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Does Heroin-Assisted Treatment Reduce Crime? A Review of Randomized-Controlled Trials

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Running head: Heroin-assisted treatment and crime

Word Count: 4,000

Keywords: heroin, opioid use disorder, treatment, crime

Conflict of interest declaration: None.

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/add.15601

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ABSTRACT

Background and Aims: Several randomized controlled trials (RCTs) conclude that heroin-assisted-treatment (HAT) has a larger benefit-cost ratio than oral methadone because HAT more reliably and substantially reduces participants' criminal activity. This review: (1) summarizes results from RCTs about the comparative effectiveness of HAT for reducing criminal activity, and (2) examines the role of different mechanisms for explaining changes in crime.

Design: Systematic search of five databases for RCTs evaluating comparative effectiveness of HAT on participant crime outcomes and potential mediators of crime. Narrative synthesis with tabular comparisons of outcomes extracted across RCTs.

Setting: Europe and Canada.

Participants: Twenty studies, spanning ten RCTs with 2,427 participants, met inclusion criteria.

Interventions: HAT compared to other treatments for opioid use disorder, primarily oral methadone.

Measurements: The primary outcome was criminal activity. Mediator outcomes included illicit heroin use, drug expenditures, employment and earnings, and social functioning.

Findings: All trials found significantly reduced criminal activity among HAT participants, and four found significantly larger reductions for HAT compared to control condition (median odds ratio [OR]=0.45). Reductions in crime are concentrated in drug-related and property offenses (median ORs of 0.47 and 0.79, respectively). Comparative efficacy of HAT for reducing illicit heroin use likely explains reductions in drug possession offenses, but does not show consistent correlation with drug dealing or property offenses. While three trials showed reductions in drug expenditures as possibly driving crime reductions, others did not report expenditures. There is little evidence that treatment effects on economic and social functioning outcomes explain within-trial changes in criminal activity.

Conclusions: Existing literature suggests heroin-assisted-treatment reduces criminal activity, but trials varied in whether these effects exceeded those from oral methadone treatment. Inconsistency in outcome measures across trials complicates understanding drivers of heterogeneity. More detailed information on legal and illegal income, drug expenditures, and social interactions could improve our understanding of the causal mechanisms underlying the effect of heroin-assisted-treatment on crime.

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INTRODUCTION

The rapid escalation of the US opioid crisis, with harms increasingly attributable to heroin and illicitly manufactured fentanyl (1), has prompted efforts to improve access to, and options for, effective treatments for opioid use disorder (OUD) (1-3). Innovative treatment approaches to engage individuals with chronic heroin dependence who have not responded to traditional medication therapies have important public health and economic implications, as this population contributes disproportionately to the health and societal costs associated with heroin dependence. This is in large part due to their high levels criminal activity and associated costs incurred by the criminal justice system (4, 5).

Several countries have experimented with offering pharmaceutical-grade heroin as treatment for heroin use disorder. Currently, heroin-assisted treatment (HAT) is available in more than 50 clinics across eight countries, with four countries offering HAT as part of the standard treatment system (6), and pilot programs recently announced in Norway and Scotland (7, 8). Despite the higher costs of HAT provision, studies suggest HAT is more cost-effective than oral methadone (OMT) in a societal sense, primarily because the models credit HAT with more substantially reducing participants' levels of criminal justice involvement and associated damages to victims of their crime activity (9-11).

A previous Cochrane review (12) evaluated the effectiveness of HAT relative to other substitution treatments, considering criminal activity as a secondary outcome. Based on a narrative synthesis of results, it concluded that HAT may reduce criminal activity more than OMT. However, this review only included studies published through 2009, and three trials have since produced results. Furthermore, the review did not evaluate potential heterogeneity in crime effects across trials or across crime types, nor did it address potential mechanisms by which HAT may produce larger benefits than OMT on criminal activities.

Several mechanisms could contribute to the greater effectiveness of HAT in reducing participants' criminal activity (13, 14). Multiple reviews find HAT more effective than OMT in reducing illicit heroin use among patients who previously attempted OMT but continued to use heroin regularly (12, 15-17). Thus, HAT could yield larger reductions in drug-related offenses; if HAT more substantially lowers illicit opioids expenditures compared to OMT, HAT may also yield greater reductions in acquisitive crimes and drug dealing. Larger reductions in opioid misuse may also produce greater improvements in employment and formal labor market attachment, lowering both the incentive and perhaps the opportunity to engage in criminal behavior. While HAT recipients continue to use heroin through HAT clinics, which may affect perceived employability, the legal and structured provision of heroin may reduce time spent procuring the drug and decrease interruptions to formal employment. Finally, through reduced reliance on illegal markets for opioids, HAT may improve social functioning or alter individuals' peer groups, which may reduce crime through greater acceptance of social norms disapproving of criminal behavior, less involvement with criminogenic peers, or reduced time spent in criminogenic contexts.

One study of the German HAT randomized controlled trial (RCT) attempted to disentangle these mechanisms to explain the effectiveness of HAT on crime (18). It found that declines in drug offenses were largely attributable to reduced drug use and reduced victimization, interpreted as indicative of drug scene involvement; declines in property offenses were mediated by declines in drug use, victimization, and time spent in the drug scene. While this

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suggests the importance of reduced drug use and drug scene involvement as primary mechanisms explaining the relationship between HAT and crime, comparable analyses have not been done for any of the other HAT trials.

This study (1) reviews the experimental evidence of the effectiveness of HAT compared with other treatments (primarily oral methadone) on criminal outcomes, and (2) explores four potential mechanisms that may explain changes in crime outcomes among trial participants.

METHODS

This review leverages a broader systematic review of the individual-level, community-level, and economic effects of HAT (19). For the purposes of this study, studies were eligible if they were an RCT or systematic review of RCTs; included HAT for opioid dependence as one of the included interventions; compared HAT to an alternative non-HAT treatment; and evaluated effects on illegal activities, crime, or criminal justice outcomes among participants, or evaluated the following potential mediators of crime: illicit heroin use, labor market outcomes, social functioning, and drug expenditures. These four mechanistic outcomes were derived based on data evaluated in our prior review (17). No restrictions were placed on setting or participant characteristics. As the review was not pre-registered, these analyses should be considered exploratory.

Five electronic databases were searched from 1990 until January 17, 2018 using key terms related to HAT. Search results were first screened for relevance by title and abstract, and relevant articles were retrieved in full text and reviewed to determine whether the selection criteria were met. We attempted to supplement published results by contacting trial investigators to request additional data, and we incorporated one additional study-outcome through these requests. For further information, see Supplemental Materials.

Data from each study were extracted using an electronic template developed prior to the search. Extracted data included general information (e.g., authors), setting (e.g., country), trial characteristics (e.g., interventions, participant eligibility), study design, analytic approach, and estimated effect sizes for relevant outcomes. For each RCT, risk of bias in the comparative effectiveness of HAT for crime outcomes was evaluated using the five bias domains of version 2 of the Cochrane Risk of Bias Assessment Tool (20).

Data were synthesized narratively and through tabular comparisons of outcomes extracted across RCTs. For dichotomous outcomes, we present effect sizes as odds ratios between the HAT and control groups. For continuous outcomes, we present effect sizes as mean differences between the HAT and control groups. Given substantive variation across trials in outcome definitions (e.g., arrest, charge, illegal activities) and measurement (e.g., self-report, official records, or a combination), as well as differences across contexts in the types of activities that would be captured as criminal or illegal, a meta-analysis was not performed. For expositional convenience the term “crime” or “criminal outcome” is used to include all illegal activities as defined by the trialists, even though not all are labeled as crimes, as opposed to civil offenses, in all settings.

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RESULTS

Figure 1 summarizes the search results. Our search yielded 20 included studies, covering ten RCTs comparing HAT to other treatments for OUD and evaluating comparative efficacy for crime or mediator outcomes (Table 1). Risk of bias was assessed as "some concerns" for all but the German and SALOME trials, which were deemed "low" risk of bias. Domains most commonly contributing to the "some concerns" designation were outcome measurement (i.e., crime outcomes assessed based on participant self-report only, and participants could not be blinded to the intervention condition) and selective reporting (i.e., multiple ways of measuring and analyzing outcomes, and no pre-specified analysis plans identified) (Table S5)

While the earliest RCT, conducted in London in the 1970s, evaluated unsupervised injectable HAT, the majority of RCTs compared supervised injectable HAT plus optional oral methadone to oral methadone alone. Two trials (23, 28) considered supervised heroin prescription through inhalable modalities, and one (29) compared injectable HAT to injectable hydromorphone. Together, the trials span seven countries, nearly four decades of investigation, and include 2,427 participants. Almost one-half of participants come from just one large RCT in Germany.

Trials varied in exact conditions (Table 2). Among OMT control groups, methadone doses varied widely, ranging from an average of 60 mg/day in earlier trials to over 100 mg/day in the UK RIOTT's optimized OMT condition. Among the HAT groups, the lowest heroin dosage (30-120 mg/day) was observed in the early UK trial for unsupervised injectable heroin; this dosage is far lower than for any of the other trials. For studies of supervised HAT, the Spanish trial exhibited the lowest average dose (<300 mg/day) and the Belgian trial the highest average dose (573 mg/day). However, HAT doses tend to taper over the study period, principally as a result of patient preferences for lower dosage (30); for instance, by the end of the 12-month trial, HAT participants in the Belgian trial received an average of 355 mg/day (28).

Effects on criminal outcomes

The trials varied in how they measured criminal outcomes (Table 3). In the early UK trial, which involved unsupervised HAT, benefits of HAT relative to OMT were large but not significant (21). For supervised HAT, four trials (Swiss, Dutch injectable, Dutch inhalable, and German) found significant reductions in criminal offending for participants in HAT relative to those randomized to the control condition. In four trials (Spanish, Canadian, Belgian, and SALOME), crime reductions were substantively larger for the HAT group but did not significantly differ from the control condition. Only one study (UK RIOTT) found larger benefits for the OMT group, but these did not significantly differ from the HAT group.

Nearly all trials found significant reductions in crime outcomes for both the HAT and control groups, just significantly larger reductions in the HAT group. Exceptions to this were the Swiss trial and the German trial's measure of police-reported criminal activity, both of which showed small and statistically insignificant increases in crime in the control groups (24, 38). In the trials that did not show significant crime reduction benefits for HAT relative to OMT,

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this pattern of both groups showing significant and substantial reductions in criminal activity similarly held, but differences across groups failed to reach levels of statistical significance.

Examining specific crime types (Table 4), comparative benefits of HAT are primarily driven by larger declines in drug offenses and property crime/damage among those receiving HAT, which is consistent with their reduced illicit heroin use leading to less reliance on illicit channels to obtain or pay for heroin. No study found a significant benefit of HAT relative to control for reducing violent crime; this aligns with prior research showing a weaker link between opioid use and violence relative to that observed for other drugs, such as stimulants (39).

In the trials that did not find significant comparative benefits of HAT for crime, only the UK RIOTT trial provided estimates detailed by crime type. The Canadian trial measured crime reduction using a composite measure, which appeared to explicitly exclude drug offenses (26). The Belgian trial reported baseline and follow-up rates of criminal involvement by crime type for all trial participants combined, showing reductions in criminal activities related to theft and selling of illicit drugs but indicating no significant differences across trial conditions; the study did not report on drug possession offenses (40). Similarly, while the Spanish trial examined changes in selling drugs and the UK RIOTT study examined changes in drug dealing and specific forms of theft, noting no significant differences in outcomes across trial conditions, these studies did not separately analyze drug possession offenses (37, 41).

Potential mechanisms for crime effects

Illicit heroin use

Given the importance of drug offenses in driving crime reductions, differences in findings for crime may be attributed to differential efficacy of HAT relative to OMT for reducing illicit heroin use across trials. All trials except the early UK study found significant benefits of HAT relative to the control condition in reducing illicit heroin use (Table 5). Different findings of effects of HAT on illicit heroin use for the early UK study are likely attributable to the different implementation of HAT in that trial (Table 2), whereby heroin injection was unsupervised and dosages were much more restrictive than in all later trials.

Given the relative efficacy of HAT for reducing illicit heroin use, we would expect HAT to produce greater reductions in drug possession crime. Given possible subjectivity in the decision to charge an offense as possession versus possession with intent to sell, we may also expect relative reductions in illicit heroin use alone to translate into relative reductions in arrests, charges, or prosecutions for drug dealing offenses. However, the Swiss, Spanish, UK RIOTT, and Belgian trials all found significant benefits of HAT relative to OMT in terms of reducing street heroin use, but these did not translate into significant differential benefits for drug dealing offenses (Table 3).

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Expenditures on illicit drugs

While reductions in illicit heroin use attributable to HAT may directly explain reductions in drug offenses, the mechanisms explaining changes in property crime are less clear. However, if HAT reduces expenditures on illicit drugs, these reduced expenditures could decrease acquisitive crime. In a retrospective study of Dutch individuals eligible for HAT, the most common reason reported as motivating property crime offense was to obtain money for drugs and alcohol (42). Indeed, baseline monthly expenditures on drugs for study participants across the trials were substantial (Table S7), roughly corresponding to between 50% and 150% of the median monthly individual income in the UK (43).

Only three trials reported on changes in illicit drug expenditures during the trial period. In the Swiss trial, past-month expenditures on drugs fell by nearly 90% from baseline to follow-up in the HAT group; expenditures fell by significantly less in the control group (8%). In the Canadian trial, median drug expenditures were reduced for both treatment and control groups, showing 73% and 67% reductions for the HAT and OMT groups, respectively; while significance of differences across groups were not reported, these reductions are qualitatively comparable. In the UK RIOTT trial, past-week illicit drug expenditures for HAT patients fell by 86% from baseline to 6-month follow-up; past-week illicit drug expenditures for patients receiving oral methadone fell by significantly less (58%).

The magnitude of reduced drug expenditures in the control groups of the UK RIOTT and Canadian NAOMI trial may help explain why reductions in criminal activity were comparable across both trial conditions. The UK RIOTT expenditure findings for the control condition are particularly striking given that the study found only modest improvements in reduced street heroin use for that group.

Employment and wage earnings

Improvement in economic status is another potential mechanism for reducing reliance on acquisitive crime among trial participants. For employment or economic status, two trials (Germany, Canada) comparing supervised injectable heroin to OMT found improvements for both the experimental and control conditions by treatment end (25, 26), although the only significant benefit of HAT relative to OMT was found in the Canadian trial (26) with respect to employment satisfaction ($p=0.02$). The early UK (21), Swiss (22), and SALOME (44) trials showed no evidence of significant changes in employment or legal income for either intervention condition. Two trials assessed labor market outcomes as part of a broader social functioning index. The Spanish trial found significant improvements in social functioning for both the HAT and OMT conditions, but no significant differences across groups (24); the UK RIOTT study found no significant changes within or across groups (37). The Dutch and Belgian trials did not publish results for labor market effects.

The relative absence of labor market improvements is perhaps unsurprising as trial participants had extremely low rates of employment at baseline (2-30%). While low baseline rates mean even modest improvements due to the intervention should be detectable, the acute economic disadvantage of trial participants at baseline, combined with the relatively short duration of the trials, likely limits participants' ability to achieve meaningful changes in labor

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market outcomes. Furthermore, most trials provided HAT along a strict regimen, with patients typically visiting the treatment centers at least twice daily, possibly impeding HAT patients' employment opportunities during the trial period.

Social functioning or involvement with drug culture

Finally, reductions in broader criminal activity could occur due to improvements in social functioning or changes in social networks. Four trials (Germany, Canada, Spain, Switzerland) found evidence of improvements in at least some social functioning domains for both the experimental and control conditions (22, 24-26, 33), although only the Canadian NAOMI study (26) found significantly greater improvement among the HAT group for social relations. The UK RIOTT study (37) did not find significant changes in social functioning measures for either intervention condition. Similarly, the early UK trial (21) did not find significant changes for social stability, measured as consumption or regular meals and type of accommodation, for either intervention condition; again it should be noted that this trial differed in its provision of prescribed heroin. The Dutch trials measured social functioning based on illegal activities and contact with drug users (discussed below), while the Belgian TADAM and SALOME trials did not report social functioning outcomes across trial conditions.

Six trials specifically evaluated measures related to drug culture involvement. The early UK study found significant differences between intervention groups, with the control exhibiting a bimodal distribution (i.e., more likely to spend "no time at all" with other drug users (23%) compared with HAT (2%) or "most/all of their time" with other drug users (36%) compared with HAT (25%)) and the HAT group more likely to report intermediate categories of involvement. The Spanish trial found significantly reduced odds of spending the majority of time with drug users for the HAT relative to OMT group (OR = 0.23, 95% CI=[0.06,0.87]). The Swiss trial asked respondents whether "all or most friends were outside the drug scene" and found no significant change for either group nor significant differences across treatment assignments. The German trial assessed "time spent in drug scene" and found greater improvement for the HAT group relative to the OMT group, although both groups showed improvements and it was unclear whether differences across groups were statistically significant. While the Dutch trials found modest improvements in the days involving personal contact with non-drug users for both trial arms, significance tests were not conducted. The Canadian, UK RIOTT, and Belgian trials did not report on this outcome separately.

Table 6 summarizes outcome information reported for the nine RCTs for six measures: Crime, heroin use, drug expenditures, labor market, time in drug scene, and social function.

DISCUSSION

In debates about implementing HAT, it is commonly argued that the benefits of HAT exceed the costs (45). While HAT is more expensive than oral methadone, several studies conclude that HAT has a larger benefit-cost ratio, primarily because HAT more reliably and substantially reduces participants' levels of criminal activity (9-11). Our review of ten RCTs supports that individuals assigned to HAT reduce their criminal activity, with reductions

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concentrated in drug-related and property crime offenses. However, the RCTs vary with respect to whether reduced crime among those randomized to HAT statistically differed from that observed for individuals randomized to oral methadone. This paper not only adds to the literature by documenting this variation across studies, it also attempts to shed light on the factors that may account for these differences.

In trials that did not find significant crime benefits of HAT relative to OMT, this seems to be the result of the control condition showing marked reductions in criminal activity (rather than the absence of an effect of HAT). While a broad literature has demonstrated that OMT can reduce criminal involvement (46-50), several features of the HAT trials make these findings novel/interesting. First, recruitment for the HAT trials generally restricted patient eligibility to treatment-refractory individuals with a history of multiple prior attempts at conventional treatment modalities, primarily OMT; this profile of prior treatment non-response makes significant benefits from OMT participation particularly surprising. Second, the HAT trials were relatively short in duration, lasting less than one year; several prior studies suggest that benefits of OMT on criminal activity are concentrated among individuals retained in stable treatment for more than one year (49, 51, 52). Finally, these comparable crime reductions for those randomized to OMT versus HAT occurred despite their substantively smaller reductions in illicit heroin use and lower rates of treatment retention. This suggests the potential for mechanisms other than illicit heroin use alone as contributing to the heroin-crime relationship.

Indeed, little is known about the importance of different mechanisms which lead to the reductions in crime observed among HAT RCT participants. While differences in outcome measurement and reporting across studies (Table 6) make it difficult to draw firm conclusions about the mechanisms at play, it seems apparent (if unsurprising) that reductions in drug possession offenses are linked to reductions in illicit heroin use. The mechanisms for reduced property crime are less clear, but appear not to be driven by improved labor market attachment, employment, or earnings. The results for social functioning and drug scene involvement use such different measures that it is difficult to draw strong conclusions. While a reduction in drug expenditures seems like a compelling explanation for lower rates of acquisitive crime, this information is not reported for most of the trials.

Understanding the causal mechanisms underlying the effect of HAT on crime outcomes requires future studies to collect detailed information on legal and illegal income, illegal drug expenditures, and social interactions. Learning more about the importance of various mechanisms for driving crime reductions from future HAT studies, or studies of any drug treatment modality for a patient population similar to HAT participants, would also be useful for informing our understanding of the heroin-crime connection more generally.

While restricting our review to evidence from RCTs allows a focus on more rigorous causal evidence of the relationship of HAT with crime, it limited our evaluation of mechanisms to those that have influence over the relatively short follow-up periods of these trials. Some treatment effects (e.g., reduced reliance on illicit markets for heroin) may manifest rapidly, but those that involve behavioral change (e.g., employment) are likely to take quite some time to emerge. Indeed, the mechanisms for explaining crime reductions from HAT may differ in the short- versus long-term (53, 54). In the six to twelve-month follow-up period of these trials it may be that reduced reliance on illegal markets for heroin is the principal

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mechanism for lowering criminal activity. Over the longer-term, sustained abstinence and subsequent improvements in social or economic functioning may have a separate and larger suppressing effect on criminal activity.

Our study is subject to additional limitations. First, criminal codes and enforcement vary across study countries, thus some activities included in the list of illegal acts (e.g., drug possession) may not be subject to penal sanctions in all countries. The probability of being arrested, contingent on breaking the law, varies across countries in ways that cannot be measured in this review. Given variation in what activities count as criminal, outcome measurements, and sources of data, we did not conduct a meta-analysis. Second, all trials included in this review were designed to determine the comparative efficacy of HAT in terms of prespecified outcome measures; illegal activities and the mechanisms we evaluated were generally treated as secondary outcomes or as part of a composite score. Thus, these studies may have been underpowered to detect statistically significant differences for these outcomes. We attempted to present effect sizes and confidence intervals for our included outcomes, but in many cases, outcomes could not be disaggregated from broader composite indices or effect measures could not be calculated from the information presented in the identified studies. Finally, the risk-of-bias assessments highlighted some concerns with outcome measurement and selective reporting that may affect the internal validity of estimated crime effects; given most trials compared HAT with a treatment (e.g., methadone) which has already produced a poor outcome for the enrolled sample, this could lead to an overstatement of HAT's benefits and may not generalize to the broader population of individuals with heroin dependence..

Overall, the consistency of findings across HAT studies suggests that in Europe there will be little interest in further RCTs. Evidence for that can be found in Denmark's decision to implement HAT without conducting its own trial (55). The extraordinary numbers of fatal opioid-related overdoses in the United States makes it plausible that a trial might be conducted there, though it is little discussed in part due to stigma against such treatment, including concerns about crime (56). However, drug-related crime has been a more prominent issue in the United States than in any European country, and benefit-cost studies in the US correspondingly emphasize that the principal economic benefits of drug treatment come from reductions in crime, both violent and property, by individuals while in treatment (57). While crime should not be the dominant focus of future medical trials for patients with OUD, collecting and reporting data on criminal involvement, victimization, and criminal justice contacts could improve our understanding of the broader benefits of treatments both to participants and communities, as well as identify subgroups that may face persistent individual-, community-, or structural-level barriers to improved social outcomes.

ACKNOWLEDGEMENTS

We are very grateful for feedback received from Beau Kilmer, as well as for the assistance provided by Jirka Taylor in article screening and data extraction. Funding for this research was provided by the RAND Corporation through gifts from RAND supporters and income from operations.

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REFERENCES

1. United Nations Office on Drugs and Crime. World Drug Report 2020. United Nations; 2020 June, 2020. Contract No.: E.20.XI.6.

2. National Academies of Sciences Engineering and Medicine. Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use. Washington, DC: National Academies Press; 2017.

3. Schottenfeld RS, O'Malley SS. Meeting the growing need for heroin addiction treatment. JAMA psychiatry. 2016;73(5):437-8.

4. Jiang R, Lee I, Lee TA, Pickard AS. The societal cost of heroin use disorder in the United States. Plos One. 2017;12(5):e0177323.

5. Fischer B, Oviedo-Joekes E, Blanken P, Haasen C, Rehm J, Schechter MT, et al. Heroin-assisted treatment (HAT) a decade later: A brief update on science and politics. J Urban Health. 2007;84(4):552-62.

6. Uchtenhagen A. The role and function of heroin-assisted treatment at the treatment system level. Heroin Addict Relat Clin Probl. 2017;19(2):17-24.

7. BBC News. Scotland's first heroin treatment clinic for addicts to open: BBC News Service; 2019 [updated November 26, 2019. Available from: https://www.bbc.com/news/uk-scotland-glasgow-west-50563163.

8. Institute of Clinical Medicine. HAB - Evaluation of heroin-assisted treatment Norway: University of Oslo; 2021 [updated April 15, 2021. Available from: https://www.med.uio.no/klinmed/english/research/projects/hab-evaluation-heroin-assisted-treatment/.

9. Nosyk B, Guh DP, Bansback NJ, Oviedo-Joekes E, Brissette S, Marsh DC, et al. Cost-effectiveness of diacetylmorphine versus methadone for chronic opioid dependence refractory to treatment. CMAJ. 2012;184(6):E317-28.

10. Byford S, Barrett B, Metrebian N, Groshkova T, Cary M, Charles V, et al. Cost-effectiveness of injectable opioid treatment v. oral methadone for chronic heroin addiction. Br J Psychiatry. 2013;203(5):341-9.

11. Dijkgraaf MG, van der Zanden BP, de Borgie CA, Blanken P, van Ree JM, van den Brink W. Cost utility analysis of co-prescribed heroin compared with methadone maintenance treatment in heroin addicts in two randomised trials. Bmj. 2005;330(7503):1297.

12. Ferri M, Davoli M, Perucci CA. Heroin maintenance for chronic heroin-dependent individuals. The Cochrane database of systematic reviews. 2011(12):Cd003410.

13. Goldstein PJ. The drugs/violence nexus: A tripartite conceptual framework. Journal of drug issues. 1985;15(4):493-506.

14. Bennett T, Holloway K. The causal connection between drug misuse and crime. The British Journal of Criminology. 2009;49(4):513-31.

This article is protected by copyright. All rights reserved.

15. Strang J, Groshkova T, Uchtenhagen A, van den Brink W, Haasen C, Schechter MT, et al. Heroin on trial: Systematic review and meta-analysis of randomised trials of diamorphine-prescribing as treatment for refractory heroin addictiondagger. Br J Psychiatry. 2015;207(1):5-14.

16. Dalsbo TK, Steiro AK, Hammerstrom KT, Smedslund G. NIPH Systematic Reviews: Executive Summaries. Heroin Maintenance for Persons with Chronic Heroin Dependence. Oslo, Norway: Knowledge Centre for the Health Services at The Norwegian Institute of Public Health (NIPH); 2010.

17. Timko C, Schultz NR, Cucciare MA, Vittorio L, Garrison-Diehn C. Retention in medication-assisted treatment for opiate dependence: A systematic review. J Addict Dis. 2016;35(1):22-35.

18. Löbmann R, Verthein U. Explaining the effectiveness of heroin-assisted treatment on crime reductions. Law and Human Behavior. 2009;33(1):83-95.

19. Smart R. Evidence on the Effectiveness of Heroin-assisted Treatment. Santa Monica, CA: RAND Corporation; 2018.

20. Sterne JA, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. bmj. 2019;366.

21. Hartnoll RL, Mitcheson MC, Battersby A, Brown G, Ellis M, Fleming P, et al. Evaluation of heroin maintenance in controlled trial. Archives of general psychiatry. 1980;37(8):877-84.

22. Perneger TV, Giner F, del Rio M, Mino A. Randomised trial of heroin maintenance programme for addicts who fail in conventional drug treatments. Bmj. 1998;317(7150):13-8.

23. van den Brink W, Blanken P. Medical co-prescription of heroin : Two randomized controlled trials. Utrecht: Central Committee on the Treatment of Heroin Addicts; 2002.

24. March JC, Oviedo-Joekes E, Perea-Milla E, Carrasco F. Controlled trial of prescribed heroin in the treatment of opioid addiction. J Subst Abuse Treat. 2006;31(2):203-11.

25. Haasen C, Verthein U, Degkwitz P, Berger J, Krausz M, Naber D. Heroin-assisted treatment for opioid dependence: Randomised controlled trial. Br J Psychiatry. 2007;191:55-62.

26. Oviedo-Joekes E, Brissette S, Marsh DC, Lauzon P, Guh D, Anis A, et al. Diacetylmorphine versus methadone for the treatment of opioid addiction. N Engl J Med. 2009;361(8):777-86.

27. Strang J, Metrebian N, Lintzeris N, Potts L, Carnwath T, Mayet S, et al. Supervised injectable heroin or injectable methadone versus optimised oral methadone as treatment for chronic heroin addicts in England after persistent failure in orthodox treatment (RIOTT): a randomised trial. Lancet. 2010;375(9729):1885-95.

28. Demaret I, Quertemont E, Litran G, Magoga C, Deblire C, Dubois N, et al. Efficacy of heroin-assisted treatment in Belgium: A randomised controlled trial. European Addiction Research. 2015;21(4):179-87.

This article is protected by copyright. All rights reserved.

29. Oviedo-Joekes E, Guh D, Brissette S, Marchand K, MacDonald S, Lock K, et al. Hydromorphone Compared With Diacetylmorphine for Long-term Opioid Dependence A Randomized Clinical Trial. JAMA psychiatry. 2016;73(5):447-55.

30. Reuter P. Can heroin maintenance help Baltimore? : what Baltimore can learn from the experience of other countries [; Computer File; Internet Resource]. Baltimore, Md : Abell Foundation; 2009 [cited WorldCat. Prescription heroin. Search2.; 43 pages : illustrations (some color), digital, PDF file]. Available from: http://worldcat.org/oclc/318071281/viewonline

http://worldcat.org/oclc/318071281/viewonline Materials specified: View Online.

31. van den Brink W, Hendriks VM, Blanken P, Koeter MW, van Zwieten BJ, van Ree JM. Medical prescription of heroin to treatment resistant heroin addicts: Two randomised controlled trials. Bmj. 2003;327(7410):310.

32. Blanken P, Hendriks VM, Koeter MW, van Ree JM, van den Brink W. Craving and illicit heroin use among patients in heroin-assisted treatment. Drug and alcohol dependence. 2012;120(1-3):74-80.

33. Lobmann R, Verthein U. Explaining the effectiveness of heroin-assisted treatment on crime reductions. Law Hum Behav. 2009;33(1):83-95.

34. Haasen C, Eiroa-Orosa FJ, Verthein U, Soyka M, Dilg C, Schafer I, et al. Effects of heroin-assisted treatment on alcohol consumption: Findings of the German randomized controlled trial. Alcohol (Fayetteville, NY). 2009;43(4):259-64.

35. Demaret I, Quertemont E, Litran G, Magoga C, Deblire C, Dubois N, et al. Loss of treatment benefit when heroin-assisted treatment is stopped after 12 months. J Subst Abuse Treat. 2016;69:72-5.

36. Oviedo-Joekes E, Brissette S, MacDonald S, Guh D, Marchand K, Jutha S, et al. Safety profile of injectable hydromorphone and diacetylmorphine for long-term severe opioid use disorder. Drug and alcohol dependence. 2017;176:55-62.

37. Metrebian N, Groshkova T, Hellier J, Charles V, Martin A, Forzisi L, et al. Drug use, health and social outcomes of hard-to-treat heroin addicts receiving supervised injectable opiate treatment: Secondary outcomes from the Randomized Injectable Opioid Treatment Trial (RIOTT). Addiction. 2015;110(3):479-90.

38. Löbmann R. Diamorphine substitution therapy and criminal activity ORIGINAL (NON-ENGLISH) TITLE Diamorphingestützte behandlung und kriminalität. Sucht. 2007;53(5):288-95.

39. Pacula RL, Lundberg R, Caulkins JP, Kilmer B, Greathouse S, Fain T, et al. Improving the measurement of drug-related crime. Washington, DC: Office of National Drug Control Policy; 2013.

40. Demaret I, Deblire C, Litran G, Magoga C, Quertemont E, Ansseau M, et al. Reduction in acquisitive crime during a heroin-assisted treatment: A post-hoc study. Journal of Addiction Research & Therapy. 2015;6(208):1-5.

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41. March JC, Oviedo-Joekes E, Carrasco F, Perea-Milla E. Programa experimental de prescripción de estupefacientes en Andalucía PEPSA. 2005 October 2005.

42. Van Der Zanden BP, Dijkgraaf MG, Blanken P, Van Ree JM, Van Den Brink W. Patterns of acquisitive crime during methadone maintenance treatment among patients eligible for heroin assisted treatment. Drug and alcohol dependence. 2007;86(1):84-90.

43. Office for National Statistics. Employee earnings in the UK: 2019 London: Office for National Statistics; 2019 [updated October 29, 2019. Available from: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2019.

44. Nikoo M, Vogel M, Choi F, Song MJ, Burghardt J, Zafari Z, et al. Employment and paid work among participants in a randomized controlled trial comparing diacetylmorphine and hydromorphone. International Journal of Drug Policy. 2018;57:18-24.

45. Drug Policy Alliance. Heroin-Assisted Treatment (HAT). New York, NY: Drug Policy Alliance; 2016.

46. Lind B, Chen S, Weatherburn D, Mattick R. The effectiveness of methadone maintenance treatment in controlling crime: An Australian aggregate-level analysis. Brit J Criminol. 2005;45(2):201-11.

47. Røislien J, Clausen T, Gran JM, Bukten A. Accounting for individual differences and timing of events: Estimating the effect of treatment on criminal convictions in heroin users. BMC Medical Research Methodology. 2014;14(1):1-10.

48. Russolillo A, Moniruzzaman A, McCandless LC, Patterson M, Somers JM. Associations between methadone maintenance treatment and crime: A 17-year longitudinal cohort study of Canadian provincial offenders. Addiction. 2018;113(4):656-67.

49. Bukten A, Skurtveit S, Gossop M, Waal H, Stangeland P, Havnes I, et al. Engagement with opioid maintenance treatment and reductions in crime: A longitudinal national cohort study. Addiction. 2012;107(2):393-9.

50. Oliver P, Keen J, Rowse G, Ewins E, Griffiths L, Mathers N. The effect of time spent in treatment and dropout status on rates of convictions, cautions and imprisonment over 5 years in a primary care-led methadone maintenance service. Addiction. 2010;105(4):732-9.

51. Deck D, Wiitala W, McFarland B, Campbell K, Mullooly J, Krupski A, et al. Medicaid coverage, methadone maintenance, and felony arrests: Outcomes of opiate treatment in two states. Journal of addictive diseases. 2009;28(2):89-102.

52. Bell J, Hall W, Byth K. Changes in criminal activity after entering methadone maintenance. Brit J Addict. 1992;87(2):251-8.

53. Stavseth MR, Røislien J, Bukten A, Clausen T. Factors associated with ongoing criminal engagement while in opioid maintenance treatment. Journal of Substance Abuse Treatment. 2017;77:52-6.

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54. Verthein U, Bonorden-Kleij K, Degkwitz P, Dilg C, Kohler WK, Passie T, et al. Long-term effects of heroin-assisted treatment in Germany. Addiction. 2008;103(6):960-6; discussion 7-8.

55. Hallam C. Briefing Paper-Heroin Assisted Treatment: The State of Play. Available at SSRN 19099442010.

56. Kilmer B, Taylor J, Caulkins JP, Mueller PA, Ober AJ, Pardo B, et al. Considering heroin-assisted treatment and supervised drug consumption sites in the United States. Santa Monica, CA: RAND Corporation; 2018.

57. Wen H, Hockenberry JM, Cummings JR. The effect of Medicaid expansion on crime reduction: Evidence from HIFA-waiver expansions. Journal of Public Economics. 2017;154:67-94.

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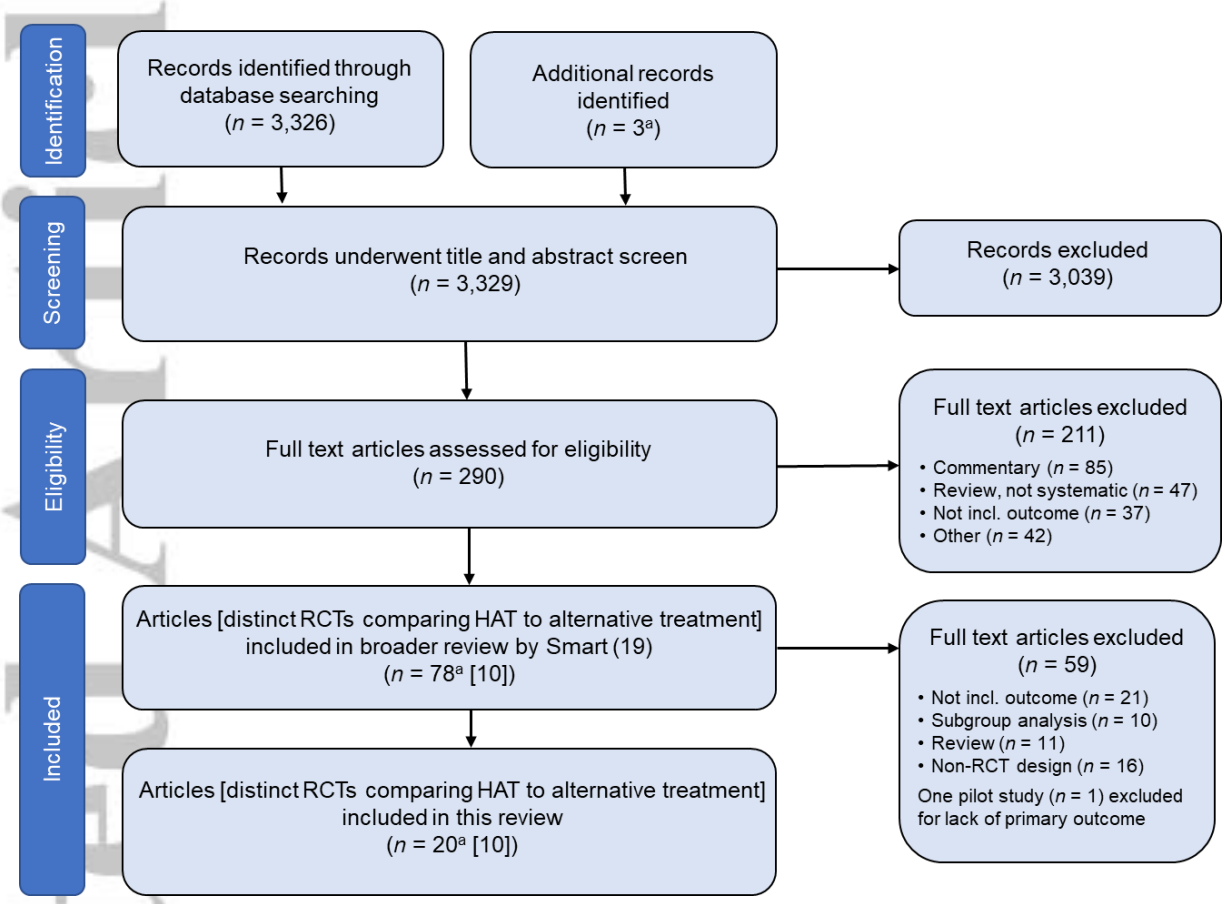
Figure 1. Flow diagram of studies included in review of heroin-assisted treatment literature



NOTES: [a]One of the additional records identified outside the database searching was identified through contact with study trialists as part of the current study. This record is thus counted in the articles included in this review but not in the articles included in the broader review by Smart (19).

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Table 1. Overview of Heroin-Assisted Treatment Randomized Controlled Trials

Trial (period)	Intervention condition (T)	Control condition (C)	Sample size	Duration (months)	Crime Outcome Measurement	Ref	ROB
Early UK trial (1972–1975)	Unsupervised injectable HAT + oral MET	Oral MET	T: 44 C: 52	12	Self-report and official records	(21)	Some concerns
Swiss trial (1995–1996)	Supervised injectable HAT + oral MET	Waiting list for HAT, during which received other conventional drug treatment	T: 27 C: 24	6	Self-report	(22)	Some concerns
Injectable Dutch trial* (1998-2001)	Supervised injectable HAT + oral MET	Oral MET	T: 76 C: 98	12	Self-report and official records	(23)	Some concerns
Inhalable Dutch trial* (1998–2001)	**T1**: Supervised inhalable HAT + oral MET **T2**: Oral MET for 6mo then inhalable heroin + optional oral MET for 6mo	Oral MET	T1: 117 T2: 119 C: 139	12	Self-report and official records	(23)	Some concerns
Spanish PEPSA (2001–2004)	Supervised injectable HAT + oral MET	Oral MET	T: 31 C: 31	9	Self-report	(24)	Some concerns
German study* (2002–2004)	Supervised injectable HAT + oral MET and: **T1**: psychoeducation & counseling **T2**: case management & MI	Oral MET plus: **C1**: education & counseling **C2**: case management/MI	T1: 258 T2: 257 C1: 255 C2: 245	12	Self-report, official records (separate)	(25)	Low
Canadian NAOMI* (2005–2008)	**T1**: Supervised injectable HAT + oral MET **T2**: Supervised injectable hydromorphone + oral MET	Oral MET	T1: 115 T2: 25 C: 111	12	Self-report	(26)	Some concerns
UK RIOTT* (2005–2008)	**T1**: Supervised injectable HAT + oral MET **T2**: Supervised injectable MET + oral MET	Optimized oral MET	T1: 43 T2: 42 C: 42	6	Self-report	(27)	Some concerns
Belgian TADAM (2011–2013)	Supervised injectable or inhalable HAT[a] + oral MET	Oral MET	T: 36 C: 38	12	Self-report and official records	(28)	Some concerns
Canadian SALOME, stage 1 (2011–2013)	Supervised injectable HAT + oral MET	Supervised injectable hydromorphone + oral MET	T: 102 C: 100	6	Self-report	(29)	Low

NOTES: *Multi-site study. [a] Participants in the Belgian trial were offered a choice of supervised injectable or inhalable heroin, but only one participant in the experimental group chose injectable heroin. HAT=heroin-assisted treatment. MET = methadone. MI = motivational interviewing. Reference listed is for the study presenting primary findings of the trial. Other sources used to examine various outcomes are listed in Table S4. Stage 1 of the Canadian Study to Assess Longer-term Opioid Medication Effectiveness (SALOME) trial was a non-inferiority trial comparing the effectiveness of supervised injectable hydromorphone to supervised injectable heroin; we present HAT as the intervention condition and hydromorphone as the control condition for greater consistency with the other trials. We did not identify results for our primary outcome for stage 2 of SALOME (oral versions of both medications), and thus we present results for all outcomes for only stage 1 of the trial.

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Table 2. Details of Treatment and Control Conditions in Heroin-Assisted Treatment RCTs

Trial (Source)	HAT intervention dosage		Control dosage	
	Heroin dose/day	**Oral methadone dose/day**	**Hydromorphone dose/day**	**Oral methadone dose/day**
Early UK (21)	Average: 60 mg Range: 30-120 mg	Unspecified		Average: 60 mg Range: 10-120 mg
Swiss trial (22)	Average: 509 mg Quartiles: (400, 480, 630 mg)	Unspecified		Unspecified
Dutch trials (31, 32)	Average: 444.1 mg 95% CI: 357.4-530.7 mg Max imposed: 1000 mg	Average: 58.3 mg 95% CI: 46.5-70.1 mg Max imposed: 150 mg		Average: 59.9 mg 95% CI: 55.2-64.5 mg Max imposed: 150 mg
Spain PEPSA (24)	Average: 274.5 mg Range: 15-600mg	Average: 42.6 mg Range: 18-124 mg		Average: 105 mg Range: 40-180mg
German study (25, 33, 34)	Average: 442 mg Max imposed: 1000 mg	Average (days received): 39 mg Average (all HAT days): 8 mg Max imposed: 60 mg		Average: 99 mg Min imposed: 60 mg
Canada NAOMI (26)	Average (no MET): 392.3 mg Average (w/ MET): 365.5 mg Max imposed: 1000 mg	Average: 34.0 mg		Average: 96.0 mg
UK RIOTT (27)	Average: 398.9 mg SD: 163.6 mg Max imposed: 900 mg	Average: 41.8 mg SD: 12.7 mg		Average: 107.3 mg SD: 39.9 mg Doses >100 mg generally encouraged
Belgian TADAM (28, 35)	Average: 573 mg Visits per day: 2.3 Max imposed: 1000 mg	Average: 20 mg		Average: 77 mg
Canada SALOME (29, 36)	Average: 506.4 mg Visits per day: 2.5 Max imposed: 1000 mg	Average (days received): 23.64 mg	Average: 261.2 mg Visits per day: 2.3 Max imposed: 500 mg	Average (days received): 24.58 mg

NOTES: CI = confidence interval. HAT = heroin-assisted treatment. MET = methadone. SD = standard deviation. Other services offered as part of the interventions are described in Table S6.

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Table 3. Comparison of Heroin-Assisted Treatment to Control Treatment Condition among Included Studies,
Findings for Overall Criminal Offenses

Experimental v Control			Experimental		Control		Findings (Experimental v. Control)	
Study	**Conditions**	**Illegal Activities Measure**	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**
		Dichotomous measures					**OR [95% CI]**	**OR [95% CI]**
Early UK	UIjH v OMT	Any arrest, past year	NR	22 / 42	NR	33 / 46	NR	0.43 [0.18, 1.05]
Swiss	SIjH v Other	Charged, past 6 months	20 / 27	5 / 27	7 / 21	12 / 21	5.71 [1.64, 19.96]	0.17 [0.05, 0.63]
German	SIjH v OMT	Self-reported criminal activity, past year	406 / 515	234 / 515	396 / 500	314 / 500	0.98 [0.72, 1.32]	0.49 [0.38, 0.63]
German	SIjH v OMT	Police-recorded criminal activity, past year	224 / 419	173 / 419	206 / 406	209 / 406	1.11 [0.85, 1.47]	0.66 [0.50, 0.87]
German	SIjH v OMT	Any imprisonment, past year	126 / 515	71 / 515	69 / 500	118 / 500	2.02 [1.46, 2.80]	0.52 [0.37, 0.72]
NAOMI	SIjH v OMT	Failure to achieve 20%+ reduction in self-reported illegal activity (non-drug) & <10% deterioration in other scores	NA	64 / 115	NA	73 / 111	NA	0.65 [0.38, 1.12]
UK RIOTT[a]	SIjH v OMT	Any self-reported crime, past month	30 / 43	12 / 42	23 / 42	9 / 38	NA	1.10 [0.39, 3.11][b]
Belgian	SInInjH v OMT	6+ acts committed or experienced as a victim, past month	NR	NR	NR	NR	NR	NS
		Continuous measures					**Mean Diff. [95% CI]**	**Mean Diff. [95% CI]**
Dutch	SIjH v OMT	Average days illicit activities, past month	12.9	2.9	11.5	8.7	NR	–5.81 [–8.68, –2.94]
Spanish	SIjH v OMT	Average days per month illegal activities	11.5	0.6	8.0	4.1	3.5 [–3.21, 10.21]	–3.5 [–7.06, 0.06]
NAOMI	SIjH v OMT	Illegal activities ASI subscale score	0.37	0.20	0.35	0.18	NA	–0.03 [–0.08, 0.02][b]
UK RIOTT[a]	SIjH v OMT	Average number of crimes	57.7	18.7	36.9	7.0	20.8 [–15.0, 47.7]	11.7 [–7.1, 23.6]
Belgian	SInIjH v OMT	Average days criminal involvement or victimization, past month	9	1	8	6	NR	NS
Dutch	SInH v OMT	Average days illicit activities, past month	11.4	3.6	11.2	7.8	NR	–4.27 [–6.62, –1.92]
SALOME	SIjH v SIjHY	Average days illicit activities, past month	15.5	3.5	12.8	4.1	NA	–1.0 [–3.1, 1.0][b]

NOTES: OR = odds ratio. CI = confidence interval. NR = not reported. NA = not applicable. NS = not significantly different. UIjH = Unsupervised injectable heroin. OMT = oral methadone treatment. SIjH = Supervised injectable heroin. SInIjH = Supervised inhalable or injectable heroin, although only one participant in this condition chose injectable heroin. SInH = Supervised Inhalable heroin. SIjHY = Supervised injectable hydromorphone. ASI = addiction severity index. [a]The crime outcome tables reported in Metrebian et al. (37) do not agree with the text and seem to have reversed the baseline and follow-up columns; we report baseline and follow-up outcomes based on the discussion in the text. [b]Estimates based on adjusted models conducted by trial authors.

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Table 4. Comparison of Heroin-Assisted Treatment to Control Treatment Condition among Included Studies, Findings for Specific Criminal Offenses

Crime Type		Experimental		Control		Findings (Experimental v. Control)	
Trial	**Criminal activity measure**	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**
Drug-Related Crimes							
Swiss	Drug use/possession, charged: Self-report	11 / 27	3 / 27	2 / 21	8 / 21	6.53 [1.26, 33.90]	0.20 [0.05, 0.90]
Swiss	Drug dealing, charged: Self-report	7 / 27	0 / 27	1 / 21	2 / 21	7.00 [0.79, 62.24]	0.14 [0.01, 3.08]
Spanish	Sold drugs: Self-report	8 / 27	2 / 27	7 / 23	4 / 23	0.96 [0.29, 3.24]	0.38 [0.06, 2.30]
German	Drug offense: Self-report	342 / 515	171 / 515	328 / 500	238 / 500	1.04 [0.80, 1.34]	0.55 [0.43, 0.71]
German	Drug offense: Police-reported	162 / 419	122 / 419	143 / 406	147 / 406	1.16 [0.87, 1.54]	0.72 [0.54, 0.97]
UK RIOTT[a]	Drug dealing: Self-report	10 / 43	2 / 42	8 / 42	2 / 38	1.14 [0.40, 3.26]	0.90 [0.12, 6.72]
Belgian	Drug dealing: Self-report	NR	NR	NR	NR	NR	NS
Dutch trials[b]	Drug offenses: Mean (SD) arrests w/ prosecution per 100 participants	NR	19 (30)	NR	73 (485)	NR	–54 [–253, 145]
Property-Related Crimes							
Swiss	Property/theft, charged: Self-report	7 / 27	1 / 27	2 / 21	5 / 21	3.33 [0.61, 18.06]	0.12 [0.01, 1.15][c]
German	Property crime: Self-report	208 / 515	119 / 515	223 / 500	181 / 500	0.84 [0.66, 1.08]	0.53 [0.40, 0.70]
German	Property crime: Police-reported	134 / 419	96 / 419	116 / 406	125 / 406	1.18 [0.87, 1.58]	0.67 [0.49, 0.91]
UK RIOTT[a]	Theft from shop: Self-report	24 / 43	7 / 42	12 / 42	5 / 38	3.16 [1.28, 7.77]	1.32 [0.38, 4.57]
UK RIOTT[a]	Sold stolen goods: Self-report	11 / 43	1 / 42	11 / 42	1 / 38	0.97 [0.37, 2.56]	0.90 [0.05, 14.95]
UK RIOTT[a]	Bought stolen goods: Self-report	8 / 43	4 / 42	11 / 42	2 / 38	0.64 [0.23, 1.81]	1.89 [0.33, 10.99]
Belgian	Theft: Self-report	NR	NR	NR	NR	NR	NS
Dutch trials[b]	Property crime: Average (SD) number of days self-reported crime	NR	10.3 (34.8)	NR	37.5 (78.6)	NR	–27 [–62, 7.50]
Dutch trials[b]	Property crime: Mean (SD) arrests w/ prosecution per 100 participants	NR	37 (134)	NR	65 (207)	NR	–28 [–127, 70.5]
Violent Crimes							
Swiss	Aggression, charged: Self-report	3 / 27	1 / 27	1 / 21	1 / 21	2.50 [0.24, 25.95]	0.77 [0.05, 13.07]
German	Violent crime: Self-report	92 / 515	53 / 515	100 / 500	70 / 500	0.87 [0.64, 1.19]	0.70 [0.48, 1.03]
German	Violent crime: Police-reported	36 / 419	28 / 419	31 / 406	35 / 406	1.14 [0.69, 1.88]	0.76 [0.45, 1.27]
UK RIOTT[a]	Force or physical threat: Self-report	0 / 43	1 / 42	0 / 42	0 / 38	NE	2.78 [0.11, 70.32]
Belgian	Assault: Self-report	NR	NR	NR	NR	NR	NS
Dutch trials[b]	Violent crime: Mean (SD) arrests w/ prosecution per 100 participants	NR	2 (16)	NR	16 (82)	NR	–14 [–48.1, 20.1]

NOTES: NR = not reported. NS = not significantly different. NE = not estimable. SD= standard deviation. [a]The tables reported in Metrebian et al. (37) do not agree with the text and seem to have reversed baseline and follow-up columns; we report baseline and follow-up outcomes based on the discussion in the text. [b]The Dutch trials reported on crimes occurring during the course of the trial. [c]While the odds ratio at follow-up was not significant, the study's test of the homogeneity of McNemar's odds ratio to compare groups yielded a significant difference (p=0.015).

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Table 5. Comparison of Heroin-Assisted Treatment to Control Treatment Condition among Included Studies, Findings for Illicit Opiate Use

			Experimental		Control		Findings (Experimental v. Control)	
Trial	**Study conditions**	**Illicit opiate use measure**	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**	**Baseline**	**Follow-up**
		Dichotomous measures					**OR [95% CI]**	**OR [95% CI]**
Early UK	UIjH v OMT	Less than (near) daily use illicit opiates, past month	0 / 42	15 / 42	0 / 46	19 / 46	NA	0.79 [0.33, 1.87]
Swiss	SIjH v Other	Less than daily use street heroin, past month	0 / 27	26 / 27	2 / 21	11 / 21	0.14 [0.01, 3.08]	23.64 [2.69, 207.7]
German	SIjH v OMT	>50% negative specimens for street heroin and no increase in cocaine use, past month	NA	356 / 515	NA	276 / 500	NA	1.85 [1.43, 2.40][a]
UK RIOTT	SIjH v OMT	>50% negative specimens street heroin, past 12 weeks	NA	28 / 43	NA	8 / 42	NA	8.17 [2.88, 23.16][a]
NAOMI	SIjH v OMT	Abstinent from street heroin, past month	NA	61 / 115	NA	32 / 111	NA	2.79 [1.61, 4.84]
UK RIOTT	SIjH v OMT	Abstinent from street heroin, past month	NA	22 / 43	NA	7 / 42	NA	6.32 [2.09, 19.18][a]
UK RIOTT	SIjH v OMT	Zero positive specimens street heroin, past 12 weeks	NA	5 / 43	NA	1 / 42	NA	7.53 [2.00, 28.31][a]
		Continuous measures					**Mean Diff. [95% CI]**	**Mean Diff. [95% CI]**
Dutch	SIjH v OMT	Average days illicit heroin use, past month	NR	NR	NR	NR	NR	–13.0 [–16.3, –9.6]
NAOMI	SIjH v OMT	Average days illicit heroin use, past month	26.6	5.3	27.4	12.0	–0.8 [–2.5, 5.8]	–6.7 [–10.95, –2.45]
Spanish	SIjH v OMT	Average days street heroin use, past month	24.5	8.3	23.3	16.9	1.2 [–4.8, 10.9]	–8.6 [–14.9, 32.4][b]
Belgian	SInIjH v OMT	Average days illicit heroin use, past month	27	8	28	16	–1.0 [–3.3, 7.6]	–8.0 [–13.07, –2.93]
Dutch	SInH v OMT	Average days illicit heroin use, past month	NR	NR	NR	NR	NR	–13.9 [–16.6, –11.2]
SALOME	SIjH v SIjHY	Average days street heroin use, past month	25.6	3.1	25.2	5.5	NA	–2.3 [–4.1, –0.5][a]
SALOME	SIjH v SIjHY	Average days street opioid use, past month	28.6	4.9	27.3	5.7	NA	–0.9 [–3.4, 1.7][a]

NOTES: OR = odds ratio. CI = confidence interval. HAT = heroin-assisted treatment. NR = not reported. NA = not applicable. UIjH = Unsupervised injectable heroin. OMT = oral methadone treatment. SIjH = Supervised injectable heroin. SIjHY = Supervised injectable hydromorphone. SInIjH = Supervised inhalable or injectable heroin, although only one participant in this condition chose injectable heroin. SInH = Supervised inhalable heroin. [a]Estimates from adjusted models conducted by the trial study authors. [b]While the mean difference at follow-up is not significant, the study's Mann-Whitney test for the mean ratio of differences identified a significant difference (mean ratio = 2.36, p=0.020).

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Table 6. Summary Table of Trial Results, by Study Conditions and Outcome

		Crime	Heroin use	Drug expenditures	Labor market problems	Time in drug scene	Social functioning problems
Unsupervised injectable HAT							
Early UK	HAT	↓*	↓*	NR	↑	NR	(0)
	OMT	↓*	↓*	NR	↑	NR	(0)
	HAT v OMT	↓	↓	NR	↑	↑[a]	(0)
Supervised injectable HAT							
Swiss	HAT	↓*	↓*	↓*	↓	↓	↓*
	Other	↑	↓*	↓	↑	↓	↓
	HAT v Other	↓*	↓*	↓*	↓	↓	↓
Spanish	HAT	↓*	↓*	NR[b]	NR[c]	↓*	↓*
	OMT	↓*	↓*	NR[b]	NR[c]	↓	↓*
	HAT v OMT	↓	↓*	NR[b]	NR[c]	↓*	↑
Dutch	HAT	↓	NR[b]	NR[b]	NR[d]	↓	NR[e]
	OMT	↓	NR[b]	NR[b]	NR[d]	↓	NR[e]
	HAT v OMT	↓*	↓*	NR[b]	NR[d]	↓	NR[e]
German	HAT	↓*	↓*	NR[b]	↓	↓	↓
	OMT	↓*	↓*	NR[b]	↓	↓	↓
	HAT v OMT	↓*	↓*	NR[b]	↑	↓	↓
Canadian NAOMI	HAT	↓*	↓*	↓*	↓	NR[d]	↓*
	OMT	↓*	↓*	↓*	↓	NR[d]	↓
	HAT v OMT	↓	↓*	↓	↑	NR[d]	↓*
UK RIOTT	HAT	↓*	↓*	↓*	NR[c]	NR[c]	↓
	OMT	↓*	↓*	↓*	NR[c]	NR[c]	↓
	HAT v OMT	↑	↓*	↓*	NR[c]	NR[c]	↑
Canadian SALOME	HAT	↓	↓*	NR	(0)	NR	NR[f]
	HYD	↓	↓	NR	(0)	NR	NR[f]
	HAT v HYD	↓	↓*	NR	(0)	NR	NR[f]
Supervised inhalable HAT[g]							
Dutch	HAT	↓	NR[b]	NR[b]	NR[d]	↓	NR[e]
	OMT	↓	NR[b]	NR[b]	NR[d]	↓	NR[e]
	HAT v OMT	↓*	↓*	NR[b]	NR[d]	↓	NR[e]
Belgian	HAT	↓*	↓*	NR[b]	NR	NR	NR
	OMT	↓*	↓*	NR[b]	NR	NR	NR
	HAT v OMT	↓	↓*	NR[b]	NR	NR	NR

NOTES: Arrows represent whether studies found decreases or increases for a given outcome (within-condition), or the relative effects for HAT versus control condition (e.g., HAT v OMT). Stars (*) indicate significance in changes from baseline to follow-up (within-condition) or differences between conditions (HAT v. Control) at the p=0.05 level; (0) indicates that the study reported no significant changes or differences, but insufficient information was provided on directionality. NR = not reported. HAT = heroin-assisted treatment. OMT = oral methadone treatment only. HYD = injectable hydromorphone
[a]Significant difference based on Chi-squared test of the categorical measure, but effect estimate for the categorical outcome variable cannot be assigned directionality; re-specifying the outcome measure as dichotomous yields effects in favor of OMT but not significantly different across groups. [b]Included in ASI drug/alcohol use composite measure (or broader treatment response index in the case of the Dutch trials), but not evaluated separately. [c]Included in Opiate Treatment Index social functioning composite measure but not evaluated separately. [d]Included in ASI social functioning composite measure but not evaluated separately. [e]Social functioning was included as a broader treatment response index. [f]Trends over the trial for some measures (e.g., housing instability) reported for both groups combined but not separately by intervention condition. [g]As noted previously, the Belgian trial offer participants supervised inhalable or injectable heroin in the HAT condition, but only one participant in this condition chose injectable heroin.

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