PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Return on investment of a model of access combining triage with initial management: an economic analysis
AUTHORS	Snowdon, David; Harding, Katherine E.; Taylor, Nicholas; Leggat, Sandra; Kent, Bridie; Lewis, Annie; Watts, Jennifer

VERSION 1 – REVIEW

REVIEWER	Liu, Yu Emory University, Health Policy and Management
REVIEW RETURNED	16-Nov-2020

GENERAL COMMENTS	Thank you very much for giving me the opportunity to read this important and interesting manuscript. This work builds on an existing trial of STAT and it is very important to understand how to reduce the wait time for a health system by a “process redesign”. The core mechanism of the STAT is to first clear the backlog of current waiting list, and then implement a new “demand-supply” mechanism to require physicians to schedule appointments for new patients in order to reduce potential waiting time for new patients. It is a great pleasure to read this manuscript and I would love to share a few suggestions and a few questions for the authors to consider. (1) One of the main outcomes of this work is: by implementing the new STAT mechanism, the wait time for new patients can be reduced by 16.9 days for the first time appointment, e.g., new patients. I am wondering does the study have any evidence or outcome for the exiting patients’ wait time and associated cost? In other words, does the improvement of reduced new patients’ wait time at the expense of existing patients’ longer wait time? If yes, can the author quantify such cost? In addition, for the participants of STAT who are “higher needs” defined by the traditional triage approach, how do their wait time and associated cost may differ in the two approaches? (2) The participants (the patients) are blind in the selection process. However, is it possible that the authors may describe more about how the “8 community centers” and the services for the trial were selected? Whether these centers were randomly selected? How do the physicians and healthcare workers comply with the new process? I understand that such information may be available in their previous published work. A little more details in this manuscript may help further understand whether such process redesign mechanism may be generalized to other places, and may last for long periods of time. Once again, thank you very much for inviting me to read this interesting paper. This paper provides significant insights and new thoughts of how to reduce waiting time for new patients by “process

	re-design", and whether this strategy may be cost-effective. I look forward to reading the revised version and learning more from the authors.

REVIEWER	Karnon, Jonathan Flinders University, CMPH
REVIEW RETURNED	15-Feb-2021

GENERAL COMMENTS	This is an interesting study reporting on an important topic. I do feel that the authors have a perhaps overly positive interpretation of the study results, as indicated by the following: "AQOL utility score increased by 0.03 (p=0.066) between after STAT implementation" – "the AQOL-8D was administered on the day of the first outpatient appointment" – and so cannot be used as a measure of outcome? If anything, it indicates that the STAT population were healthier and so would be expected to have lower costs. As prioritisation was used in the pre-STAT period, the patients seen in the pre-STAT period would include a higher proportion of higher priority patients. The collected and presented variables in Table 2 are not sufficient to pick up differences in priority and the potential imbalance in patient populations is a weakness of the study. In addition, the study has only partially assessed the intervention – it has not assessed the potential adverse effects of "scaled back or ceased" triage processes and the cited reduction in repeat or review appointments. Given the "scaled back or ceased" triage processes, it would be interesting to compare the distributions of waiting times – did some patients wait longer (i.e. the patients who were previously prioritized)? More minor comments: "it is common for waiting lists to be stable over time, suggesting that supply and demand may be balanced but with the response to new referrals months behind.[15]" Can the authors clarify this statement – which seems to be in contradiction to the statement that "temporary increases in supply only resolve the issue in the short term". A health service utilisation questionnaire was used to collect data about the 3 months prior to first appointment. Health service utilisation data in the 3 months after the first appointment were obtained from medical records. Did you compare data from medical records for the prior 3 months with reported data? "Cost of emergency department presentations were based on the price for non-admitted triage category 4" Why was cat 4 assumed? Did you consider requesting hospital administrative data to provide more precise estimates? "The cost of a hospital admission was calculated at a per diem rate, by dividing the average total cost of admission by the average length of stay" How was the average total cost of admission and average length of stay estimated? This is an imprecise approach as we know costs are skewed. Did you consider requesting hospital administrative data to provide more precise estimates? I think it may be useful to present an additional outcome as the number of new patients seen over defined time periods (i.e. 3 months in the base case), and the ICER as the incremental cost per additional patient seen. Was demand accurately predicted across all study clinics?

VERSION 1 – AUTHOR RESPONSE

Reviewer 1:
Comment 1: One of the main outcomes of this work is: by implementing the new STAT mechanism, the wait time for new patients can be reduced by 16.9 days for the first time appointment, e.g., new patients. I am wondering does the study have any evidence or outcome for the existing patients' wait time and associated cost? In other words, does the improvement of reduced new patients' wait time at the expense of existing patients' longer wait time? If yes, can the author quantify such cost?

Response: There is no evidence from the findings of the stepped wedge trial that waiting time reductions achieved in the STAT model are at the expense of delays in other parts of the system. There were no differences in time from 1st to 2nd appointment, and the number of appointments delivered per patient and rate of discharge at 12 weeks were similar between groups. In addition, the time period over which data were collected (20 months) suggest that positive results were unlikely at the expense of existing patients. Given the average length of stay relative to the time period of data collection we suggest the results are applicable across the services investigated.

Short term strategies to reduce the existing wait list (reported on page 9) were conducted over a 3-month period at each service. One of the aims of this intervention was to reduce the backlog of patients waiting for the service (i.e. the existing waiting list). Any patients that were on the 'wait list' following this period were included as part of the STAT group (i.e. provided with the next available appointment). This also ensured that reductions in new patients' waiting time were not at the expense of existing patients' waiting time. We have modified the text on page 10, line 43 to reflect this as follows:
'Short term strategies to reduce the existing waiting list: Participating services were provided with small injection of resources to assist with reducing backlog. Services were permitted to use these resources in whatever way they deemed most effective (e.g. employing additional short-term staff, contracting work to private providers). These resources were provided in the short term only (i.e. 3-months) and no additional ongoing resources were provided. Existing patients who remained on the wait list following this short term reduction strategy, were assigned the next available appointment, consistent with the STAT model.'

Comment 2: In addition, for the participants of STAT who are "higher needs" defined by the traditional triage approach, how do their wait time and associated cost may differ in the two approaches?

Response: The results from our main trial showed that it was likely that the 'lowest priority' patients, who waited longest for an appointment, benefited most from the STAT model (Harding 2018). Therefore, it is possible that patients with clinician perceived 'higher needs' may have received little benefit from STAT or even waited longer for an outpatient appointment. However, in many cases it is unclear what a patient with 'higher' needs is, as there is low agreement (28%) between clinicians on what constitutes 'high' clinical need (Harding 2010). Furthermore, agreement isn't necessarily improved with training, indicating that there is a degree of subjectivity in prioritising patients based on their clinical need (Harding 2011).

However, we acknowledge that some of the patients who are identified as the highest priority by clinicians will require immediate healthcare. To accommodate this, most services introduced systems for 'emergency' appointments that patients with an immediate clinical need could be allocated. This ensured that the services could prioritise patients who would otherwise deteriorate if not seen within a short time period. We have included this information in the manuscript on page 11, line 12:
'Required appointments protected: The appointments required to keep up with demand were

protected in clinician schedules. New patients were allocated to these appointments immediately after referral in order of arrival. Triage processes were scaled back or ceased and booking processes were simplified, although most services maintained systems for 'emergency' appointments to accommodate very urgent patients if required.'

Given the subjectivity of prioritising patients based on clinical need and the systems for emergency appointments that were incorporated as part of the STAT model, we think it is unlikely that clients with a true 'high' need for healthcare would have waited longer for an appointment as a result of the STAT model. In addition, results from our main trial indicate that there were no adverse effects on patient care or outcomes (Harding 2018). In the discussion section on page 24, line 15 we have acknowledged the limitations of the study including the identification of patients with 'higher' needs: 'Findings from the main STAT trial suggest that STAT was most likely to benefit patients who waited the longest for an appointment.[17] This means that those who waited the shortest to receive an appointment may have received little benefit from the STAT intervention. Weighted mean waiting time at the 10th percentile increased by 1.1 days with STAT, although this first appointment was still within 10 days of referral. A limitation of our study is that we were unable to determine the impact of STAT on patients who would be categorised as 'high' need by clinicians using a triage approach under a traditional waitlist model. However, the STAT model incorporated systems for emergency appointments for patients with immediate clinical needs, ensuring that those with 'high' clinical needs could immediately access the service and were not disadvantaged. Also, in our main trial, STAT had no detrimental effects on outpatient care or outcomes, with no increase in the number of unplanned hospital readmissions or decrease in the number of review appointments.[17] Therefore, it is unlikely that patients with a 'high' clinical need were disadvantaged by the STAT model.'

References:
Harding KE, Taylor NF, Leggat SG, Wise VL. (2010) Prioritizing patients for community rehabilitation services: do clinicians agree on triage decisions? Clinical Rehabilitation;24:928-934.

Harding KE, Taylor NF, Leggat SG, Wise VL. (2011) A training programme did not increase agreement between allied health clinicians prioritizing patients for community rehabilitation. Clinical Rehabilitation;25:599-606.

Harding KE, et al. (2018) A model of access combining triage with initial management reduced waiting time for community outpatient services: a stepped wedge cluster randomised controlled trial. BMC Medicine;16:182.

Comment 3: The participants (the patients) are blind in the selection process. However, is it possible that the authors may describe more about how the "8 community centers" and the services for the trial were selected? Whether these centers were randomly selected? How do the physicians and healthcare workers comply with the new process? I understand that such information may be available in their previous published work. A little more details in this manuscript may help further understand whether such process redesign mechanism may be generalized to other places, and may last for long periods of time.

Response: On page 9, line 41 we have provided further detail on the services and provided a reference to the main study (which contains more detail on the services):
'The eight services provided the following speciality clinical services: continence (n=2), movement disorders (n=1), developmental disorders (n=1), mixed (orthopaedics/neurological/general frailty) (n=4). They included a mixture of single discipline (n=3) and multi-disciplinary (n=5) services, and provided healthcare to paediatric (n=3), adult (n=4) and mixed (n=1) populations.[17]'

Also on page 9, line 27 we have explained how the services were selected:

‘The community outpatient sites each offered allied health, medical and/or nursing therapy services (most within multi-disciplinary teams); provided care over a series of appointments; prior to the implementation of STAT had used waiting lists with triage systems to manage demand; and had demonstrated stable waiting lists over the previous two years. Services meeting these criteria were selected from 28 community outpatient services within the network that participated in a preliminary study exploring perceptions of factors that affect waiting lists.[4]’

On page 23, line 22 we discuss the long term effects of the STAT model, including generalisability, return on investment, sustainability and possible issues with compliance with STAT processes across the different services:
‘Implementing STAT involves a one-off financial investment to reduce the waiting list, followed by the introduction of strategies to maintain patient flow at the rate of demand. Therefore, the return on investment of STAT should improve with time as more patients receive timely services. Our modelling showed that the cost per day of waiting saved reduced from $9 three months after STAT implementation to $4 if the benefits are maintained at 12 months. A 12-month follow-up evaluation to the main trial showed that these benefits are mostly maintained with a 29% reduction in waiting time attributable to STAT over 12 months, compared to 34% in the original trial.[37] However, results varied between services, possibly indicating that there were differences in compliance with STAT processes between services.[37] The original trial was not powered to explore the differences between sites and this could be addressed in future research.’

Reviewer 2:
Comment 1: I do feel that the authors have a perhaps overly positive interpretation of the study results, as indicated by the following:
“AQOL utility score increased by 0.03 (p=0.066) between after STAT implementation” – “the AQOL-8D was administered on the day of the first outpatient appointment” – and so cannot be used as a measure of outcome? If anything, it indicates that the STAT population were healthier and so would be expected to have lower costs. As prioritisation was used in the pre-STAT period, the patients seen in the pre-STAT period would include a higher proportion of higher priority patients. The collected and presented variables in Table 2 are not sufficient to pick up differences in priority and the potential imbalance in patient populations is a weakness of the study.

Response: We accept the point made by the reviewer that the observed differences in AQOL measured at the first assessment could indicate that the STAT group were healthier at time of admission to the service. If this were the case, then it is possible that this is a confounding variable impacting on the study outcomes. However:
1. The differences were very small (0.68 vs. 0.71) and not statistically significant (p=0.066), so we believe that it is unlikely that this would have had a substantial impact on the findings.
2. There was a wide variation in waiting time in the pre-intervention group, suggesting that this group included a mix of high priority patients who had been seen quickly, as well as lower priority patients who had endured long waiting periods prior to their first appointment.
3. In as much as the 0.03 observed difference might be considered meaningful, it is possible that patients in the STAT group were healthier at the time of admission because they had a shorter wait time for health service input. Systematic reviews have shown that patients experience significant declines in both physical and psychological health with longer wait times for health services (Lynch 2008; Lewis 2018). We have amended our interpretation of the AQOL utility scores on page 22, line 47 to include this point:

‘In our study participants in the STAT group were observed to have higher AQOL utility scores at admission to health service than participants in the traditional waitlist group; a difference of 0.03 units that approached but did not reach significance. If a genuine difference exists, one interpretation of this finding is that differences in the baseline characteristics of groups is a limitation of the study. An

alternative explanation is that observed reductions in health-related quality of life in participants in the traditional waitlist group were due to a deterioration in health status during the waiting period. Systematic reviews have demonstrated that patients experience significant declines in both physical and psychological health with longer wait times for health services.[12, 36] Clinicians identified that the main advantage of the STAT model was that patients could receive a healthcare intervention sooner which had positive impacts on their health outcomes.[33] Therefore, it is possible that patients in the STAT group may have been healthier at time of admission because they had a shorter wait time for health service input. Consequently, it is difficult to predict the directional relationship between utility scores and healthcare costs.'

References:
Lewis AK, Harding KE, Snowdon DA, Taylor NF. (2018) Reducing waiting time from referral to first visit for community outpatient services may contribute to better health outcomes: A systematic review. BMC Health Services Research;18:869.

Lynch ME, Campbell F, Clark AJ, et al. (2008) A systematic review of the effect of waiting for treatment for chronic pain. Pain;136(1-2):97-116..

Comment 2: In addition, the study has only partially assessed the intervention – it has not assessed the potential adverse effects of "scaled back or ceased" triage processes and the cited reduction in repeat or review appointments. Given the "scaled back or ceased" triage processes, it would be interesting to compare the distributions of waiting times – did some patients wait longer (i.e. the patients who were previously prioritized)?

Response: Because the STAT model does not involve prioritisation systems (based on clinician perceived patient clinical need) we are unable to identify those participants with 'higher needs' and this could be seen as a limitation of the study. However, systems were in place at most sites to accommodate very urgent patients (a very limited form of triaging). Additional text has been added to page 11, line 12 to make this clear:
'Required appointments protected: The appointments required to keep up with demand were protected in clinician schedules. New patients were allocated to these appointments immediately after referral in order of arrival. Triage processes were scaled back or ceased and booking processes were simplified, although most services maintained systems for 'emergency' appointments to accommodate very urgent patients if required.'

We have added further information in the results comparing those that waited the least amount of time (10th percentile) and those waiting the longest (90th percentile) with both STAT and traditional waitlist. These results show a 1.1 day difference in mean weighting time at the 10th percentile favouring traditional waitlist and a 46.1 day difference at the 90th percentile favouring STAT (page 19, line 34):
'Weighted mean waiting time for the participants in the 10th percentile (i.e. those that waited the least amount of time) was 1.1 days longer in the STAT group (10.0 days) compared to the traditional waitlist group (8.9 days). Weighted mean waiting time for participants in the 90th percentile (i.e. those that waited the most amount of time) was 46.1 days shorter in the STAT group (86.0 days compared with the traditional waitlist group (132.1 days).'

In addition, results from our main trial indicate that there were no adverse effects on patient care or outcomes (Harding 2018). We have added a paragraph to the discussion about the issue of the impact on patients with different priority needs. We discuss these points on page 24, line 15:
'Findings from the main STAT trial suggest that STAT was most likely to benefit patients who waited the longest for an appointment.[17] This means that those who waited the shortest to receive an appointment may have received little benefit from the STAT intervention. Weighted mean waiting time

at the 10th percentile increased by 1.1 days with STAT, although this first appointment was still within 10 days of referral. A limitation of our study is that we were unable to determine the impact of STAT on patients who would be categorised as 'high' need by clinicians using a triage approach under a traditional waitlist model. However, the STAT model incorporated systems for emergency appointments for patients with immediate clinical needs, ensuring that those with 'high' clinical needs could immediately access the service and were not disadvantaged. Also, in our main trial, STAT had no detrimental effects on outpatient care or outcomes, with no increase in the number of unplanned hospital readmissions or decrease in the number of review appointments.[17] Therefore, it is unlikely that patients with a 'high' clinical need were disadvantaged by the STAT model.'

References:
Harding KE, et al. (2018) A model of access combining triage with initial management reduced waiting time for community outpatient services: a stepped wedge cluster randomised controlled trial. BMC Medicine;16:182.

Comment 3: "it is common for waiting lists to be stable over time, suggesting that supply and demand may be balanced but with the response to new referrals months behind.[15]" Can the authors clarify this statement – which seems to be in contradiction to the statement that "temporary increases in supply only resolve the issue in the short term".

Response: Waiting lists are often stable over time, meaning that supply (staff availability to assess patients/capacity to provide a new appointment) can meet the demand (rate of incoming referrals) for the service. However, periods of service inefficiencies or temporary disruptions to supply can lead to the growth of a backlog that services are subsequently unable to address. Once supply and demand are again balanced, the entrenched backlog results in continuing long delays for all patients even though capacity is theoretically sufficient to meet demand.

Short term strategies to reduce backlogs often have only short-term effects; inevitably service inefficiencies, temporary disruptions to supply and a complacency associated with a relatively short waiting list means that waiting lists soon return if the underlying issues are not addressed. Eventually the service finds an equilibrium between supply and demand that accounts for the inefficient processes and maintains a waiting list that sits just below the limits of acceptability to service providers. We have clarified this on page 6, line 15:
'When this discrepancy is not addressed queues or waiting lists are formed.[8] Where waiting lists continue to grow, this is likely to indicate an ongoing imbalance between supply and demand. However, if there is a short term disruption to supply, a wait list might develop that becomes stable over time, suggesting that supply and demand may be balanced but with the response to new referrals always weeks or months behind.'

And on page 6, line 35:
'Two common approaches to managing waiting lists are short-term increases in supply to reduce the waiting list and implementation of triage and prioritisation systems to sort patients according to their urgency of care.[7, 14] Temporary increases in supply without ongoing changes to service delivery only resolve the issue in the short term; inefficient processes, lack of protected appointments for new patients and temporary disruptions to supply mean that waiting lists soon reappear.[7] Triage systems may ensure that urgent patients have access to care, but make limited difference to waiting times overall and those classified as 'low priority' in triage systems may never receive care.[14] Neither of these strategies address the discrepancy between supply and demand over the long term.'

STAT aims to address the underlying issues that can result in decreased supply. For example, calculating the rate of demand and scheduling appointments based on this rate ensures that clinicians are responsible for meeting supply regardless of the number of patients they are currently managing.

Another example is ensuring that processes are efficient and not personnel dependent (e.g. having clear processes for rescheduling appointments where a patient cancels their appointment on the morning or day before). Therefore, short term reductions in waiting time should be better maintained with STAT because it addresses a number of the underlying causes of disruption in supply.

Comment 4: A health service utilisation questionnaire was used to collect data about the 3 months prior to first appointment. Health service utilisation data in the 3 months after the first appointment were obtained from medical records. Did you compare data from medical records for the prior 3 months with reported data?

Response: Yes. We have amended this section on page 12, line 12 as follows:
'Information from health service utilisation questionnaires was compared with participant medical records from the previous 3 months to check data accuracy.'

Comment 5: "Cost of emergency department presentations were based on the price for non-admitted triage category 4" Why was cat 4 assumed? Did you consider requesting hospital administrative data to provide more precise estimates?
Response: Many of the participants included in our study had been referred to health services following admission to emergency department (or hospital) at another health network. We did not have access to administrative data from other health networks so had to make an assumption about likely triage category for ED presentations.

Reasons for admission to emergency departments were not always provided by participants or available (due to the reason above). However, based on the reasons that were provided and participants' clinical presentation/diagnosis, we assumed that non-injurious falls, minor fractures and musculoskeletal pain were the primary reasons for readmission to hospital. These are likely to be coded as triage category 4.

We have acknowledged the limitations of estimating these costs in the manuscript on page 24, line 55:
'We also had limited access to hospital administration data to determine the cost of emergency department presentations and hospital admissions. We therefore modelled the costs of these services based on assumptions from the information we had and publicly available hospital data sources.'

Comment 6: "The cost of a hospital admission was calculated at a per diem rate, by dividing the average total cost of admission by the average length of stay" How was the average total cost of admission and average length of stay estimated? This is an imprecise approach as we know costs are skewed. Did you consider requesting hospital administrative data to provide more precise estimates?

Response: Many of the participants included in our study had been referred to health services following admission to emergency department or hospital at another health network. We did not have access to administrative data from other health networks so had to make an assumption about the cost of a hospital admission.

Similarly the reason for hospital readmission was not always provided or available. Therefore, we used the average total cost of admission to hospital and average length of stay from the following source:
Australian Government. Admitted patient care 2015-16: Australian hospital statistics. https://www.aihw.gov.au/getmedia/3e1d7d7e-26d9-44fb-8549-aa30ccff100a/20742.pdf.aspx?inline=true

We have acknowledged the limitations of estimating these costs in the manuscript on page 24, line 55:
'We also had limited access to hospital administration data to determine the cost of emergency department presentations and hospital admissions. We therefore modelled the costs of these services based on assumptions from the information we had and publicly available hospital data sources.'

Comment 7: I think it may be useful to present an additional outcome as the number of new patients seen over defined time periods (i.e. 3 months in the base case), and the ICER as the incremental cost per additional patient seen.

Response: We thank the reviewer for this comment, as it highlights an interesting issue in analysing the data for this study. As we did not complete cost data for individual patients we were unable to calculate the marginal cost of each additional patient admitted to the service. To determine cost at the patient level we were only able to use the average cost at the service level reported in Table 3 (where the mean cost for the STAT intervention is higher than the mean cost for the traditional waitlist group). The number of new patients that could be admitted under STAT is higher than the new patients admitted under the traditional waitlist model, therefore you would expect the marginal cost to fall in the intervention group. Using the average cost in the ICER would show a higher ICER for each new patient admitted to the STAT intervention group compared to the traditional waitlist group.

Reporting the ICER as cost per day of reduction in waiting time is also consistent with the study by Propper (1990) estimating the population willingness to pay to avoid waiting for non-urgent outpatient treatment.

After careful consideration, we have decided not to modify the manuscript to reflect the above, as we believe that adding to the discussion section about different methods of reporting the ICER may be confusing to the reader.

References:
Propper C. (1990) Contingent valuation of time spent on NHS waiting lists. The Economic Journal;100(400):193-9.

Comment 8: Was demand accurately predicted across all study clinics?

Response: It is possible that there were variations between the eight services in the accurate prediction of demand. This is one possible explanation for the variability in reductions in waiting time observed across sites (Harding 2020). We discuss this on page 23, line 34:
'A 12-month follow-up evaluation to the main trial showed that these benefits are mostly maintained with a 29% reduction in waiting time attributable to STAT over 12 months, compared to 34% in the original trial.[37] However, results varied between services, possibly indicating that there were differences in compliance with STAT processes between services including ongoing estimation of demand.[37] The original trial was not powered to explore the differences between sites and this could be addressed in future research.'

References:
Harding KE, Snowdon DA, Prendergast L, et al. (2020) Sustainable waiting time reductions after introducing the STAT model for access and triage: 12-month follow up of a stepped wedge cluster randomised controlled trial. BMC Health Serv Res;20:968