**Title:**

Evaluation of a new Out-of-Hospital Newborn Life Support (OH-NLS) course in the UK South Western region: a mixed methods survey study.

**Word count:** 3333

**Keywords:**

Newborn, Paramedics, Midwifery, Ambulance, Emergency Medical Services, Resuscitation, Community, Birth

**List of abbreviations:**

NHS – National Health Service

MCQ – multiple choice questionnaire

NLS – Newborn Life Support

OH-NLS – Out-of-hospital Newborn Life Support

RCUK – Resuscitation Council UK

UOHB – Unplanned Out-of-hospital Birth

**ABSTRACT**

**Background:** Unplanned out-of-hospital births (UOHBs) are associated with poorer outcomes for babies, especially those born prematurely. The current Newborn Life Support (NLS) course offered by Resuscitation Council UK (RCUK) is not designed to address the challenges associated with birth in the out-of-hospital setting. A new out-of-hospital newborn life support (OH-NLS) course was developed to address these challenges. This study aimed to evaluate the impact of this course on attendees’ knowledge and confidence in supporting transition, stabilisation and onward transfer of newborns in an out-of-hospital setting and providing resuscitation as required.

**Methods:** A convergent mixed methods approach was used consisting of a quantitative survey, post course multiple-choice paper and qualitative free-text responses. A pre-course, post-course and follow up survey asked participants to rate their confidence, on a 5-point Likert scale (‘Underconfident/fearful’ to ‘Very confident’) across seven domains of NLS, as well as an individual assessment of provider confidence in community resuscitation of newborns before and after attending the course. Free text comments were also collected as part of the survey and analysed using a reflective thematic analysis approach to generate themes reflecting provider experience.

**Results**: Attendees at the OH-NLS course compromised of multidisciplinary staff from midwifery, ambulance, nursing and medical backgrounds from the from the Southwest of England. The pre-course survey was completed by 32 of the 33 participants and the post-course survey by 31 of the participants. All 33 attendees completed the post-course multiple choice questionnaire and 18 participants completing the follow up survey. Percentage of participants reporting feeling ‘very confident’ in their ability to deliver optimal resuscitation support to a newborn baby out-of-hospital increased from 3% (1/32) pre-course to 52% (16/31) post-course. Post-course survey data showed self-reported increases in knowledge across all aspects of NLS in an out-of-hospital setting. The qualitative analysis resulted in themes being developed relating to participants’ feelings about managing babies born outside of hospital before the training, perceived barriers to implementing the training (immediately post training) and how they have implemented their learning following the training.

**Conclusions:** The proof-of-concept OH-NLS course appears to address the learning needs of the target candidate group and the results suggests improved short-term knowledge and confidence in the immediate management of babies born in an out of hospital setting. Further evaluation is required to determine whether such training has a long-term impact and translates into improved outcomes across a larger group of participants in other

# INTRODUCTION

Birth outside the hospital environment may be defined as either planned or unplanned. For multiparous women deemed to be at low-risk of complications, birthing in the home environment with appropriate support has been shown to be as safe as birth in hospital (Birthplace in England Collaborative Group, 2011). However, unplanned out-of-hospital birth (UOHB) is associated with poorer outcomes for babies (Javaudin et al., 2019; Ovaskainen et al., 2015; Snowden et al., 2015). For preterm babies, mortality has been reported to be more than twice as high for UOHB than in-hospital matched controls (Jones et al., 2011). Severe perinatal brain injury has been associated with an early postnatal transfer for extremely preterm babies (Helenius et al., 2019). Reduction in neonatal mortality and brain injury is a national priority in England (National Health Service, 2019).

Rates of UOHB in the United Kingdom (UK) are estimated to be similar to the United States, France and Australia (Amorim and Machado, 2018); with around 4,000 UOHBs a year attended by emergency ambulance services in the UK (Goodwin et al., 2022; McClelland, Burrow and McAdam, 2019; Office for National Statistics, 2019). The rate of such births may be increasing internationally (Australian Institute of Health and Welfare, 2023; Ovaskainen et al., 2015b). Most UOHBs in an Australian study were uncomplicated, precipitous term births (McLelland et al., 2018). However, 11% of babies were born before 36-weeks’ gestation and of these, just over a third were born between 24- and 32-weeks’ gestation. Research shows that mothers giving birth in the out-of-hospital setting are more likely to be multiparous, have increased rates of perinatal complication, and more likely to occur out-of-hours (Bhoopalam and Watkinson, 1991; Collis and Dastgir, 2006; Goodwin et al., 2023; Loughney, McLelland et al., 2013). There may be higher than baseline rates of preterm birth and perinatal complications to contend with outside of hospital (McLelland et al., 2018).The most common neonatal morbidity following UOHB is hypothermia, defined as a temperature of <36.5°C (World Health Organization, 1997). Neonatal hypothermia can lead to hypoxia, hypoglycaemia, and acidosis. For premature (<37 weeks) or low birthweight (<2500g) infants, mortality has been shown to increase by 28% per 1°C decrease in admission temperature below 36.5°C (Laptook et al., 2007). Despite the known risk of hypothermia following UOHB, neonatal temperature has been found to be poorly recorded by ambulance staff, ranging from just 2-10% of cases in published audits. When neonatal temperatures are recorded outside of hospital, the vast majority are below <36.5°C (Flanagan, Lord and Barnes, 2017; Goodwin et al., 2022; McClelland, Burrow and McAdam, 2019). A large proportion of babies remain hypothermic on arrival at hospital (Goodwin et al., 2023; Javaudin et al., 2023; Ovaskainen et al., 2015).Click or tap here to enter text. Even modest improvements to rates of hypothermia could be associated with improved outcomes for these babies, yet ambulance providers are reported to feel unprepared dealing with newborn infants (Goodwin et al., 2022; Hill et al., 2023; Madar et al., 2017; Persson et al., 2019; Hill et al., 2023; Vagle et al., 2019; Madar et al., 2017).

Resuscitation Council UK (RCUK) offers a well-established NLS course grounded in hospital-based practice for all healthcare professionals who are involved in the delivery and care of the newborn (Resuscitation Council UK, 2023a). While some out-of-hospital practitioners in the UK do attend this course, it is not designed to address the different environmental, logistic, teamworking, transport and equipment challenges encountered outside of a hospital setting.

**METHODS**

A working group was established in May 2022 to adapt the core NLS material and principles to an out-of-hospital setting. This consisted of a multidisciplinary, expert faculty representing the major healthcare and professional groups involved in attending community births and resuscitation. Two proof-of-concept Out-of-Hospital NLS (OH-NLS) courses were delivered in November 2022 (Supplementary file 1). The evaluation was funded by Health Innovation South West (2022) and New Life Special Care Babies (2023).

**Setting**

Participants were from a range of roles and healthcare professions who attend UOHBs, which were mostly paramedics or midwives working in the South West of England, covering rural and urban areas with a range of population densities (see Table 1).

**Study design**

The aim of the study was to assess the impact of the training on participants levels of knowledge and confidence in supporting transition, stabilisation and onward transfer of newborns in an out-of-hospital setting and providing resuscitation as required.

For this convergent mixed methods study, both qualitative and quantitative data were gathered through surveys and questionnaires framed around three of the four levels of the Kirkpatrick (1996) model of training evaluation (Reaction, Learning, Behaviour, Results).

**Data collection**

A total of 33 multidisciplinary healthcare staff attended over two courses. Attendees were asked to complete a pre-course, post-course and follow-up survey (hosted on Microsoft (MS) Forms) to evaluate the course (Supplementary files 2-4), and a paper-based post-course Multiple Choice Questionnaire (MCQ) to assess their learning. Participants were asked to put their candidate numbers on the surveys to match pre-course, post-course and follow-up data. While it is possible that this introduced an element of bias to the responses, participants had already received their final pass mark at the point of completing the post training and follow-up surveys.

Informed consent was obtained at the start of the survey, with participant information about the use of data being displayed on the welcome page.

The pre-course, post-course and follow-up surveys each asked participants to rate their confidence, on a 5-point Likert scale (‘Underconfident/fearful’ to ‘Very confident’) across seven domains of NLS.

* airway management for a newborn baby;
* cardiac compressions for a newborn baby;
* thermal care for a newborn baby;
* management of a preterm baby at birth;
* transportation of a newborn baby;
* communication with the parents about the condition of the baby; and
* assessment of the need to bring the apparently well baby to be taken into hospital.

Participants were also asked to share their overall feeling of confidence in their ability to deliver optimal resuscitation support to a newborn baby in the community setting. The surveys aditionally used free-text questions to ask participants about their prior experience and their reaction to the training itself in their own words.

The pre-course survey was distributed via email by the course director to all attendees prior to training (October-November 2022). The post-course survey was distributed at the end of the course via survey link and QR code, and the follow-up survey was distributed eight months after the training, via email. The follow up survey was open for completion in June and July 2023.

The post-course MCQ consisted of 50 multiple choice (true/false) questions completed at the end of the course, with a pass mark of 80%, at the same standard as the existing RCUK NLS course.

**Analysis**

For the quantitative analysis, survey responses were exported from MS Forms to a MS Excel spreadsheet and converted into numeric interval-level data (‘Underconfident/fearful’ = 1; ‘Very confident’ = 5), and the sum of pre-course, post-course and follow up survey responses calculated for each participant. Differences between participants’ responses at each of the three time points were assessed using a paired Wilcoxon signed rank test.

Qualitative responses to the free-text survey questions were analysed using a reflexive thematic analysis approach (Braun and Clarke, 2019). Free text responses were reviewed to allow familiarity with the data, with initial codes generated using open coding and an inductive approach. As this was not a large dataset, this was done manually by one researcher, with codes being refined and reapplied to the whole dataset using an iterative process to develop themes.

**RESULTS**

32 attendees completed the pre-course survey, 31 completed the post-course survey and 18 completed the follow up survey. Pre- and post-course surveys could be matched for 27 candidates, of which 21 had complete data on both. All 33 attendees completed the graded, post-course MCQ.

**Participant characteristics**

Participants’ job titles can be seen in Table 1. The surveys did not record demographic information, which was to increase the confidence in respondents knowing their responses would remain anonymous within a relatively small group. Candidate numbers were included only to link to the MCQ scores and did not form part of the analysis.

**Table 1: Participant characteristics**

|  |  |
| --- | --- |
| Participant job title | Frequency |
| Paramedic | 15 (45%) |
| Community Midwife | 12 (36%) |
| Emergency Care Assistant | 2 (6%) |
| Hospital Midwife | 1 (3%) |
| Nurse | 1 (3%) |
| Prehospital emergency medicine doctor | 1 (3%) |
| Unknown | 1 (3%) |
|  |  |
| **Frequency previously called on** |  |
| 0 times | 17 (53%) |
| 1 time | 5 (16%) |
| 2 times | 5 (16%) |
| 3 times | 1 (3%) |
| 6 times | 1 (3%) |
| 8 times | 1 (3%) |
| 10 times | 2 (6%) |
|  |  |
| **Previous training (within last four years)** | |
| Less than one day | 19 (59%) |
| 1 day | 11 (34%) |
| 2 or more days | 2 (6%) |
|  |  |

Most (94%) participants had received a day or less of previous training in the last four years. More than half (17/32, 53%) of pre-course survey participants had not been called on to provide NLS outside of hospital in the last four years (Table 1).

**REACTION: Perspectives on the course**

In the post-course survey, participants reported being ‘very satisfied’ with the content (30/31, 97%), structure (29/31, 94%) and pace (27/31, 87%) of the course, as well as the venue (31/31, 100%) and materials (28/31, 90%) used for the course.

**LEARNING: Knowledge and confidence**

Scores from the MCQ ranged between 76% and 100% (mean 87%, SD 6.9). Most participants (29/33, 88%) reached the pass mark for the course. It is not known how this may have improved as a result of the course alone or to what extent this knowledge was retained longer term or translated into practice.

The percentage of participants reporting their overall feeling of confidence in ability to deliver optimal NLS in the community setting as ‘very confident’ increased from 3% (1/32) before the course to 52% (16/31) afterwards. Eight months after the course, 33% (6/18) participants reported feeling very confident, suggestive of a fade in confidence but still considerably higher than the pre-course level.

**Figure 1. Self-reported ratings of overall confidence to manage a newborn baby outside of hospital, over time.**

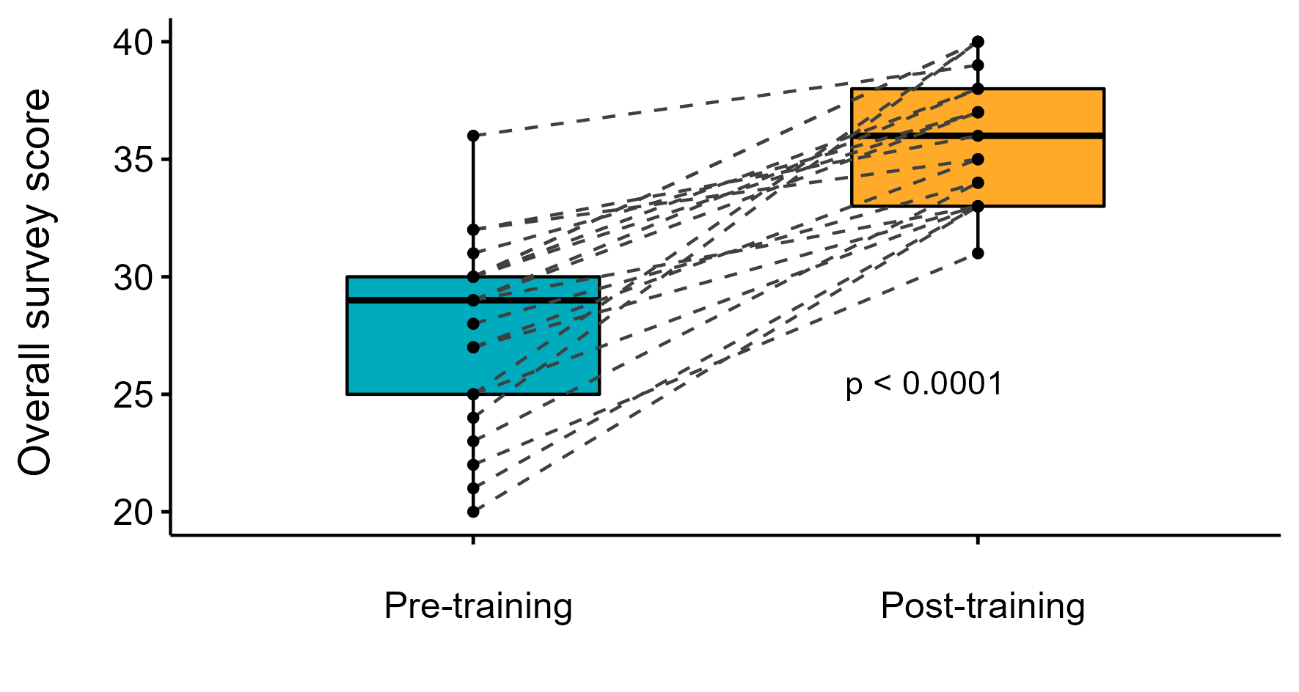
Table 2 shows a noticeable shift in the participants’ self-reported confidence in all seven domains before and after the course, and at follow up.

**Table 2: The proportion of participants reporting feeling ‘very confident’ in their NLS abilities before and after the course**

|  |  |  |  |
| --- | --- | --- | --- |
| **Aspect of care** | **Pre-course (n=32)**  **N (%)** | **Post-course**  **(n=31)**  **N (%)** | **Follow-up**  **(n=18)**  **N (%)** |
| 1. Airway management for a newborn baby | 2 (6%) | 16 (59%) | 10 (56%) |
| 1. Cardiac compressions for a newborn baby | 1 (3%) | 20 (74%) | 13 (72%) |
| 1. Management of a preterm baby at birth | 0 (0%) | 8 (30%) | 7 (39%) |
| 1. Thermal care for a newborn baby | 4 (13%) | 24 (89%) | 17 (94%) |
| 1. Transportation of a newborn baby | 1 (3%) | 10 (37%) | 9 (50%) |
| 1. Assessment of the need to bring the apparently well baby to be taken into hospital | 2 (6%) | 15 (56%) | 8 (44%) |
| 1. Communication with the parents about the condition of the baby | 2 (6%) | 15 (56%) | 14 (78%) |

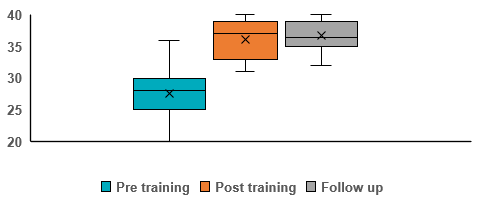
For five of the seven domains (1, 2, 4, 6, 7), 100% of participants reported feeling either ‘somewhat’ or ‘very’ confident in their ability, immediately after attending the course and at follow-up.

The results of the comparison analysis showed a significant difference in the confidence between pre- and post-course surveys (n = 21, Z = -4.014, p < 0.0001), although the participant numbers were too small to



**Figure 2. Comparisons of combined domain, matched** **Pre- and Post-course self-reported confidence in managing a newborn baby outside of hospital**

Observation of the average scores over time (see figure 3) suggest that confidence was maintained at follow up for those completing the follow up survey.



**Figure 3. Comparisons of all respondents combined domain Pre, Post and Follow up self-reported confidence in managing a newborn baby outside of hospital**

Follow up survey data showed self-reported increases in knowledge across all the different aspects of care and stabilisation of a newborn baby outside of hospital (Table 3).

|  |  |  |  |
| --- | --- | --- | --- |
| **Aspect of care** | **Some increase**  **N (%)** | **Significant increase**  **N (%)** | **Total** |
| 1. Airway management for a newborn baby | 7 (39%) | 10 (56%) | 17 (94%) |
| 1. Cardiac compressions for a newborn baby | 7 (39%) | 7 (39%) | 14 (78%) |
| 1. Management of a preterm baby at birth | 3 (17%) | 15 (83%) | 18 (100%) |
| 1. Thermal care for a newborn baby | 4 (22%) | 14 (78%) | 18 (100%) |
| 1. Transportation of a newborn baby | 5 (28%) | 10 (56%) | 15 (83%) |
| 1. Assessment of the need to bring the apparently well baby to be taken into hospital | 7 (39%) | 9 (52%) | 16 (89%) |
| 1. Communication with the parents about the condition of the baby | 6 (33%) | 7 (36%) | 13 (72%) |
| 1. Appropriately assess a baby immediately after birth | 5 (28%) | 11 (61%) | 16 (89%) |
| 1. Communicating with a multidisciplinary team around the optimal management of a newborn baby | 8 (44%) | 8 (44%) | 16 (89%) |
| 1. Cord management | 5 (28%) | 9 (50%) | 14 (78%) |

**Table 3. The proportion of participants reporting an increase in their knowledge and understanding of aspects of Newborn Life Support care after attending the course (at follow up, n=18)**

**BEHAVIOUR: Impact of the course as perceived by attendees**

Half (9/18) of the participants who responded to the follow-up survey stated that they had experienced the opportunity to implement their learning from the course.In the follow-up survey, eight participants described a scenario where they had implemented learning from the course. When asked the extent to which they felt the course was helpful in how they approached the situation, 38% (3/8) reported that it was ‘critical’, and 63% (5/8) reported it as ‘very helpful’.

**Qualitative Findings**

Three themes were identified from the free text responses across 5 questions (See Supplementary File 5) providing insight into how participants felt about out of hospital NLS before and following the training.

**Theme 1: Lack of exposure**

Prior to the course, participants felt that the infrequent nature of the requirement for out of hospital NLS led to feelings of fear and anxiety and a lack of confidence.

*“As a Paramedic, I have received limited training in newborn care. In my third year of university (2021), we had a day training in resuscitation following birth. In my Paramedic induction we spent less than 1 Hour focusing on newborn care/resuscitation… we do not have regular training in this, which causes under confidence in practice, whilst I know how to care/stabilise/transport a newborn, it can be daunting due to the lack of training”*

Even where people felt some confidence, they recognised the need for more training or “room to improve”. Many felt the lack of frequent expose would lead to skills fade so frequent training should be offered in this area. These thoughts were echoed following the training where participants cited “skills fade” and “lack of practice” as barriers to practice.

**Theme 2: Practical benefits of the training**

This theme recognises the tangible difference the course made to the system when some of the participants took the opportunity to apply their learning. The course gave them the confidence and knowledge to improve their own and others’ practice by sourcing and introducing new equipment and training up colleagues.

*“Transwarmers purchased for all homebirth bags.* *Myself and my colleague have run training sessions for community midwives on thermoregulation and resus in pre-hospital settings.”*

*“We have taken to the management team the need for iGels in all homebirth bags and encouraged this into our mandatory NLS training. All midwives are receiving training to use iGels now”*

*“In process of introducing the penguin suction device to homebirth bags”*

The course also provided attendees with the confidence to talk to parents and to manage events “in a calm way”. Some attendees even referenced the application of their learning into real life situations. One attendee managed a “*neonatal resus at home birth followed by transfer into hospital*” and stated it was “*really good to build knowledge and found it [the course] extremely useful being based in the community with the paramedics that we are likely to work with*.”

**Theme 3: Systemic barriers to caring for newborns, born out-of-hospital**

Participants noted the challenges beyond individual provider training that need to be addressed to support community-based resuscitation outcomes across the system. Several participants cited a lack of appropriate or available equipment as a barrier to effective care.

*“The lack of specialist/neonatal kit ambulances carry.”*

*“Equipment available in the community setting.”*

Others referenced ambulance delays as a potential problem that causes them anxiety while others described the difficulties in managing situations with colleagues who have not attended the training.

*“Understanding from the wider cohort of paramedics who were questioning the correct procedures that then they agreed with but without my intervention delayed care would have occurred.”*

More and wider reaching training to “all colleagues in flash teams” was called for to support these issues.

**DISCUSSION**

Findings from the pre-course data support other published literature on the experiences of prehospital and community practitioners (Goodwin et al., 2022, Hill et al., 2023; Heys et al., 2022) by confirming that there remains an unmet need for access to training on NLS skills applicable to the out-of-hospital setting. While the frequency of attending scenarios where NLS is needed in the community setting is low, their nature as ‘high acuity, low occurrence’ (HALO) events means that they remain ever-present in the practitioners’ minds as daunting, anxiety-inducing possibilities (Goodwin et al., 2022; Persson et al., 2019; Hill et al., 2023; Heys et al., 2022).

Evaluation of the OH-NLS course found that it improved practitioners’ self-reported knowledge and confidence in all aspects of delivering care to stabilise a newborn baby outside of the hospital setting. This increased confidence was sustained at eight months past course attendance. Findings suggested that the course was very effective in improving confidence in two key areas of neonatal care delivery: airway management and thermal care; areas in which improved care delivery could offer significant improvements in outcomes for those born outside hospital (Javaudin et al, 2019; Nguyen, Lefevre and Dreyfus, 2916; Chitty and Wyllie, 2013).

In their book ‘Four levels of Training Evaluation’ (2016),James), James and Wendy Kirkpatrick argued that learner satisfaction was a crucial element of course design, stating that participants learn more effectively when they are engaged actively in the learning process. Practitioners reported that the pre-course materials, the teaching on the day, and the assessments used at the end of the course were useful, helpful, and appropriate. Qualitative comments about the overall learning environment and experience of the course pointed to it being equally as relevant to prehospital practitioners and paramedics as to the community midwives. Participants felt that learning was strengthened by the inclusion of multidisciplinary, broad practitioner groups in each cohort of candidates, bringing fidelity to the interactions of the multidisciplinary team as would be reflecting what was experienced in the ‘real world’. This supports previous literature both in NLS and other areas of clinical practice, where multidisciplinary team training has been positively evaluated by practitioners, enhanced teamwork, and improved patient care (Capella et al., 2010; Hernández et al, 2021; Lavelle et al., 2018; Thomas et al., 2007; Thomas et al., 2010; Weller et al., 2008). After eight months, several participants reported having used the training and reported it as being critical to the way they had managed the care episode. The course also appeared to have had an impact on practice that spread wider than the course attendees, through the uptake of best practice NLS equipment in the participants’ organisations. Consistent with previous literature, the results suggested that availability of suitable equipment was a key barrier to confident management of UOHB (Goodwin et al., 2022; Persson et al., 2019). Candidates reported feeling empowered to explore ways to improve the availability of this equipment within their organisations. As a result of the OH-NLS course development, RCUK have produced a recommended minimum equipment list for UOHB (Resuscitation Council UK, 2023b). This has since been used by NHS England to update the recommended equipment list for UK ambulance services.

**Strengths and Limitations**

The evaluation was able to demonstrate the efficacy of a course specifically designed for out-of-hospital practitioners and it is suggested that similar benefits could be achieved by delivering this type of course in other settings. The mixed-methods approach allowed a range of data to be collected to show how confidence was improved and to capture additional insights into the challenges faced by these professional groups attending UOHB.

Despite a high response rate, the number of participants on the course was relatively small and limited to two courses in one region of the UK, so there is limited external validity. The evaluation was not designed to report on improved objective competency, but was focussed on self-reported benefits to practice as perceived by participants. This was still of value as a means of determining educational benefit, but further study to determine additional, more objective measures of sustained change in practice would be beneficial. There was a risk of bias in the sample cohorts used as they were the first volunteers of attendees on a new course, who may have been more motivated to learn and change their practice, and more aware of where their learning needs lie. Therefore, they may have performed better than later candidate cohorts and valued the course more highly, expressed through greater reported improvements in confidence. In addition, MCQ scores were not recorded pre-course to show improvement and were not repeated at the eight-month follow-up. So, whilst self-reported confidence remained high at this the time point used, we cannot be sure of the extent to which knowledge of NLS skills were sustained over time. It is suggested that reinforcement through further teaching or use in clinical practice would be needed (Yang et al., 2012; Mosley and Shaw, 2013) so future research should address this.

**Recommendations**

There is a potential patient benefit of this course being available more widely, particularly if it leads to a reduction in hypothermic and hypoxic babies arriving in hospital after UOHB, and potentially impact on newborn mortality and brain injury in line with the NHS Long-term Plan (National Health Service, 2019; Dempsey et al, 2015). The course has now been successfully accredited via the RCUK with an aspiration to make it available across the UK. Future research exploring baseline data on clinical outcomes following out-of-hospital management as a result of attending this type of training would be beneficial.

**CONCLUSIONS**

The findings of this study suggest that the newly developed OH-NLS course improved attendees’ knowledge and confidence in delivering care to stabilise a newborn baby outside of the hospital setting. As the national RCUK roll-out of this course proceeds, the expectation is that it will contribute to raising the standards of care for the newborn born outside of hospital, with the same success as the NLS course has for those in-hospital. Future work could explore the clinical impact of this training on outcomes for babies following UOHB, as well as long-term confidence and knowledge amongst practitioners.

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