Leadership sharing in maternity emergency teams: a retrospective cohort study in simulation

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ABSTRACT
Background Shared leadership is associated with improved team performance in many domains, but little is understood about how leadership is shared spontaneously in maternity emergency teams, and if it is associated with improved team performance. Methods A video analysis study of multidisciplinary teams attending a maternity emergency management course was performed at a simulation centre colocated with a tertiary maternity hospital. Sixteen teams responding to a simulated postpartum haemorrhage were analysed between November 2016 and November 2017. Videos were transcribed, and utterances coded for leadership type using a coding system developed a priori. Distribution of leadership utterances between team members was calculated using the Gini coefficient. Teamwork was assessed using validated tools and clinical performance was assessed by time to perform a critical intervention and a checklist of required tasks. Results There was a significant sharing of leadership functions across the team despite the traditional recommendation for a singular leader, with the dominant leader only accounting for 58% of leadership utterances. There was no significant difference in Auckland Team Assessment Tool scores between high and low leadership sharing teams (5.02 vs 4.96, p=0.574). Time to critical intervention was shorter in low leadership sharing teams (193±312 s, p=0.018) but checklist completion did not differ significantly. Teams with better clinical performance had fewer leadership utterances beyond the dominant two leaders compared with poorer performing teams. Conclusions Leadership is spontaneously shared in maternity emergency teams despite the recommendation for singular leadership. Spontaneous leadership emerging from multiple team members does not appear to be associated with the improvements in team performance seen in other domains.

INTRODUCTION
Leadership is a critical component of teamwork and is an ongoing focus of training in emergency maternity teams.1 Like many healthcare action teams (HCAT), maternity teams are trained to have a singular leader who remains hands off during an emergency.2 At odds with this recommendation is the nature of some obstetric emergencies which require the senior clinician to be ‘hands on’, thus risking cognitive overload resulting in a loss of situational awareness and deterioration in leadership function. It is increasingly recognised that sharing leadership may improve team performance,3,4 particularly in time critical, high-stakes settings with high complexity and task interdependence.5 Shared leadership enacted to improve leadership effectiveness may be planned or spontaneous.6 A recent review of HCATs confirmed the presence of planned leadership sharing units (as dyads or even triads) and spontaneously shared leadership, but most studies were qualitative and few quantified the extent of shared leadership, or examined the relationship between shared leadership and team performance.7

Spontaneous shared leadership occurs when team members in addition to the designated leader, or in the absence of one, perform leadership functions in order to augment leadership without prior agreement or arrangement. Spontaneous shared leadership may assist an overwhelmed, task-fixated or ineffective leader, but also has the potential to cause conflict, disruption or distraction.7 Although frequently described in HCATs, few studies have assessed the impact of spontaneous shared leadership on team performance.8,9

Maternity HCATs are multidisciplinary teams that deal with complex, time critical tasks. These antecedent conditions are present in many other teams that share leadership, however there is paucity of literature examining leadership sharing in maternity teams. The aim of this study was to evaluate the extent to which leadership functions are spontaneously shared in maternity emergency teams, and to determine if spontaneous sharing of leadership is related to team performance.

METHODS
Design/setting/participants A video analysis study of 16 teams responding to a simulated postpartum haemorrhage (PPH) between November 2016 and November 2017 was performed.

Subject teams were attending the ‘Maternity Emergency Management’ (MEM) course. MEM is an 8-hour multidisciplinary simulation training day delivered at a simulation centre colocated with a tertiary maternity hospital in Brisbane, Australia. MEM faculty consist of multidisciplinary clinician educators with advanced training in simulation-based education. The curriculum comprised a 60 min prebriefing and orientation, skills stations and six fully immersive simulation scenarios, each followed by debriefing. A 60 min interactive module including trigger videos and small group discussions, focusing on crisis resource management principles and emphasising the importance of singular, hands-off leadership was delivered following the
first scenario and prior to study scenarios. Teams were instructed that the most appropriate (not necessarily most senior) clinician should be nominated verbally at the commencement of an emergency response. The study scenarios were run after each participant had been involved in at least one immersive simulation scenario of a different clinical emergency.

Course participants included multidisciplinary clinicians of various levels of training and experience, typical of teams responding to real life maternity emergencies. Teams responding to the simulated emergency varied in size from five to seven participants with the remaining course participants observing from an adjacent room via video link. While all teams contained both midwifery and obstetric staff, anaesthetic staff were not always present, similar to the situation in the hospital. The majority of participants were hospital employees; however, midwifery students and external obstetric and midwifery participants were also included. Participants provided informed written consent to participate in the study. Due to an inability to individually exclude non-consenting course participants, only videos in which all participants consented to the study were included. Videos were assessed only during the acute phase of the emergency, measured from the time an emergency alert was activated by the team until the scenario was terminated by the educators.

Measures

Leadership sharing

A leadership utterance coding system was developed to identify and classify leadership functions following review of existing leadership taxonomies and assessment tools. This was refined following subject matter expert review. Leadership utterances were categorised as clinical, coordinating, communicating and supportive. Clinical utterances related directly to patient diagnosis, monitoring and management. Coordinating utterances included statements relating to managing team roles, material and human resources. Communicating leadership was coded when utterances related to maintenance of situational awareness for both the team and the patient, and supportive utterances included coaching and utterances related to maintaining a positive team climate (See online supplementary material A for the coding matrix). Utterances were transcribed using 5 s time periods into a spreadsheet which recorded the clinician from whom it emerged and utterance type. If more than one utterance was recorded in each time period, an additional unit of analysis was created. Two authors (SJ and SB) trained together to use the utterance coding tool until nearly complete agreement was reached. During coding the videos were replayed while concurrent viewing of the transcription. Each video was coded by SJ and SB independently with at least 2 rater sessions. A Cohen’s kappa was used to evaluate the magnitude of agreement. Agreement was considered sufficient if the kappa coefficient was 0.6.

Clinical performance

A checklist for expected clinical actions was developed following a review of international guidelines and a review by subject matter experts. As two scenarios of PPH were studied (retained tissue and uterine inversion) the checklists varied slightly for each scenario, however both contained 12 items. Time to the critical intervention (decision to go to the operating room in the retained tissue scenario and replacement of the inverted uterus in the inversion scenario) was also recorded as a measure of clinical performance (see online supplementary material B).

Study size

Previous studies of anaesthetic teams using the Auckland Team Assessment Tool revealed a mean score of 5.78. It was calculated that 14 scenarios would be required for a power of 80% to detect a significant change in teamwork scores with an alpha of 0.05.

Statistical methods

Inter-rater reliability was assessed for leadership utterances using Cohen’s kappa, and for teamwork scores the intraclass correlation coefficient was used applying a two-way model. The Gini coefficient was used to calculate the distribution of leadership utterances and utterance types within the teams. The Gini coefficient was chosen as a measure of dispersion, with G=0 indicating perfect equality of utterances across all team members and G=1 indicating one team member was responsible for all leadership utterances. Teamwork scores, checklist scores and time to critical interventions were compared between high and low sharing teams using the Mann-Whitney U test. Spearman’s correlations were used to compare teamwork and clinical outcomes. Statistical analysis was performed using R V.3.1 (R studio V.1.1.442) (Rproject).

RESULTS

Participants

Sixteen scenarios were rated for teamwork scores with 100 participant utterances coded during the scenarios. Nine scenarios assessment of both leadership and team member performance with 23 specific items related to observed behaviours, with five of these leadership specific, and two global assessment items. Although a precursor of this tool was used in a large maternity simulation trial, the current version of the tool used has not been assessed in a maternity context. To support the use of this tool in this context, the Clinical Teamwork Scale (CTS), a 15-item tool with ratings from 0 (unacceptable) to 10 (perfect) was used as an additional assessment of teamwork as it had the most (although still limited) validity evidence in the maternity context. Leadership items were rated as they pertained to all leadership in the team, not just that of the assigned leader. Two authors (SJ and SB) trained in the use of both tools over two 90 min sessions. A scoring guide for the Auckland Tool was developed and used. Each video was rated independently using both tools sequentially. Raters met after each set of four videos to compare ratings and discuss causes of divergent ratings. Rating did not occur; instead average scores of the two raters are reported.
consisted of a PPH caused by uterine inversion and seven were secondary to retained placental tissue.

Outcome data
Inter-rater reliability for the leadership utterance coding and teamwork assessment scores were both substantial. Cohen’s kappa was high for coding of utterances as any type of leadership versus not leadership (0.74 (924.9, p≤0.001)) and for leadership categorisation (0.71 (924.9, p<0.001)). Inter-rater reliability for teamwork scoring for both the Auckland Tool and CTS was high with intraclass correlations of 0.830 (p=0.001) and 0.835 (p=0.001), respectively. There was a high correlation between the Auckland Tool score and the CTS (Spearman correlation =0.95, p≤0.001) and a moderate correlation between the Auckland Team Assessment Tool score and the completion of checklist items (Spearman correlation 0.56, p=0.024) and time to critical intervention (Spearman correlation −0.60, p=0.015).

Main results
Leadership was significantly shared across team members with the dominant leader (Leader 1) accounting for a median of 57.7% (IQR 45.0%–63.8%) of all leadership utterances. A quarter of utterances (25.3% (IQR 18.0%–29.3%)) were spoken by the second most dominant (Leader 2). Of the remainder, 11.2% (IQR 8.7%–16.3%) were spoken by the third most dominant, and 6.3% (IQR 3.5%–9.2%) by any other team member (figure 1). In one team, only two team members spoke leadership utterances, and of note were the best performing team.

The main results are displayed in table 1. The median distribution of leadership expressed by the Gini coefficient was 0.40

![Figure 1](Image)

**Figure 1** Leadership utterances by team member.

![Figure 2](Image)

**Figure 2** Leadership utterances by type.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Outcomes for low and high leadership sharing teams</th>
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<tbody>
<tr>
<td></td>
<td>Low sharing (IQR)</td>
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<tr>
<td>G* All leadership utterances</td>
<td>0.54 (0.46–0.62)</td>
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<tr>
<td>Auckland Team Assessment Tool score</td>
<td>5.02 (4.03–5.41)</td>
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<tr>
<td>Clinical Teamwork Scale score</td>
<td>6.30 (4.42–7.05)</td>
</tr>
<tr>
<td>Seconds to critical intervention</td>
<td>193 (96–248)</td>
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<tr>
<td>Checklist completion (maximum score 12)</td>
<td>8.5 (8.0–10.5)</td>
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*Gini coefficient.

The amount of leadership sharing (as determined by the median Gini (G) coefficient for each scenario) differed by utterance type; clinical G=0.47 (IQR 0.38–0.55), coordinating G=0.41 (IQR 0.34–0.59), communicating G=0.51 (IQR 0.46–0.66) and supportive G=0.75 (IQR 0.58–0.75), p=0.003 (Friedman rank-sum test).

Sensitivity analysis
Leadership sharing did not vary with presence of anaesthetist, cause of PPH or discipline of dominant leader.

DISCUSSION
The results of this study suggest that despite the recommendation for a singular leadership model, significant spontaneous sharing of leadership occurs in simulated maternity emergencies. Spontaneous shared leadership was not associated with teamwork scores and was present to a higher degree in teams with inferior clinical performance as measured by time to critical intervention. This finding is consistent with previous studies that associate a single dominant leader with improved team performance; however, it is in contrast to two recent studies examining shared leadership in HCATs. Küntze et al demonstrated better clinical performance when leadership was spontaneously shared in anaesthetic teams and Doumouras et al reported improved non-technical skills when leadership was shared between surgeon and anaesthetist. It is not clear why teamwork scores in this study did not differ between high and low sharing teams. It may be that a poor dominant leader resulted in higher levels of emergent leadership from team members.
study of anaesthetic teams responding to simulated emergencies showed that nurses expressed more leadership when a less experienced doctor was present.\textsuperscript{26} Another simulation study noted paramedics were more likely to contribute leadership if the general practitioner present lacked appropriate skills.\textsuperscript{27} Alternatively, team members who contributed leadership may have confused team members or caused duplication or conflict with the dominant leader, impairing overall teamwork. This spontaneous misalignment of leadership functions has been described in interdisciplinary trauma teams\textsuperscript{28}\textsuperscript{\textendash}\textsuperscript{30} and is a recognised risk of shared leadership.\textsuperscript{30} Although not formally assessed, coders reported informally observing both instances of spontaneous shared leadership assisting a poor leader and emergent leadership that caused confusion or delay when the primary leader seemed effective.

This study demonstrated all forms of leadership emerged from a number of team members beyond the dominant leader, which has not previously been quantified in HCATs. When considering sharing, which leadership functions should be shared, and with whom they should be shared to optimise performance, is yet to be determined.\textsuperscript{31} Some authors argue that certain functions should not be shared because doing so may result in significant negative effects on performance.\textsuperscript{32} All four types of leadership utterances, in similar proportions, were shared by team members rather than certain individuals performing only certain types of leadership. This finding suggests a degree of duplication of leadership functions and a potential lack of coordination of sharing which may be detrimental to team performance.\textsuperscript{30} For optimal performance, it is thought that leaders should coordinate sharing in a complementary way.\textsuperscript{31} Such coordination may be difficult to enact spontaneously during an emergency, particularly across large numbers of leaders and team members. This may explain why both Künze\textit{et al} and Doumouras\textit{et al} found a positive effect of spontaneously shared leadership, as they only examined the leadership of two clinicians. A smaller leadership unit may also allow other team members to more easily identify leadership and follow instructions if roles are not clear a priori. In line with this concept, this study showed the highest performing team (both clinically and Auckland teamwork score) had no leadership utterances beyond a leadership dyad. Furthermore, when clinically high and low-performing teams were compared, low-performing teams had a larger proportion of leadership utterances beyond the dominant two leaders compared with high-performing teams (25.6\% low-performing teams, 15.7\% high-performing teams, \(p=0.011\)).

In order to investigate if this was a dyad effect or simply the result of the dominant leader within the dyad, a post hoc analysis of leadership utterances per minute was performed. This revealed the rate of utterances by the dominant leader (Leader 1) had the strongest influence on the time to critical intervention (Spearman correlation \(-0.59, p=0.015\)), however, checklist completion was only correlated to rates of leadership utterances from a leadership dyad (Spearman correlation 0.56, \(p=0.025\)), not Leader 1 alone (Spearman correlation 0.43, \(p=0.09\)). In other words, a single dominant leader may enable critical interventions to occur in a timely manner, however, the addition of a strong secondary leader may contribute to a more complete management of the patient, suggesting a role for leadership dyads.

Leadership dyads are a form of shared leadership described as coleadership. Coleadership is enacted in a planned way in trauma teams with a medical and nursing leader performing complementary roles or, when two (or three) leaders manage ‘micro­teams’ under a hierarchical overall leader.\textsuperscript{33}\textsuperscript{34} The need to coordinate sharing of leadership functions suggests an argument for planned sharing of leadership rather than relying on spontaneous sharing. Previous studies of HCATs demonstrating superior clinical performance with a singular dominant leader did not specifically consider leadership functions performed beyond the dominant leader, perhaps unknowingly disregarding the important role of a secondary leader such as an ‘event manager’ in a complementary role to a ‘clinical leader’ or those team members leading microteams.\textsuperscript{1}\textsuperscript{\textendash}\textsuperscript{4}\textsuperscript{24}\textsuperscript{3}\textsuperscript{3} It may be that leadership can be shared effectively among a small leadership unit to reduce workload, but when leadership is dispersed too widely, sharing of leadership becomes ineffective in crisis situations due to the high degree of coordination required. Paquin\textit{et al} recently described this phenomenon in a qualitative study of paediatric emergency departments.\textsuperscript{34} They noted that when unstructured situations occurred, as defined by significant unpredictability in the team or in a dynamic clinical presentation, a distributed leadership structure of multiple microteams was avoided. Others have described the avoidance of sharing leadership functions with an ‘empowering’ leadership style when patients or situations are too complex.\textsuperscript{36}\textsuperscript{37} However, a primary leader with a directive leadership style does not necessarily preclude the presence of a secondary leader. It is important to note that both studies were carried out in trauma settings which commonly include a trauma nurse leader with defined leadership functions.

Limitations

There are several limitations to this study. Analysis of team behaviours in simulation may not accurately represent real life, however ‘research with simulation’ is a well-established concept in healthcare simulation.\textsuperscript{38} Despite utterance coding being an established method for communication analysis,\textsuperscript{39}\textsuperscript{40} coding of utterances may not allow for a comprehensive analysis of all leadership behaviours. The low proportion of non-clinical leadership utterances precluded meaningful analysis of their origin, distribution and influence on team performance in a study of this size but may be worthy of future investigation.

The Auckland Team Assessment Tool scores are heavily influenced by a single leader performance as many items assess the observed behaviours of the ‘leader’. In this study, raters assessed leadership across the whole team taking a wide view of leadership. Teamwork scores may have been different had the most dominant leader only been assessed. The high correlation with the CTS which rates ‘leader/helper’ collectively suggests the influence of this is likely to not be significant.

Finally, and importantly, results may not be relevant to other healthcare emergency contexts, with different task, team composition or environmental conditions.

CONCLUSIONS

This study demonstrated a significant amount of spontaneous leadership sharing in maternity teams which has not been previously quantified. This spontaneous shared leadership was not associated with improved teamwork scores and negatively correlated with clinical performance, particularly beyond the dominant two leaders. While it would be unreasonable to prohibit useful leadership input from team members beyond designated leadership, a focus on how to minimise the need for spontaneous leadership input from other team members by optimising the leadership unit is required. The concept of leadership dyads may be a form of leadership sharing worthy of further study in the HCAT context.
Contributors SJ, MB, RS and SM all contributed to the conception, design and manuscript preparation. SJ and SB contributed to data collection and analysis, and preparation of the manuscript.

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Competing interests None declared.

Ethics approval The study was granted ethical approval (HREC/15/MHS/121) and registered in the ANZCTR (registration number 373318) following video collection but prior to any video review, rating or data analysis.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES