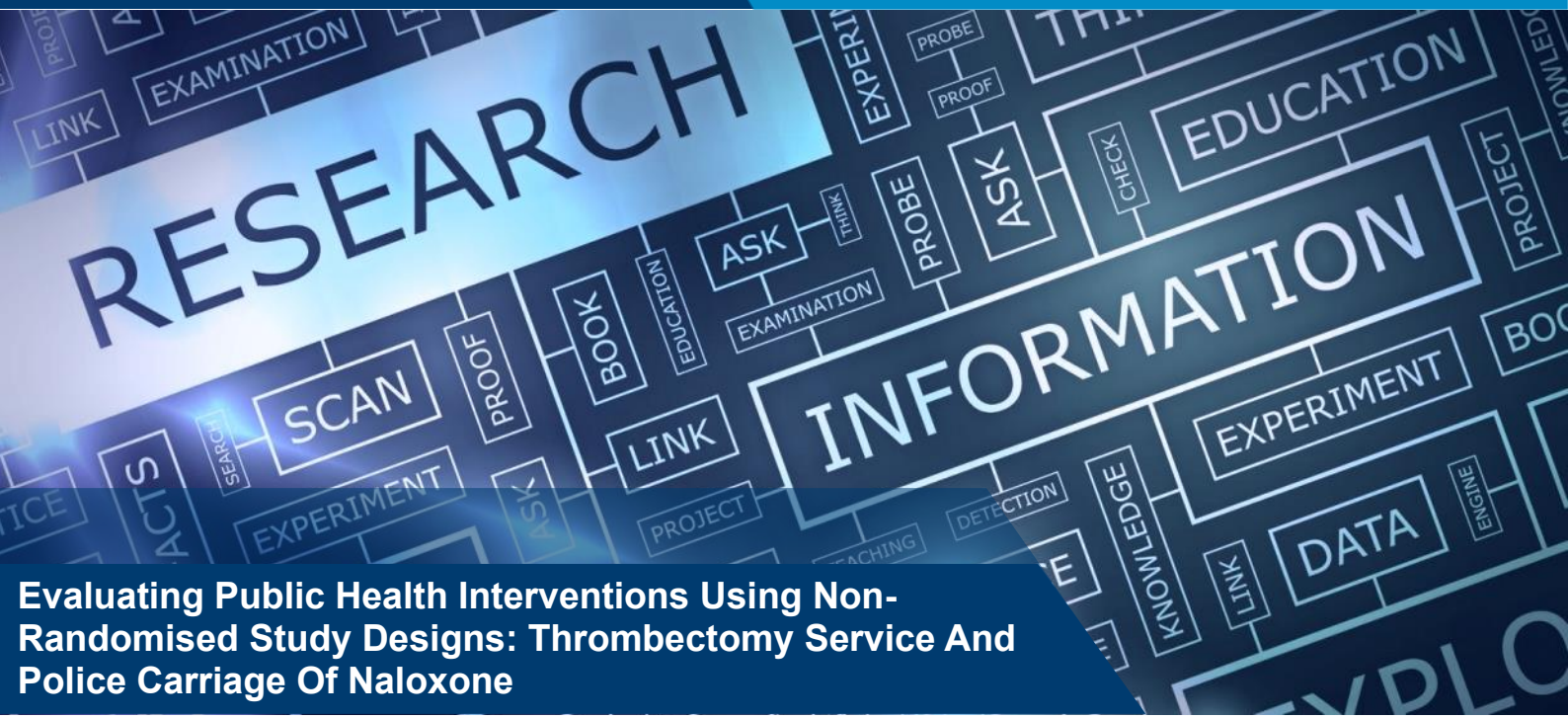

Evaluating Public Health Interventions Using Non-Randomised Study Designs: Thrombectomy Service And Police Carriage Of Naloxone

AIMS

This study aims to evaluate public health interventions recently undertaken in Scotland using study designs based on observational data. Evaluations based on observational data differ from lab experiments, where there is an isolation of control and treated subjects, and are more prone to confounders (elements that affect the robustness of the analysis). Therefore, an additional aim was to assess and test the most appropriate statistical approaches to improve methodologies for evaluations based on observational data. Specifically, the aims were to evaluate:

- Two recent public health interventions,
  a. police equipped with drugs to treat people experiencing an overdose (started in 2022)
  b. national thrombectomy service (started in 2020)
- Methods to evaluate observational studies, with a specific focus on controlled interrupted time series designs (CITS), one of the most widely used approaches in the evaluation of public health interventions.

KEY FINDINGS

- Police-carried naloxone (a drug reversing near fatal opiate overdoses) was associated with a decrease in drug-related deaths in all piloted areas. We found that its impact varied widely across areas. Tayside, the region with the most reliable data, showed a 18% decrease in the incidence in drug-related deaths after policy implementation.
- Thrombectomy –a procedure to pull out blood clots for stroke patients- was rolled out in Scotland from 2020. Until 2024, approximately 400 patients received it in Scotland, representing less than 2% of the total number of people who had a stroke. The small numbers limited our ability to evaluate whether thrombectomy treatment in Scotland improves patient outcomes.
- Having a suitable control group when evaluating a new public health intervention helps us be confident that any effect is truly due to the intervention and not some other factor. However, there are various ways in how a control group can be accounted for in statistical analyses and, using computer simulations, we have identified an approach which works consistently well.

WHAT DID THE STUDY INVOLVE?

Observational non-randomised study evaluating whether levels of drug-related deaths are associated with the police carriage and administration of Naloxone. Using drug-related deaths data we first analysed data descriptively and then we built statistical models to assess whether, after the policy implementation, the three police areas which initially piloted the policy (Glasgow, Falkirk and Tayside), had an associated variation in Opioid Induced Deaths (OIDs). We assessed the effect in the three pilot areas that used the policy with remaining areas in Scotland as a control group. We sought police involvement and held several meetings to discuss the results. Their perspectives on policy uptake and the utility of the findings for their practice were subsequently integrated into our project.

Assessing the feasibility of analysing thrombectomy service rollout in Scotland as a non-randomised study. The small number of procedures conducted in Scotland compared to early expectations did not allow for a complete thorough evaluation. However, we were able to do some initial analyses and they showed encouraging findings. We are exploring options to continue this research as the thrombectomy numbers further increase.

Computer simulation study on how best to include controls in interrupted time series (a common non-randomised study design). We compared the statistical performance of a range of options on how to handle CITS study design across different scenarios, challengin which can theoretically impact methods' performance. The design of the simulation study was informed by the 'police carriage of naloxone' case study. We had conversations with other researchers in the field to discuss results and investigate the usefulness of our research, we embedded their perspective into our study development.

WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

1. **Non-randomised study to evaluate whether opioid-related deaths are associated with the police carriage and administration of Naloxone.**

   Our statistical models showed that in Glasgow the policy was associated with a decrease in incidence in rate of OIDs -2.2% (95% CI: -13%, +7%). For Falkirk, despite a statistically significant decrease (-25%), we have concerns that the result is not reliable due to a smaller sample. Tayside, which had the most robust data, had a statistically significant decrease in OIDs (point estimate in absolute values: -13, 95% CI:-18, -8) in the follow up period (15 months). Tayside figures suggest nearly 30% of incidents with naloxone administration could have saved lives. However, the findings of the implementation in Tayside and Glasgow which are areas with highest incidence of OID in Scotland, mean that 'regression to the mean' could be occurring and further research is required to strengthen the causal claims and generalisation of the findings.

2. **Assessing the feasibility of analysing thrombectomy service rollout in Scotland as a non-randomised study.**

   Scotland's thrombectomy procedures are delivered in three main hospitals. By the end of 2024, all hospitals offered a daytime weekday service to patients presenting to the thrombectomy hospitals or hospitals local to them. This expansion has been slower than initially planned, and between 2020 and 2024 thrombectomies represented less than 2% of all patients who were eligible for the treatment. Evidence suggests approximately 10% could benefit. Assessing the reasons of this low expansion was out of the scope of our study. We tested our method to evaluate this with a non-randomised study design, using an instrumental variable associated with the likelihood of getting the treatment but not with the final health outcome we wanted to study. In our case, the instrument was a proxy of the proximity of the patient location with a hospital providing (or referring to a hub providing) thrombectomy. We tested and confirmed that our instrument respected all the assumptions we could test with the data. However, to deliver the analysis we would require a higher sample size. Our findings offer a method to evaluate the thrombectomy service; however, further expansion of the service is needed for robust evidence to be gained.

3. **Computer simulation study on how best to include controls in interrupted time series.**

   Using the difference between intervention and control series in an CITS study was the most powerful way to integrate a control group. Adding time ‘splines’ of time as a covariate (a variable allowing to connecting data-points trough curves rather than with linear segments) can reduce bias from unmet assumptions (e.g., parallel trends), even when these are untestable, without harming validity if assumptions are met. As CITS studies are common in public health but there is a lack of guidance on how to implement control studies, such findings can inform methods in future research using real world data.

WHAT IMPACT COULD THE FINDINGS HAVE?

The impact these findings could have are: 1. Police Carriage of naloxone demonstrated the potential for saving lives; while its effect was definitively non-negative (it did not increase OID), its extent varied across intervention areas. Further research into the drivers of this variation would benefit

future evaluations. 2. Future expansion of Scotland's Thrombectomy service is required for generating robust real-world effectiveness evidence, as the current rollout, below initial expectations, precludes such impact. We showed that our proposed method has excellent potential to be used in future investigations of thrombectomy effectiveness in Scotland. In this regard, we also had a meeting with National Services Scotland to explore how the instrument could inform future planning. Furthermore, our study was referenced in the Scottish Stroke Improvement Plan as an exemplar of how Scottish Stroke Care Audit data (data collected by Public Health Scotland) can be used in research. 3. The insights into how to make CITS methods more flexible will enhance the design and evaluation of future non-randomised studies.

HOW WILL THE OUTCOMES BE DISSEMINATED?

- We plan to publish findings in leading addiction and statistical methodology/epidemiology or cardiovascular journals as well as to present findings at national and international conferences.
- We aim to develop further our partnership with Police Scotland and deliver findings of our research to them.
- Results will be also shared with people involved in steering group and other stakeholders; opportunities for workshops disseminating statistical and methodological findings are in the pipeline.

CONCLUSION

This evaluation confirms that equipping police with naloxone can reduce opioid-induced deaths. Furthermore, our study shows that geographic proximity is a powerful tool for measuring the real-world impact of thrombectomy services. Finally, the use of CITS with time-integrated splines ensures that even in non-randomized studies, we can produce reliable results necessary to inform public health policy.

RESEARCH TEAM & CONTACT

Prof Jim Lewsey, Prof Daniel Mackay, Prof Terence Quinn, Dr Francesco Manca

School of Health and Wellbeing, University of Glasgow

jim.lewsey@glasgow.ac.uk

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