for prevention, their presentation, and prognostic factors. Additionally, further understanding of the discrepancy in treatments is needed to better serve this population.

Ethical approval

Not applicable.

Consent

Not applicable.

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Author contribution

B.S., D.B.S., and Y.R.S.: contributed to the concept and design; D. B.S.: performed analysis and interpretation of data; B.S., P.R.O., S.S., B.P., and J.S.: contributed to the literature search, review, data extraction, and initial manuscript drafting; Y.R.S., M.R., N. K.P., A.S., K.S., I.W., S.B., M.S.K., M.K., and I.Y.E.: guided in the whole process and revised from intellectual aspects.

All authors were involved in drafting and revising the manuscript and approved the final version.

Conflicts of interest disclosure

The authors declare that they have no conflicts of interest.

Research registration unique identifying number (UIN)

We performed this systematic review aligned with published protocol (PROSPERO ID: CRD42022341389).

Guarantor

B.S., D.B.S., and Y.R.S.

Data availability statement

The data analyzed during the current study are available within the manuscript or in supplementary files.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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