Evidence Brief

UNIVERSITY OF Southampton

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Are nurses wasting their time on the road?

A number of health and social care services in the UK provide care to patients at home. Typically, this involves a team of staff, e.g. nurses or care workers, sharing the patients in a geographical region among themselves. However, dividing the workload in an efficient manner is a challenging task. Too much time spent travelling between patients diminishes the time available to care for them.

Automated planning using Operational Research methods can save both planning and travelling time. Researchers at the Universities of Southampton and Exeter are working to close the gap between these methods and the practicalities of home care planning. This Evidence Brief draws attention to the difficulty of finding the best route and schedule.

Planning home healthcare visits

Health and social care teams that work providing visits in patients' homes try to assign patients to staff members in a safe and efficient way. This planning needs to consider many practical constraints. For example, some injections need to be administered during a specific time of day and perhaps not all members of the team are trained to administer them. Likewise, some patients might require the presence of two staff members, who will need to synchronise their schedule to be there at the same time. Ultimately, good planning involves matching patients with the right carers, scheduling the visits at the right time of the day and creating routes that are relatively short, manageable, and balanced.

Companies have recently developed software to automate planning (like TPP's Autoplanner). A range of other industries also plan routes and schedules in a similar fashion, e.g. delivery companies or home technicians [1]. Nonetheless, small and medium teams in health and social care still often use one of their staff members to perform these allocations manually.

How many possible routes are there?

We have roughly described the problem planners face, but how difficult is it exactly? To answer this question, let us take a step back and consider a simple case, where one nurse needs to visit three patients, Andrew, Barbara and Claire. There are six options to choose from: Andrew first, then Barbara then Claire (A-B-C), B-A-C, B-C-A, A-C-B, C-A-B or C-B-A. An example of this is depicted in Figure 1.

The possible ways of ordering these three patients can be calculated as 3x2x1 = 6 ways and it is certainly manageable for a planner to compare these. However, if numbers start to grow, the number of possible routes can very quickly get out of hand. With 10 patients' homes, there are over 3 million possible routes (try doing 10x9x8x7x6x5x4x3x2x1 on a calculator), and with 14 patients, there are tens of billions of possible routes.

Luckily, there is no need to evaluate all those possibilities to pick the best. Thanks to advances in Combinatorial Optimisation and Operational Research, the shortest route to visit 14 patients can be found on a personal laptop in milliseconds using readily available software for the so-called Travelling Salesperson Problem [2]. Currently, computers are able to solve much larger problems. For example, researchers have been able to find the optimal (shortest possible) walking tour to visit all 49,687 pubs in the UK [3].

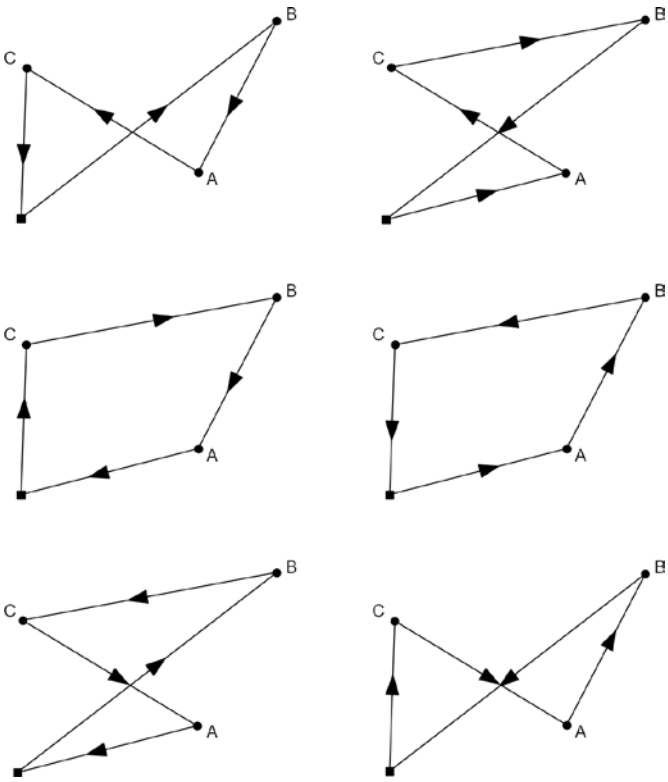

Figure 1 All six possible routes for a nurse starting from a given location (square) visiting patients Andrew (A), Barbara (B) and Claire (C).

Moving on to more realistic problems, if we have more than one nurse visiting patients, this can be dealt with in the same way as planning vehicle deliveries (the Vehicle Routing Problem, also studied by Operational Research methods). When we add more specific constraints such as nurse skills required for particular care tasks, time windows during which tasks need to be completed, “double-ups” (synchronised visits to a patient) or patient preferences, the problem is known as Home Health Care Routing and Scheduling Problem. In recent years, researchers have been studying this problem [4], [5] and have proposed a wealth of mathematical methods to solve it with varying degrees of detail, speed and accuracy.

The practical challenges

Deciding what makes a route “good” or even “optimal” is not straightforward. There are some measures that will be desirable: shorter driving times and distances, timely visits, continuity of care, a balanced workload across the team or respecting patients’/staff preferences. However, in practice, these measures are often at odds with each other. For example, shorter routes might imply that the most skilled nurses are overloaded, and a more balanced workload will come at the expense of less efficient travel. Deciding the relative importance of different criteria (multi-criteria optimisation) can help with this, but eventually all comes down to choosing one plan.

Other barriers to adoption of automated systems are data availability (access to a computerised database), the difficulty to obtain (freely) actual distances between addresses or the reliance on commercial (and expensive) software for the most advanced methods. While good open-source solutions for solving Vehicle Routing Problems exist [6]–[8], these are rarely out-of-the-box software that can readily work for this more complicated problem, let alone be integrated easily with existing working practices in health and social care teams.

What does the future hold?

While every team is different and might have different planning approaches, there is evidence that there are large efficiency (and financial) gains that can be achieved by using automated planning systems for home health care [9]. Further, using automated software to help human planners might save valuable planning time, which is often undertaken by trained care professionals, rather than trained planners. Some researchers, including the authors [10], are looking at narrowing the gap between increasingly sophisticated academic methods and the realities of day-to-day home care planning. This kind of research, paired with the flourishing of open-source software and increased digitalisation of health records, are signs that in the near future most teams might have access to automated planning software.

Conclusions

Home visits pose a complicated planning challenge to health and social care delivery teams. This challenge is not only difficult to solve, but also to formulate correctly and to implement in practice. Academic research has recently turned towards solving this problem and making care delivery more efficient, however a significant gap between theory and practice remains.

Key points:

• Operational Research provides the right tools to solve problems that appear in home health care planning

• Limited uptake of these methods might be resulting in poorly optimised staff time

• Freely available routing tools exist, but there are practical challenges preventing teams from using them.

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References

1. T. Vidal et al., A concise guide to existing and emerging vehicle routing problem variants, Eur. J. Oper. Res., vol. 286, no. 2, pp. 401–416, 2020, doi: 10.1016/j.ejor.2019.10.010

2. D. L. Applegate et al., Concorde TSP solver. http://www.math.uwaterloo.ca/tsp/concorde

3. W. Cook et al., UK49687 - Shortest possible tour to nearly every pub in the United Kingdom, 2018, http://www.math.uwaterloo.ca/tsp/uk

4. C. Fikar et al., Home Health Care Routing and Scheduling: A Review, Comput. Oper. Res., vol. 77, pp. 86–95, Jan. 2016, doi: 10.1016/j.cor.2016.07.019

5. M. Cissé et al., OR problems related to Home Health Care: A review of relevant routing and scheduling problems, Operations Research for Health Care, vol. 13–14, Elsevier, pp. 1–22, Jun. 01, 2017, doi: 10.1016/j.orhc.2017.06.001

6. G. Erdoğan, An open source Spreadsheet Solver for Vehicle Routing Problems, Comput. Oper. Res., vol. 84, pp. 62–72, Aug. 2017, doi: 10.1016/J.COR.2017.02.022

7. L. Perron et al., OR-Tools. [Online]. Available: https://developers.google.com/optimization/

8. T. Monks, Julia for healthcare modelling and data science, 2020, https://www.juliahealthcare.org/routing_methods

9. P. Eveborn et al., Operations research improves quality and efficiency in home care, Interfaces (Providence), vol. 39, no. 1, pp. 18–34, 2009, doi: 10.1287/inte.1080.0411

10. C. Lamas-Fernandez et al., ARC research project ‘Improving community health care logistics using Operational Research’ https://www.arc-wx.nihr.ac.uk/research-areas/workforce-and-health-systems/improving-community-health-care-planning/

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