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Original Article

Efficacy and safety of steroids for chronic subdural hematoma: A systematic review and meta-analysis

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ABSTRACT

Background: Chronic subdural hematoma (CSDH) is a condition characterized by the accumulation of fluid, blood, and blood breakdown products between the brain's arachnoid and dura mater coverings. While steroids have been explored as a potential treatment option, their efficacy and safety remain uncertain. This meta-analysis and systematic review aimed to assess the impact of steroids on CSDH management, including mortality, recurrence, complications, and functional outcomes.

Methods: We conducted a comprehensive literature search in major electronic databases up to June 2023, following Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and Cochrane Handbook for Systematic Reviews and Interventions. Inclusion criteria encompassed adult patients with CSDH, the use of steroids as monotherapy or adjuvant therapy, and clearly defined outcomes. Randomized controlled trials and cohort studies meeting these criteria were included in the study.

Results: The initial search yielded 4315 articles, with 12 studies meeting the inclusion criteria. Our findings indicate a non-significant trend toward reduced mortality with steroids in combination with standard care (Odds ratios [OR] = 0.66, 95% confidence interval [CI] 0.20–2.18). However, substantial heterogeneity was observed (I^2 = 70%). Sensitivity analysis, excluding influential studies, suggested a potential increased mortality risk associated with steroids (OR = 1.47, 95% CI 0.87–2.48). Steroids showed a possible benefit in reducing the recurrence of CSDH (OR = 0.58, 95% CI 0.20–1.67), but with significant heterogeneity (I^2 = 89%). No clear advantage of steroids was observed in terms of functional outcomes at three months (modified Rankin scale scores). Furthermore, steroids were associated with a significantly higher incidence of adverse effects and complications (OR = 2.17, 95% CI 1.48–3.17).

Conclusion: Steroids may have a potential role in reducing CSDH recurrence but do not appear to confer significant advantages in terms of mortality or functional outcomes. However, their use is associated with a higher risk of adverse effects and complications. Given the limitations of existing studies, further research is needed to refine the role of steroids in CSDH management, considering patient-specific factors and treatment protocols.

Keywords: Chronic subdural hematoma, Complications, Dexamethasone, Meta-analysis, Mortality, Recurrence, Steroids, Systematic review

INTRODUCTION

Chronic subdural hematoma (CSDH) is an isolated collection of fluid, blood, and blood breakdown products placed on the surface of the brain between the arachnoid and dura mater coverings. An early idea concerning the creation of CSDH was that it was caused by a severe injury that caused the piercing of the bridge veins that connect the brain to the draining dural-venous sinuses.[1,17] Affected individuals are usually male and above the age of 70. Non-contrast computed tomography imaging reveals crescentic layering of fluid in the subdural region on computed tomography scan, best viewed in sagittal or coronal reformats.[36] It is generally accepted that it takes 4–7 weeks after trauma for a CSDH to become apparent.[7,31]

Each year, the incidence of CSDH ranges from 1 to 5.3 cases/100,000 people. The incidence of this condition is increasing due to an older population and medical conditions such as hemodialysis, anticoagulants, and/or antiplatelet medication.[11,14] The disorder mostly affects the elderly as well as people with coagulopathy, who often have coexisting medical conditions prone to sustaining surgical complications, including tension pneumocephalus and severe intracranial hemorrhage, wound infection, and subdural hematoma empyema.[13,23]

There are several routes by which blood or fluid might collect within the dural border cell layer. The most prevalent mechanism is head trauma, which produces bridging vein ripping and, as a result, acute subdural hematoma.[37] CSDH symptoms might range from no symptoms to headache, seizures, poor memory, and confusion. Patients may have trouble speaking, swallowing, and walking, arm, leg, and facial numbness or weakness may occur.[36]

Asymptomatic patients are often handled conservatively, with an observation period, medical care, intracranial pressure control, anticoagulant reversal, and serial examinations.[19] In contrast, symptomatic individuals with clinical or radiographic evidence of cerebral compression and a low surgical risk are treated surgically. There are numerous surgical procedures available, including twist drill craniostomy, burr-hole craniostomy, and craniotomy/mini-craniotomy.[5,10] Furthermore, innovative surgical techniques, including middle meningeal artery embolization, have been developed as new reliable surgical treatment modality for CSDH.[26] Steroid-based medical therapy is also proposed, but long-term use can lead to infections, gastrointestinal bleeding, and hyperglycemia as common problems.[4] Therefore, A comprehensive review was undertaken and updated to identify the usage and investigation of the impact of steroids on clinical outcomes in individuals with symptomatic CSDH.

MATERIALS AND METHODS

Protocol

We conducted a comprehensive meta-analysis and systematic review, which was previously registered on PROSPERO (CRD42023454162), to assess the efficacy of steroids in treating CSDH and its long-term outcomes. Our study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and the Cochrane Handbook of Systematic Review and Intervention.

Search strategy

We conducted a thorough literature search across electronic databases, including PubMed, Google Scholar, Medline, Embase, and Scopus. Our search included articles up until June 2023**,** using relevant keywords such as "steroids," "dexamethasone (DXM)," "chronic subdural hematoma," "CSDH," and "chronic SDH." The full mesh phrase has been separately provided in Supplementary File 1. Only the English language was used for the data search.

Eligibility criteria

We included studies that met specific criteria: Patients diagnosed with CSDH, patients receiving steroids orally or through other forms as monotherapy or adjuvant therapy, adults aged over 18, control group patients not using steroids, clearly defined primary and secondary outcomes, such as mortality, modified Rankin scale (mRS) 0–3, mRS 4–6, complications, and recurrence. Only randomized controlled trials (RCTs) or cohort studies were considered. We excluded studies that did not meet these criteria, such as those in languages other than English, studies involving non-human subjects, pediatric populations, studies lacking desired outcomes, and study types other than RCTs or cohorts (e.g.,case–control, case series, editorials, and single-arm studies).

Study screening and data extraction

Two reviewers independently screened articles. Articles meeting inclusion criteria were initially included, and subsequent exclusion was based on title, abstract, and full-text review. A third reviewer resolved any discrepancies or conflicts through mutual agreement. Authors' names, publication year, and baseline characteristics, including demographic data (population age, CSDH follow-up, and sample size), intervention details (steroids duration and dosage), and outcome data (recurrence, mortality, and complication rate) were all extracted from relevant studies.

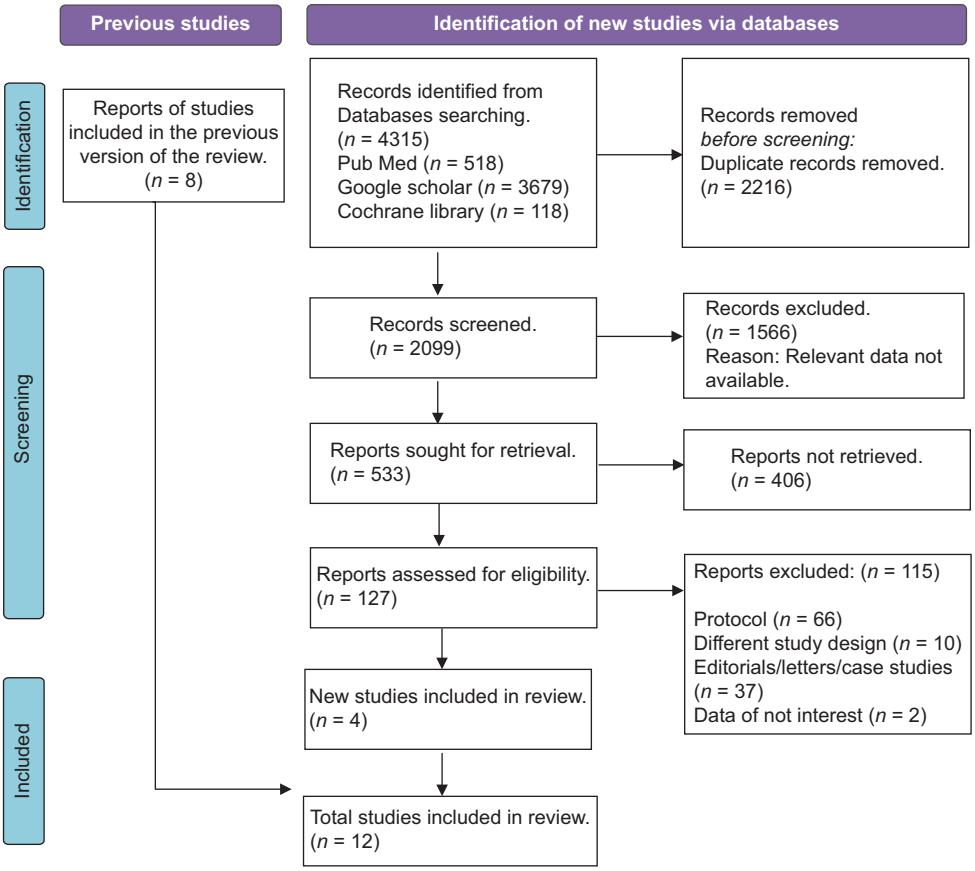

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart demonstrating search strategy of present systemic review and meta-analysis.

Outcomes

Primary outcomes assessed include mortality in patients treated with steroids only, steroids and surgery, and no steroids, as well as recurrence rate and mRS score at six months. Secondary outcomes encompass complications and hospital stays exceeding 30 days.

Data analysis and risk of bias

We analyzed the data using RevMan version 5.4 from the Cochrane Collaboration. Odds ratios (OR) were employed with a confidence interval of 95%, and a random or fixed effect model was selected and used. Funnel plots were created for primary and secondary outcomes using this model for mortality, mRS score, and complication rate. I^2 statistic was used to assess heterogeneity among included studies. When I^2 exceeded 50%, the heterogeneity was deemed significant, and sensitivity analysis was interpreted in light of the features of the study. Risk of Bias of included RCTs was assessed using the Cochrane tool for risk of bias. Studies were graded as low risk, high risk, and uncertain risk for selection bias, reporting bias, other bias, and performance bias. Observational studies and cohorts' Risk of bias were interpreted using the Newcastle-Ottawa scale for selection, comparability, and outcome.

RESULTS

Literature search

The initial phase of the literature search yielded a pool of 4315 articles. After removing duplicates, 2099 unique records were left for the subsequent screening process. All 533 records underwent an initial assessment based on their titles and abstracts, leading to the identification of 127 articles for more in-depth evaluation. Following a rigorous examination, 115 studies were excluded due to a range of reasons, such as failure to meet inclusion criteria or the absence of relevant data. Ultimately, the meta-analysis focused on a total of 12 articles that met the predefined inclusion criteria [Figure 1].

Study characteristics

All studies included focused on CSDH patients undergoing steroid intervention.[6,9,18,20-22,24,25,27,28,32,34] The sample size ranged from 20 to 748 participants. Through all included studies, primary and secondary outcomes were mortality,

recurrence rate, and mRS score compared with steroids uptake and control among the CSDH population, as shown in Table 1. These outcomes were chosen to assess the efficacy of the intervention used in the context of included studies. The description of PICO is shown in Table 2.

Mortality

The comparison of steroids alongside standard of care (SOC) versus the control group yielded an OR of 0.66 (95% confidence interval [CI] 0.20, 2.18; I^2 70%; P = 0.50), indicating a non-significant trend toward reduced mortality with steroids [Figure 2]. The wide confidence interval and high I^2 value highlight the uncertainty and significant heterogeneity among the studies, primarily due to the impact of the study by Sun *et al*. (2005).[32] Sensitivity analysis, excluding the influential study, resulted in an OR of 1.47 (95% CI 0.87, 2.48; I^2 1%; P = 0.15). This suggests a potential increased odds of mortality associated with steroids, although the result remained statistically non-significant.

Mortality outcome between different treatment regimes

In the exploration of various treatment strategies, the meta-analysis did not identify statistically significant differences in terms of mortality rates across different combinations of steroids, surgery, and standard care. The ORs, indicated by their respective confidence intervals, suggest a lack of definitive effect. The wide confidence intervals reflect the inherent uncertainty in these findings. While the analysis does not firmly establish distinct mortality effects associated with these diverse treatment regimens, it underscores the intricate and varied nature of treatment responses, as evidenced by the collected data. To provide a more comprehensive understanding, the odds ratios and their associated values for each comparison are as follows:

Steroids ± SOC versus control

The odds ratio is 0.91, indicating no significant difference (95% CI 0.13, 6.43; I^2 0%; P = 0.92) [Figure 2].

Steroids with surgery versus surgery alone

The OR is 0.95, indicating no significant difference (95% CI 0.52, 1.72; I^2 0%; P = 0.87) [Figure 2].

Steroids alone versus surgery alone

The odds ratio is 1.11, indicating no significant difference (95% CI 0.16, 7.58; I^2 53%; P = 0.92) [Figure 2].

Steroids versus control

The OR is 0.67, indicating no significant difference (95% CI 0.09, 4.85; I^2 66%; P = 0.69) [Figure 2].

Recurrence of subdural hematoma

The use of steroids appeared to be associated with lower odds of recurrence of subdural hematoma compared to the control group, as suggested by the OR of 0.58. However, the wide CI (0.20–1.67) indicates uncertainty, and the high I^2 value (89%) signifies substantial variability among the studies. Sensitivity analysis, which mitigates the impact of a specific study, yielded a more pronounced effect size (OR = 0.41), implying a potential beneficial effect of steroids in reducing recurrence risk [Figure 3].

mRS score at three months

Regarding functional outcomes at three months, as measured by mRS scores, the use of steroids did not exhibit a distinct advantage over the control group. The ORs for both mRS scores (0–3 and 4–6) hovered around 1, indicating no substantial difference. The wide CIs and moderate I^2 values (69% and 51%) underscore variability and limited precision in these results. Sensitivity analysis produced minor adjustments to the ORs but did not reveal a strong, statistically significant effect [Figure 4].

Occurrence of overall adverse effects/complications

Occurrence of overall adverse effects/complications between steroids versus control: OR = 2.17 (95% CI 1.48, 3.17; I^2 42%; $P < 0.0001$). The analysis suggests a significant increase in adverse effects and complications with steroids [Figure 5].

Risk of bias

Funnel plot was used for the assessment of publication bias for the recurrence outcome of the included studies [Figure 6]. Utilizing the Cochrane tool for risk of bias for included RCTs, the risk of bias of the included trials was interpreted. The systemic review includes all included RCTs since they all show a low risk of bias for various factors, such as selection bias and reporting bias [Figure 7]. The Newcastle-Ottawa scale was also used to assess the risk of bias in observational cohort studies, and all included studies showed minimal risk of bias [Supplementary File 2]. A summary of the results is shown in Table 3.

DISCUSSION

Our study found significantly lower odds of recurrence of CSDH in the treatment group as compared to control group which was similar to Shrestha *et al*.,[30] where the

Table 1: Baseline characteristics of included studies.

Author	Year	Country	Design	Intervention (Steroids) Males: Females	Control (Other treatment/ surgery) Males: Females	Patients	Outcome
Hutchinson *et al.*[9]	2020	United Kingdom	RCT	375 268:107	373 286:87	Of CSDH patients, mean age 75 years, 94% underwent surgery for hematoma evacuation, with 60% of patients having mRS between 1 and 3.	Patients undergoing surgery with DXM had more adverse events and less favorable outcomes.
Miah *et al.*[21]	2020	Netherlands	ROS	60 45:15	60 49:11	CSDH patients with 70% of patients having an mRS score of 1–3 and 96% pts with an MGS score of 0–1,	DXM was associated with more extended hospital stays and more unfavorable outcomes when compared to surgery alone
Papacocea *et al.*[25]	2019	Romania	ROS	22 7:15	16 5:11	CSDH patients	DXM involves shorter hospital stays, fewer complications, and more favorable outcomes
Prud'homme *et al.*[27]	2015	Canada	RCT	10 8:2	10 10:0	CSDH patients who received DXM as treatment and lactose-filled capsules as placebo	Few adverse events were reported with the intervention group, such as PE, cellulitis, pulmonary edema, suicide, and death.
Sun *et al.*[32]	2005	Hongkong	Prospective	95 N/A	17 N/A	CSDH patients out of which 30 were treated nonoperatively (26 with steroids and four expectantly). 69 with surgery+DXM and 13 with burr-hole drainage only.	Steroids are a good option for patients, especially those having comorbidities
Qian *et al.*[28]	2017	China	ROS	75 N/A	167 N/A	CSDH	Additional steroid therapy is required in patients with advanced age, midline displacement, and mixed-density hematoma to improve outcomes.
Ng *et al.*[24]	2021	France	RCT	78 56:22	77 58:19	CSDH patients were randomized to receive either DXM or placebo.	DXM may lower the radiologic appearance of CSDH but the clinical outcome is unclear.
Mebberson *et al.*[18]	2020	Australia	RCT	23 15:8	24 19:5	CSDH patients	Adjuvant dexamethasone (steroid) with postoperative drainage has found to be safe and significantly decrease recurrences.

(Contd...)

Table 1: *(Continued)*.

Author	Year	Country	Design	Intervention (Steroids) Males: Females	Control (Other treatment/ surgery) Males: Females	Patients	Outcome
Tariq and Bhatti[34]	2021	Pakistan	RCT	46 34:12	46 33:13	CSDH who were advised burr-hole craniotomy were divided into two groups, that is, with and without dexamethasone.	Neurologic, radiologic, and mortality outcomes were similar in both groups.
Miah *et al*.[22]	2023	Netherlands	RCT	127 99:28	125 96:29	CSDH patients.	DXM group was associated with more complications with an increased likelihood of later surgery.
Miah *et al*.[20]	2023	Netherlands	RCT	27 17:10	58 47:11	CSDH patients, mean age of 75 years, with a mRS between 1 and 3, and patients receiving DXM post-treatment	The largest hematoma reduction was seen in patients without hyperdense components and receiving steroids.
Fountas *et al*.[6]	2019	Greece	ROS	10 8:2	136 92:44	CSDH patients mean age of 76 years, divided in three groups, BHC with DXM, BHC without DXM, and DXM alone as conservative treatment	Combination therapy of BHC and DXM showed better results apart from surgery or DXM alone

CSDH: Chronic subdural hematoma, BHC: Burr-hole craniotomy, MGS: Markwalder grading scale, PE: Pulmonary edema, mRS: Modified Rankin scale, DXM: Dexamethasone, RCT: Randomized controlled trials, ROS: Retrospective observational study, N/A: Not available

Table 2: Table showing PICO incorporated throughout the review.

P: Population	Adult population developing CSDH
I: Intervention	Steroids (Dexamethasone)
C: Control	Placebo or surgery
O: Outcome	Mortality, Recurrence, mRS 0–3, mRS 4–6, and Complication.

CSDH: Chronic subdural hematoma, mRS: Modified Rankin scale

odds for recurrence of CSDH were reduced by 61% in treatment group as compared to control group. However, we also found similarities in the studies conducted by Liu *et al*.,[16] Yao *et al*.,[38] and Shi *et al*.[29] All of these studies have shown similar results of reduced incidence of CSDH after steroid treatment as compared to the control group. The pathogenesis behind the recurrence of hematoma includes increase in intrinsic clotting, defective clot formation and overall induced hemostatic-fibrinolytic alterations which result in the recurrence of hematoma.[15] Breakdown of red blood cells induces inflammatory reaction which results in the formation of neomembrane and neocapillaries. DXM works by suppressing the formation of neocapillaries and neomembranes and reducing the inflammation.[3,8] Eventually, the overall recurrence rate of CSDH is declined.

Our study suggests a significant increase in overall adverse effects and complications with steroids in treatment group as compared to control group. This finding is also evident in Kolias *et al*.[12] According to Prud'homme *et al*., the most common side effects noted in steroid group were fatigue, increased appetite, weight gain, depressive symptoms, shortness of breath, etc.[27] However, another study Zhao *et al*., found that the use of adjuvant glucocorticoid therapy resulted in the increase incidence of psychiatric symptoms.[24,39]

There is no difference in the treatment success and neurologic outcome in the steroid group as compared to control group in our study. This is similar to Shrestha *et al*.[30] He also found no differences in neurologic outcomes in the treatment group. Similarly, due to heterogenicity among studies and various treatment regimes, our meta-analysis did not identify any significant differences in terms of mortality. This is similar to

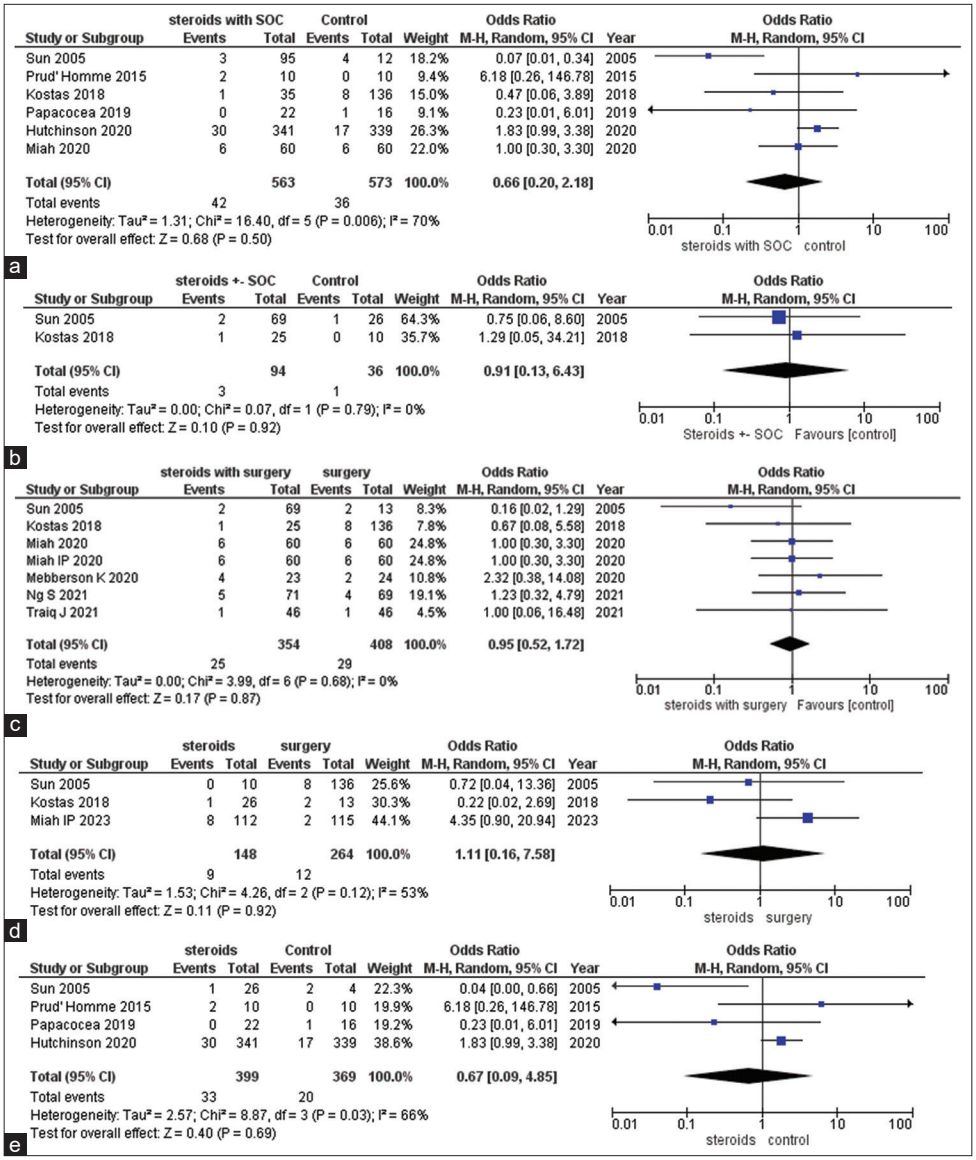

Figure 2: (a) Forest plot demonstrating mortality outcome between steroids with standard of care (SOC) and control group. (b) Forest plot demonstrating mortality outcome between steroids ± SOC and control group. (c) Forest plot demonstrating mortality outcome between steroids with surgery and control. (d) Forest plot demonstrating mortality outcome between steroids and surgery group. (e) Forest plot demonstrating mortality outcome between steroids and control group. M-H: Mantel-Haenszel test, CI: Confidence interval.

study Tang *et al*., where he found that corticosteroids do not improve mortality rates in the treatment group.[33]

The study Berghauser *et al*. demonstrated the therapeutic advantage of steroid therapy.[2] The variations in the results can be attributed to the inclusion of 7 and 5 non-randomized observational studies, respectively, in prior meta-analyses by Shrestha *et al*., cohort by Miah *et al*., and randomized control trials by Hutchinson *et al*.[9,21,30] The findings strengthens our meta-analysis, which also incorporated Hutchinson *et al*. 's and Wang *et al*.'s results from randomized controlled trials.[9,35] Our meta-analysis produced results that were consistent with those of the prior meta-analysis, but with significantly more statistical power by Shrestha *et al*.[30] Miah *et al*. compared first DXM medication with primary surgery in a group of 120 symptomatic CSDH patients in one of the trials that were excluded from the study.[21] In their review, Shrestha *et al*.[30] found that corticosteroids combined with surgery had reduced recurrence rates than corticosteroid therapy alone. Hutchinson *et al*. randomly assigned patients to receive DXM or a placebo in one of the included trials, and the final

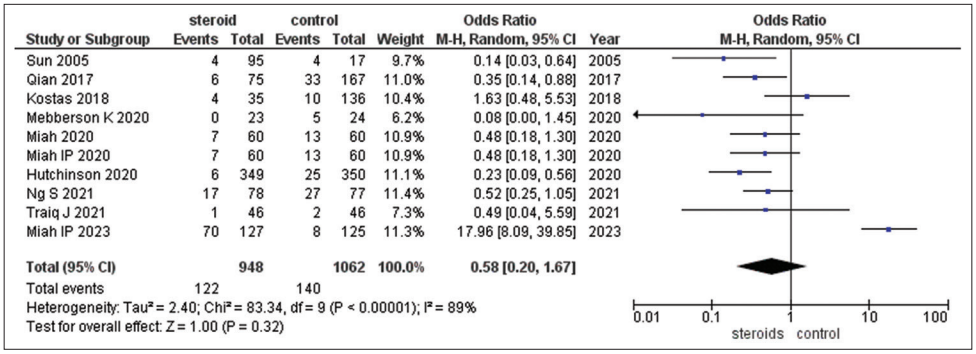

Figure 3: Forest plot demonstrating recurrence outcome between steroids and control group. M-H: Mantel-Haenszel test, CI: Confidence interval.

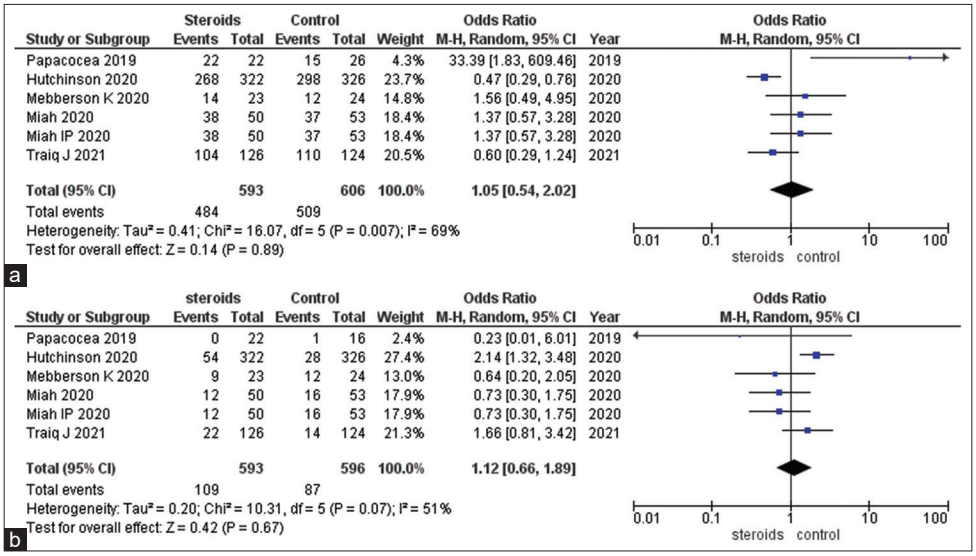

Figure 4: (a) Forest plot demonstrating modified Rankin scale (mRS) 0–3 outcome between steroids and control group. (b) Forest plot demonstrating mRS 4–6 outcome between steroids and control group. M-H: Mantel-Haenszel test, CI: Confidence interval.

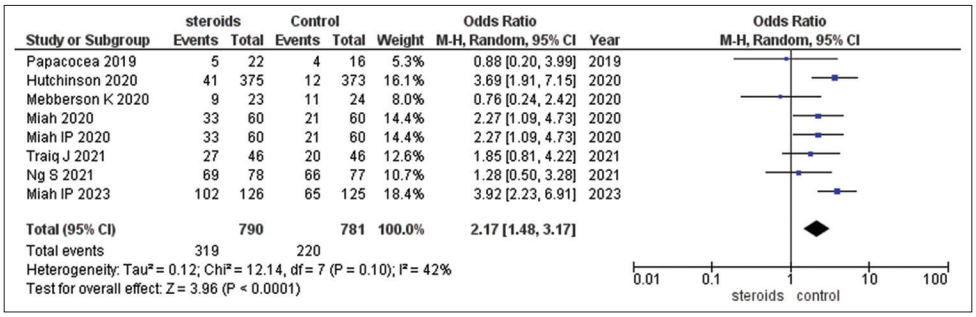

Figure 5: Forest plot demonstrating complication outcome between steroids and control group. M-H: Mantel-Haenszel test, CI: Confidence interval.

treatment choice (surgery or conservative monitoring) was left to the doctors in consultation with the patients.[9] To improve the accuracy of our study, we conducted sensitivity analysis and subgroup analysis to compare the mortality and recurrence of CSDH in four groups: steroid and surgery versus surgery, steroid versus surgery, and steroid and surgery versus steroid. The sensitivity analysis and subgroup analysis confirmed our findings of similar mortality and decreased risk of recurrence of CSDH in several categories, which strengthens the validity of our study.

Table 3: Result summary of effect size of outcomes assessed between steroids and control group in CSDH population.

Outcomes	OR	95% CI
Mortality		
Steroids with SOC and control group	0.66	(0.20, 2.18)
Steroids+SOC and control group	0.91	(0.13, 6.43)
Steroids with surgery and control group	0.95	(0.52, 1.72)
Steroids and surgery group	1.11	(0.16, 7.58)
Steroids and control group	0.67	(0.09, 4.85)
Recurrence	0.58	(0.20, 1.67)
mRS 0–3	1.05	(0.54, 2.02)
mRS 4–6	0.94	(0.60, 1.46)
Complication	2.17	(1.48, 3.17)

CSDH: Chronic subdural hematoma, SOC: Standard of care, mRS: Modified Rankin scale, OR: Odds ratio, CI: Confidence interval

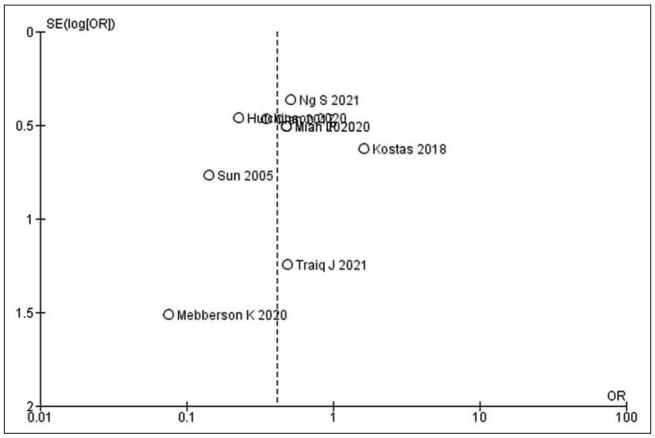

Figure 6: Funnel plot of included studies of recurrence outcome. SE: Standard error, OR: Odds ratio.

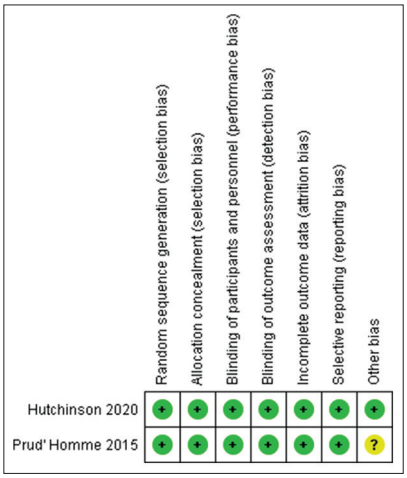

Figure 7: Risk of bias summary of included randomized controlled trials. Yellow color: uncertain risk, Green color: low risk.

Our Analysis findings point to a potential benefit of steroids in lowering the possibility of recurrence. According to the investigation, steroids have a markedly increased risk of side effects and problems. Because there is no advantage in terms of therapeutic success, mortality, or neurologic outcomes for individuals with subdural hematoma, the use of steroids is restricted to special cases.

The majority of the included studies were observational and nonrandomized, which increased the possibility of confounding and selection bias. In addition, there were heterogeneities in our study as a result of the population's different baseline characteristics, different DXM treatment dosages in various trials, varying DXM treatment durations of 1–3 weeks in various studies, and various treatment modalities in control groups. Our meta-analysis has its limitations due to these heterogeneities. A subgroup analysis was carried out to address the variance in treatment modalities.

In a nutshell, the major findings of our study were decrease in the recurrence rate of CSDH in patients receiving DXM treatment as compared to control group and increase in the adverse effects or complications after DXM treatment. Due to significant heterogenicity among studies and various treatment regimes, we did not see any significant advantage in terms of mortality, treatment success, and mRS score at 3 months. These findings are somewhat similar to previous meta-analysis done by Shrestha *et al*.[30] Therefore, taking all these results into account, further research is needed in this regard to further evaluate the use of steroids in the management of CSDH.

Limitations

After our thorough assessment, the shortcomings of the current corpus of research become evident. The methodology used in earlier research is one of the main obstacles. Our findings highlight the critical need for more meticulously designed cohort studies and RCTs. The validity and relevance of previous research are weakened by the dearth of well-designed studies. Moreover, we limited the scope of our literature review to adult populations with an age of 18 years or older. This criterion limited the generalizability of our findings, even if it was required for the particular scope of our review. Subgroups based on age, such teenagers and the elderly, are glaringly absent from the current body of research. Furthermore, the current research's geographic reach is constrained. Since many research have only been carried out in certain areas or nations, extrapolating the results to a global setting can be difficult.

CONCLUSION

This meta-analysis delving into the application of steroids in CSDH sheds light on several pivotal clinical outcomes.

While discernible trends suggestive of reduced mortality and recurrence rates were observed in conjunction with steroid use, these trends often fell short of statistical significance, primarily due to the extensive confidence intervals and significant study heterogeneity. Furthermore, the intricate interplay of distinct treatment protocols in influencing mortality outcomes was evident, as illustrated by the diverse ORs witnessed across various comparisons. The analysis also underscores the potential trade-off between favorable effects and an elevated likelihood of encountering adverse effects and complications linked to steroid administration. These outcomes underscore the necessity for continuous research to elucidate the precise impact of steroids within this context and underscore the significance of tailoring treatment decisions to encompass patient-specific attributes while taking into account the broader landscape of available evidence.

Authors' contributions

AH did the conceptualization. MAS, SMSA, and MAR conducted the literature search and screening. Drafting of the manuscript and writing was done by ZUNM, AK, RN, and MSM. AH did the statistical analysis. TKFA performed the editing. All authors have read and agreed to the final version of the manuscript.

Ethics approval

Not required.

Availability of data and material

Not applicable.

Declaration of patient consent

Patient's consent is not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Ayub K, Yarnell O. Subdural haematoma after whiplash injury. Lancet 1969;294:237-9.
2. Berghauser Pont LM, Dirven CM, Dippel DW, Verweij BH, Dammers R. The role of corticosteroids in the management of chronic subdural hematoma: A systematic review. Eur J Neurol 2012;19:1397-403.
3. Coleman PL, Patel PD, Cwikel BJ, Rafferty UM, Sznycer-Laszuk R, Gelehrter TD. Characterization of the dexamethasone-induced inhibitor of plasminogen activator in HTC hepatoma cells. J Biol Chem 1986;261:4352-7.
4. Delgado-López PD, Martín-Velasco V, Castilla-Díez JM, Rodríguez-Salazar A, Galacho-Harriero AM, Fernández-Arconada O. Dexamethasone treatment in chronic subdural haematoma. Neurocirugia (Astur) 2009;20:346-59.
5. Feghali J, Yang W, Huang J. Updates in chronic subdural hematoma: Epidemiology, etiology, pathogenesis, treatment, and outcome. World Neurosurg 2020;141:339-45.
6. Fountas K, Kotlia P, Panagiotopoulos V, Fotakopoulos G. The outcome after surgical vs nonsurgical treatment of chronic subdural hematoma with dexamethasone. Interdiscip Neurosurg 2019;16:70-4.
7. Gelabert-González M, Iglesias-Pais M, García-Allut A, Martínez-Rumbo R. Chronic subdural haematoma: Surgical treatment and outcome in 1000 cases. Clin Neurol Neurosurg 2005;107:223-9.
8. Glover D, Labadie EL. Physiopathogenesis of subdural hematomas. Part 2: Inhibition of growth of experimental hematomas with dexamethasone. J Neurosurg 1976;45:393-7.
9. Hutchinson PJ, Edlmann E, Bulters D, Zolnourian A, Holton P, Suttner N, *et al.* Trial of dexamethasone for chronic subdural hematoma. N Engl J Med 2020;383:2616-27.
10. Ivamoto HS, Lemos HP Jr., Atallah AN. Surgical treatments for chronic subdural hematomas: A comprehensive systematic review. World Neurosurg 2016;86:399-418.
11. Karibe H, Kameyama M, Kawase M, Hirano T, Kawaguchi T, Tominaga T. Epidemiology of chronic subdural hematomas. No Shinkei Geka 2011;39:1149-53.
12. Kolias AG, Edlmann E, Thelin EP, Bulters D, Holton P, Suttner N, *et al.* Dexamethasone for adult patients with a symptomatic chronic subdural haematoma (Dex-CSDH) trial: Study protocol for a randomised controlled trial. Trials 2018;19:670.
13. Kravtchouk AD, Likhterman LB, Potapov AA, El-Kadi H. Postoperative complications of chronic subdural hematomas: Prevention and treatment. Neurosurg Clin N Am 2000;11:547-52.
14. Krupa M. Chronic subdural hematoma: A review of the literature. Part 1. Ann Acad Med Stetin 2009;55:47-52.
15. Labadie EL, Glover D. Local alterations of hemostatic-fibrinolytic mechanisms in reforming subdural hematomas. Neurology 1975;25:669-75.
16. Liu W, Bakker NA, Groen RJ. Chronic subdural hematoma: A systematic review and meta-analysis of surgical procedures. J Neurosurg 2014;121:665-73.
17. Markwalder TM. Chronic subdural hematomas: A review. J Neurosurg 1981;54:637-45.

18. Mebberson K, Colditz M, Marshman LA, Thomas PA, Mitchell PS, Robertson K. Prospective randomized placebo-controlled double-blind clinical study of adjuvant dexamethasone with surgery for chronic subdural haematoma with post-operative subdural drainage: Interim analysis. J Clin Neurosci 2020;71:153-7.
19. Mehta V, Harward SC, Sankey EW, Nayar G, Codd PJ. Evidence based diagnosis and management of chronic subdural hematoma: A review of the literature. J Clin Neurosci 2018;50:7-15.
20. Miah IP, Blanter A, Tank Y, Zwet EW, Rosendaal FR, Peul WC, *et al.* Change in hematoma size after dexamethasone therapy in chronic subdural hematoma subtypes: A prospective study in symptomatic patients. J Neurotrauma 2023;40:228-39.
21. Miah IP, Herklots M, Roks G, Peul WC, Walchenbach R, Dammers R, *et al.* Dexamethasone therapy in symptomatic chronic subdural hematoma (DECSA-R): A retrospective evaluation of initial corticosteroid therapy versus primary surgery. J Neurotrauma 2020;37:366-72.
22. Miah IP, Holl DC, Blaauw J, Lingsma HF, den Hertog HM, Jacobs B, *et al.* Dexamethasone versus surgery for chronic subdural hematoma. N Engl J Med 2023;388:2230-40.
23. Missori P, Salvati M, Polli FM, Conserva V, Delfini R. Intraparenchymal haemorrhage after evacuation of chronic subdural haematoma. Report of three cases and review of the literature. Br J Neurosurg 2002;16:63-6.
24. Ng S, Boetto J, Huguet H, Roche PH, Fuentes S, Lonjon M, *et al.* Corticosteroids as an adjuvant treatment to surgery in chronic subdural hematomas: A multi-center double-blind randomized placebo-controlled trial. J Neurotrauma 2021;38:1484-94.
25. Papacocea T, Popa E, Dana T, Papacocea R. The usefulness of dexamethasone in the treatment of chronic subdural hematomas. Farmacia 2019;67:140-5.
26. Petralia CC, Manivannan S, Shastin D, Sharouf F, Elalfy O, Zaben M. Effect of steroid therapy on risk of subsequent surgery for neurologically stable chronic subdural hemorrhage-retrospective cohort study and literature review. World Neurosurg 2020;138:e35-41.
27. Prud'homme M, Mathieu F, Marcotte N, Cottin S. A pilot placebo controlled randomized trial of dexamethasone for chronic subdural hematoma. Can J Neurol Sci 2016;43:284-90.
28. Qian Z, Yang D, Sun F, Sun Z. Risk factors for recurrence of chronic subdural hematoma after burr hole surgery: Potential protective role of dexamethasone. Br J Neurosurg 2017;31:84-8.
29. Shi M, Xiao LF, Zhang TB, Tang QW, Zhao WY. Adjuvant corticosteroids with surgery for chronic subdural hematoma: A systematic review and meta-analysis. Front Neurosci 2021;15:786513.
30. Shrestha DB, Budhathoki P, Sedhai YR, Jain S, Karki P, Jha P, *et al.* Steroid in chronic subdural hematoma: An updated systematic review and meta-analysis post DEX-CSDH trial. World Neurosurg 2022;158:84-99.
31. Stroobandt G, Fransen P, Thauvoy C, Menard E. Pathogenetic factors in chronic subdural haematoma and causes of recurrence after drainage. Acta Neurochir (Wien) 1995;137:6-14.
32. Sun TF, Boet R, Poon WS. Non-surgical primary treatment of chronic subdural haematoma: Preliminary results of using dexamethasone. Br J Neurosurg 2005;19:327-33.
33. Tang G, Chen J, Li B, Fang S. The efficacy of adjuvant corticosteroids in surgical management of chronic subdural hematoma: A systematic review and meta-analysis. Front Neurol 2021;12:744266.
34. Tariq J, Bhatti SN. Adjunctive postoperative course of dexamethasone in chronic subdural hematoma: Effect on surgical outcome. Pak J Med Sci 2021;37:1877-82.
35. Wang D, Gao C, Xu X, Chen T, Tian Y, Wei H, *et al.* Treatment of chronic subdural hematoma with atorvastatin combined with low-dose dexamethasone: Phase II randomized proof-of-concept clinical trial. J Neurosurg 2020;134:235-43.
36. Yadav YR, Parihar V, Namdev H, Bajaj J. Chronic subdural hematoma. Asian J Neurosurg 2016;11:330-42.
37. Yamashima T, Friede R. Why do bridging veins rupture into the virtual subdural space? J Neurol Neurosurg Psychiatry 1984;47:121-7.
38. Yao Z, Hu X, Ma L, You C. Dexamethasone for chronic subdural haematoma: A systematic review and meta-analysis. Acta Neurochir (Wien) 2017;159:2037-44.
39. Zhao Y, Xiao Q, Tang W, Wang R, Luo M. Efficacy and safety of glucocorticoids versus placebo as an adjuvant treatment to surgery in chronic subdural hematoma: A systematic review and meta-analysis of randomized controlled clinical trials. World Neurosurg 2022;159:198-206.e4.

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SUPPLEMENTARY FILES

Supplementary File 1: Search string including MESH terms.

("controlling"[All Fields] OR "controllability"[All Fields] OR "controllable"[All Fields] OR "controllably"[All Fields] OR "controller"[All Fields] OR "controller s"[All Fields] OR "controllers"[All Fields] OR "controlling"[All Fields] OR "controls"[All Fields] OR "prevention and control"[MeSH Subheading] OR ("prevention"[All Fields] AND "control"[All Fields]) OR "prevention and control"[All Fields] OR "control"[All Fields] OR "control groups"[MeSH Terms] OR ("control"[All Fields] AND "groups"[All Fields]) OR "control groups"[All Fields]) AND (("intracranial"[All Fields] OR "intracranially"[All Fields]) AND ("blood"[MeSH Subheading] OR "blood"[All Fields] OR "blood"[MeSH Terms] OR "bloods"[All Fields] OR "hematology"[All Fields] OR "hematology"[MeSH Terms] OR "hematology"[All Fields] OR "hematoma"[All Fields] OR "hematoma"[MeSH Terms] OR "hematoma"[All Fields] OR "hemorrhage"[All Fields] OR "hemorrhage"[MeSH Terms] OR "hemorrhage"[All Fields] OR "hemorrhages"[All Fields] OR "hemorrhagic"[All Fields] OR "hemorrhaging"[All Fields] OR "hematologies"[All Fields] OR "hematomas"[All Fields] OR "hematomas"[All Fields] OR "hematoma s"[All Fields] OR "hematoma"[All Fields] OR "hemorrhaged"[All Fields] OR "hemorrhagic"[All Fields] OR "hemorrhagical"[All Fields] OR "hemorrhaging"[All Fields]) AND ("steroidal"[All Fields] OR "steroidals"[All Fields] OR "steroidic"[All Fields] OR "steroids"[MeSH Terms] OR "steroids"[All Fields] OR "steroid"[All Fields]))	518 result
"subdural hematoma"[All Fields] OR "hematoma, subdural"[MeSH Terms] OR ("hematoma"[All Fields] AND "subdural"[All Fields]) OR "subdural hematoma"[All Fields] OR ("subdural"[All Fields] AND "hematoma"[All Fields])	13577 results

Supplementary File 2: Risk of bias interpretation of cohort by Newcastle-Ottawa scale and randomized controlled trials by Cochrane tool for risk of bias assessment.

First author	Newcastle-Ottawa Quality Assessment Scale									Meta-analysis	
	Selection				Comparability		Outcome			Eligible	selected
	1	2	3	4	5	6	7	8	9		
Koastas 2018	*	*	*	*	*	/	*	*	*	Yes	Yes
Mebberson *et al*. 2020	*	*	*	*	*	*	/	*	*	Yes	Yes
Miah *et al*. 2020	*	*	*	*	/	*	*	*	*	Yes	Yes
Miah *et al*. 2020	*	*	*	*	/	*	*	*	*	Yes	Yes
Miah *et al*. 2023	*	*	*	*	/	*	*	*	*	Yes	Yes
Ng *et al*. 2021	*	*	*	*	*	/	*	*	*	Yes	Yes
Papancocea *et al*. 2019	*	*	*	*	*	*	*	/	*	Yes	Yes
Qian *et al*. 2017	*	*	*	*	*	*	*	/	*	Yes	Yes
Sun *et al*. 2005	*	*	*	*	*	*	*	/	*	Yes	Yes
Tariq and Bhatti 2021	*	*	*	*	*	/	*	*	*	Yes	Yes

*: yes, /: no.

	Cochrane Collaborations tool for risk of bias								
	A	B	C	D	E	F	G		
Hutchinson *et al*. 2020	Low	Low	Low	Low	Low	Low	Low	Yes	Yes
Prud'homme *et al*. 2015	Low	Low	Low	Low	Low	Low	U/s	Yes	Yes

Newcastle-Ottawa scale		
Newcastle-Ottawa Quality Assessment Scale		
Selection:	1	Representation of the intervention cohort (steroids)
	2	Selection of the non-intervention cohort (surgery)
	3	Has the correct intervention been utilized?
Comparability:	5	Are the cohorts comparable based on the basis of the design or analysis: age, sex, and injury severity?
	6	Are the cohorts comparable on the basis of the design or analysis? Additional factors
Outcome:	7	Was the outcome assessed?
	8	Was the follow-up long enough for measured outcomes to occur?
	9	Was the cohort follow-up long enough?

Cochrane collaborations tool for assessing risk of bias: Domains

A: Sequence generation
B: Allocation concealment
C: Blinding of participants and personnel
D: Blinding of outcome assessors
E: Incomplete outcome data
F: Selection outcome reporting
G: Other sources of bias