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ORIGINAL ARTICLE

'Beyond Milestones': A randomised controlled trial evaluating an innovative digital resource teaching quality observation of normal child development

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Aims: The study aimed to create and evaluate the educational effectiveness of a digital resource instructing paediatric trainees in a systematic approach to critical and quality observation of normal child development.

Methods: A digital educational resource was developed utilising the skills of an expert developmental paediatrician who was videoed assessing normal early child development at a series of critical stages. Videos illustrated aspects of language, sophistication of play and socialisation, cognition, and motor progress. Expert commentary, teaching text and summaries were used. A randomised controlled trial evaluated the resource. Paediatric trainees were recruited from The Sydney Children's Hospitals Network. Outcome measures were repeated at three time points (pre-teaching, immediate-post and 1 month) and included self-rated attitudes, knowledge of markers of development and observational expertise. Qualitative data on teaching usefulness were obtained through open-ended questions.

Results: Fifty-six paediatric trainees (registrar 79%, women 82%; mean age 31 years) completed the pre-assessment, 46 the immediate-post and 45 the 1-month follow-up (20% attrition). Compared with the Control group, the Teaching group scored higher over time on markers of development ($P = 0.006$), observational expertise ($P < 0.0001$), confidence ($P = 0.035$) and satisfaction ($P < 0.0001$). Teaching participants valued the video and expert commentary and reported improvement in confidence and understanding and acquiring a more structured approach.

Conclusions: The 'Beyond Milestones' free online resource for medical professionals <http://learnpaediatrics.org/beyondmilestones/password=cunningham> improves knowledge, increases confidence and is useful, providing a structured approach to developmental assessment. The techniques taught can be applied to every paediatric consultation.

Key words: child development; developmental assessment; developmental milestone; developmental screening; medical education.

What is already known on this topic

1 Despite mandatory training requirements, many Australian paediatricians report inadequate training in child development.
2 Barriers to training include a lack of high-quality educational resources and a limited accessibility to teaching.
3 Previous research evaluating developmental teaching is limited.

What this paper adds

1 'Beyond Milestones' improves knowledge of developmental markers and observational expertise.
2 'Beyond Milestones' increases user confidence in developmental assessment.
3 'Beyond Milestones' is a useful teaching tool providing a structured approach to developmental assessment that can be applied to every paediatric consultation and is suitable for use in medical education.

An understanding of child development is integral to paediatric practice.[1] Australian data estimate that 20–34% of new consultations address developmental–behavioural problems.[2–4]

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However, despite mandatory training requirements, many Australian paediatricians report that their developmental education is inadequate,[1–3] with training described as variable and site dependent.[1] Recognised barriers to effective learning include inadequate resources[5] and limited accessibility to education.[6] A potential solution to these concerns is online education. This teaching modality has been endorsed in the literature with international audits showing that most paediatric training programmes would welcome its use.[5]

Research investigating integrated approaches to teaching developmental screening using specific tools and live patients

has demonstrated high student acceptability[7] and improved technical skills but limited knowledge gain.[8] However, the use of live patients in training packages is often problematic because of difficulties with scheduling and patient co-operation.[8] Outcomes are further limited because of a lack of comparative data with other educational modalities. Alternatively, teaching milestones using animated cartoons, compared with a non-randomised control group, have demonstrated increased knowledge of milestones.[9] Cartoon usage, however, lacks the authenticity and individual nuances of a realistic clinical session. The best illustration of developmental milestones involves using video recordings of children demonstrating appropriate skills.[9]

The proposed digital resource 'Beyond Milestones' aimed to train users in the skill of critical and quality observation. The resource utilises footage of real-life developmental assessments emphasising the importance of critical observation in the areas of language, play, motor skills and cognition. Comprehensive observations of the child, along with appropriate history and attention to the concerns of the parent, are integral to developmental surveillance.[10] Although the latter skills are recognised as basic attainments in training, the development of critical and comprehensive observation is often overlooked. The skills taught in 'Beyond Milestones' address this gap in training and can be applied throughout all paediatric consultations. The resource is easily accessible to all medical professionals responsible for child health care.

Materials and Methods

Teaching resource

'Beyond Milestones' was developed as an interactive teaching resource designed for online use. Clear learning objectives,[11] the instructional principles of attention, relevance, confidence and satisfaction,[12] and an interactive approach were utilised.[13] In the introductory video, the expert developmental paediatrician (CC) discusses approach and advises on the choice of age-appropriate aides, such as blocks and toys. CC was then videoed assessing children at six key ages (9–12, 15–16, 18–21, 24–27, and 36–40 and 48–54 months, video length range = 20–38 min). A video on the important sequence of development between 9 and 12 months and a handout highlighting the markers of development for each child were also provided.

The teaching segments show children during free play and in interaction with CC and their caregiver. CC demonstrates how to elicit key skills in language, fine motor, gross motor, cognition/problem solving and social domains. These assessments, edited to 15–30 min each, were performed in a routine clinical setting and formed the foundation of the teaching. Key skills are highlighted using expert commentary and on-screen text. At the end of each assessment, skills are reviewed and summarised according to domain. Engagement strategies are demonstrated throughout. The developmental sequence between 9 and 12 months is also highlighted and discussed. Limited discussion of disordered development is provided but was not the focus of the teaching. The Griffiths Mental Developmental Scales[14–16] was the gold standard for the age ranges of attainment of key developmental milestones.

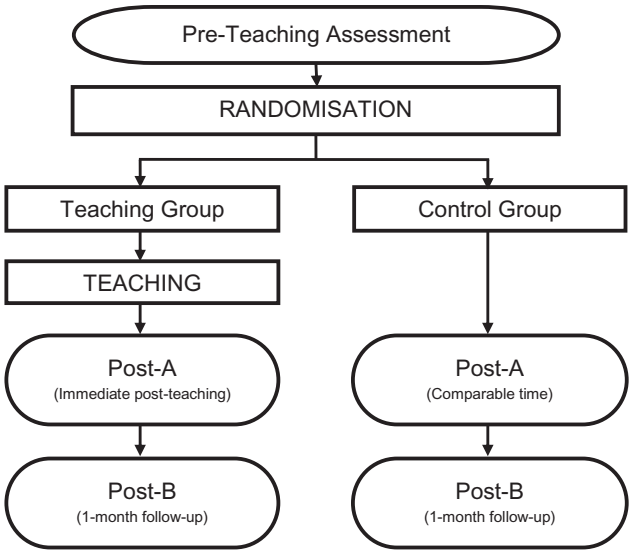

Fig. 1 Randomised controlled trial utilising a within (pre-, post-A, post-B) and between (Teaching, Control) group design.

Ethics

The development of the 'Beyond Milestones' resource and the evaluation study were approved by the South Eastern Sydney Local Health Network Human Research Ethics Committee. Written informed consent was obtained from parents for use of video footage on the Internet and from the medical trainees involved in the evaluation study.

Design

The intervention was evaluated in a randomised controlled trial utilising a within (pre-, post-A, post-B) and between (Teaching, Control) group design. The allocation to group sequence was generated using a computerised random number generator. The Teaching group received the teaching intervention, and the Control group, no teaching. Both groups continued to participate in their normal paediatric training.

Participant commitment to the study was 3 h for the Control group (1 h per assessment session) and 7 h for the Teaching group (1 h per assessment session and 4 h for teaching), completed in set time frames for each session over approximately 4 months. The study design and assessment timing are illustrated in Figure 1.

Recruitment

Resident medical officers in paediatric training were recruited from the Sydney Children's Hospitals Network. Participants completed the online pre-assessment and were then randomised to the Teaching or Control group (Fig. 1).

Outcome measures

The major outcome measures were attitudes, knowledge and usefulness. The assessment strategy is reported in Table 1.

Table 1 Assessment strategy and outcome measures

Domain	Assessment type
Attitudes	Self-rated attitude questionnaire[17,18]
Knowledge	Open-ended questions assessing knowledge of markers of development and observational expertise
Usefulness*	Instructional Materials Motivational Survey (IMMS)[19]
	Critical Incident Questionnaire (CIQ)[20]
	Open-ended questions

*Education group only.

Attitudes were assessed based on a scale previously developed by the authors.[17,18] At all three assessment time points, participants in both groups (Teaching, Control) rated their confidence in developmental assessment, satisfaction with the teaching, interest in childhood development, motivation for further learning and relevance of the teaching on a 5-point Likert-type scale ranging from 'strongly disagree' to 'strongly agree'.

Participants in both groups recorded milestones of children aged 24 and 36 months to assess their knowledge of markers of development. Observational expertise was assessed by participant analysis of video assessments of two children aged approximately 24 and 36 months (video length range = 11–19 min). These videos did not have teaching overlay but were otherwise identical to those in the educational component. Both assessments (markers of development, observational expertise) were repeated at all three assessment time points.

At post-A for the Teaching group only, the value of the resource was assessed using the Instructional Materials Motivational Survey (IMMS).[19] The IMMS is a 36-statement questionnaire assessing the instructional domains of attention (or interest in the material), relevance (to learners goals and needs), confidence (in ability to succeed in completing the material) and satisfaction (with their learning) using a 5-point Likert-type scale ranging from 'not true' to 'very true'. Reliability for the subscales ranges between 0.81 and 0.92.[19]

At post-A for the Teaching group only, qualitative data were collected using the Critical Incident Questionnaire (CIQ).[20] The CIQ asked participants to reflect on the resource strengths and weaknesses and to provide suggestions for improvement. In addition, at post-B, open-ended questions asked participants to record whether their confidence, understanding and approach to assessment changed following the teaching.

Analysis plan

Attitudes

Pre- to post-difference scores were calculated for each attitude question, and mean differences were compared between groups using independent sample *t*-tests.

Knowledge of markers of development and observational expertise

Gold standard answers were developed by CC based on the same categories and subcategories tested in the Griffiths Scales of Mental Development.[14–16] A comprehensive scoring guide was developed using a 20% random sample of participant responses in comparison with the gold standard. AJS (paediatric neurology advanced trainee) scored the assessments following training by the expert (CC). CC independently scored a 25% random sample. Interrater reliability was assessed using the intra-class correlation coefficient (ICC) statistic and measurement error. Worksheets were fully randomised for marking and data entry. Coders and data entry were blinded to group and, when possible, to time point (pre- or post-teaching). Raw scores for each age group and child were converted to *z*-scores and aggregated to form a total *z*-score each for markers of development and observational expertise for pre-, post-A and post-B. Data were analysed using a general linear mixed model analysis assessing changes in knowledge (markers of development, observational expertise) between groups over time (group × time). A mixed-model analysis takes into account loss to follow-up, thus maximising sample size and increasing statistical power.[21] A significance level of $P < 0.05$ was used for all analyses.

Usefulness

The IMMS[19] subscales were described using descriptive statistics (means and standard deviation (SD)), and qualitative data were content analysed for themes.

Results

'Beyond Milestones' resource

'Beyond Milestones' is a free online developmental teaching resource for medical professionals. It includes two optional assessment videos (pre and post) with self-assessment worksheets and model answers, an introductory video, and eight assessment videos. A summary of development handout is also provided. The final package takes approximately 5 h to complete. It is available at <http://learnpaediatrics.org/beyondmilestones/ password: cunningham>.

Participants

Fifty-six medical trainees participated in the trial, and 30 and 26 were randomised to the Teaching and Control groups, respectively. Overall, 45 participants completed the study. Forty-six (82%) participants were women, and the mean age was 31.4 years (SD = 3.8; range = 24–42 years). Forty-four (79%) participants were registrars. Participants had an average of 3.4 years (SD = 2.3) of paediatric experience, and 41 (73%) were within their first 3 years of paediatric training. Only nine (16%) participants had completed or were completing a rotation in developmental paediatrics.

Loss to follow-up

Eleven participants failed to complete the study (20% attrition: Teaching group (7), Control group (4)) because of sickness (1), holiday (1), lack of time (2), technical problems (2) and no response to follow-up contact (5). There were no significant differences between groups for gender ($P = 0.975$), age ($P = 0.530$), years of experience ($P = 0.978$), position ($P = 1.000$) and

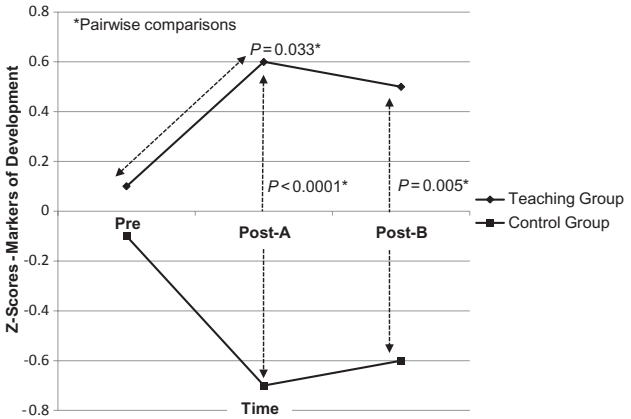

Fig. 2 Comparison of mean *z*-scores for participant's knowledge of markers of development over time (pre-, post-A, post-B) and between groups (Teaching, Control). (—◆—) Teaching group, (—■—) Control.

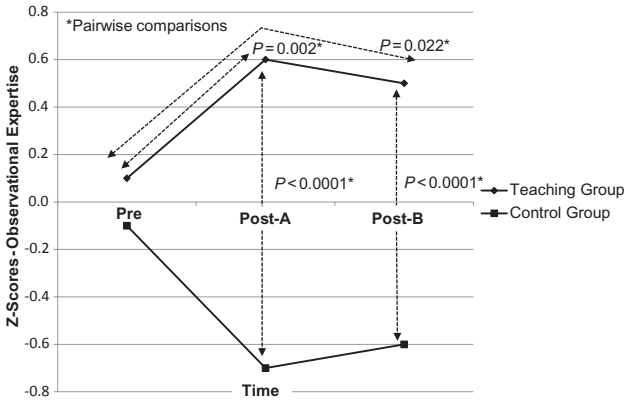

Fig. 3 Comparison of mean *z*-scores for a participant's observational expertise over time (pre-, post-A, post-B) and between groups (Teaching, Control). (—◆—) Teaching group, (—■—) Control.

baseline knowledge of markers of development ($P = 0.478$) and observational expertise ($P = 0.711$).

Interrater reliability

Interrater reliability for markers of development and observational expertise for pre-, post-A and post-B ranged between ICC = 0.88 (mean difference = 0.00, limits of agreement = −0.80, 0.80, error range = 0.56) and ICC = 0.99 (mean difference = 0.00, limits of agreement = −0.34, 0.34, error range = 0.24).

Timing of assessment

Participants had 3 weeks to complete each assessment. Modules were accessed a median average of two times at each time point. The distribution of knowledge scores was the same across categories of access for all time points for markers of development and observational expertise, respectively (pre: $P = 0.445$, $P = 0.207$; post-A: $P = 0.452$, $P = 0.067$; post-B: $P = 0.232$, $P = 0.537$). The mean number of days between pre- and post-A assessment was 82, and post-A and post-B, 54.

Attitudes

Compared with the Control group, the Teaching group reported higher confidence in their developmental assessment skills at post-A (mean difference = 0.56; $t_{(44)} = -2.170$; $P = 0.035$) and higher satisfaction with instruction received at post-A (mean difference = 1.24; $t_{(44)} = -4.503$; $P < 0.0001$) and post-B (mean difference = 0.90; $t_{(43)} = -3.031$; $P = 0.004$). No significant differences were seen between groups in interest, motivation or relevance.

Knowledge

Markers of development

There was a significant interaction between group and time for knowledge of markers of development ($F_{(2,90.94)} = 5.466$; $P = 0.006$; Fig. 2). Specifically, the Teaching group scored higher on markers pre- to post-A (mean difference *z*-score = 0.405; $P = 0.033$), and compared to the Control group, at post-A (mean difference *z*-score = 1.078; $P < 0.0001$) and post-B (mean difference *z*-score = 0.730; $P = 0.005$).

Table 2 IMMS subscale scores[19]

Subscale	Mean (SD)
Attention	3.67 (0.58)
Relevance	4.03 (0.42)
Confidence	3.49 (0.71)
Satisfaction	3.31 (0.96)

Scale: 1 = Not True, 3 = Moderately True, 5 = Very True. IMMS, Instructional Materials Motivational Survey; SD, standard deviation.

Observational expertise

There was a significant interaction between group and time for observational expertise ($F_{(2,86.43)} = 11.823$; $P < 0.0001$; Fig. 3). Specifically, the Teaching group scored higher on observational expertise pre- to post-A (mean difference *z*-score = 0.521; $P = 0.002$) and pre- to post-B (mean difference *z*-score = 0.452; $P = 0.022$), and compared to the Control group, at post-A (mean difference *z*-score = 1.243; $P < 0.0001$) and post-B (mean difference *z*-score = 1.075; $P < 0.0001$).

Usefulness

IMMS

Mean ratings for the IMMS[19] subscales were in the moderately or mostly true range, reflecting positive learning attitudes towards the 'Beyond Milestones' resource (Table 2).

Qualitative data

Twenty-four participants from the Teaching group provided qualitative data. The videos, commentary and summaries were thought to be most useful:

'. . . really delightful to watch the concepts come alive, we hardly get the opportunity to sit in on developmental clinics, so this has made it really accessible and therefore very helpful'

'. . . gave me a lot of insight into the skill of assessment that I would otherwise not [be] able to pick up'

A minority (n = 7) thought that the videos were too long for sustained attention, and several participants suggested improvements in technical presentation.

Twenty-two participants stated their confidence improved, and twenty reported their understanding of developmental assessment improved, becoming more systematic and structured. Twenty participants indicated their approach to assessment changed:

'Before the Trial I was very haphazard in my approach and was unsure of the techniques that I needed to use to elicit the proper developmental age'

Overall, the resource attracted positive review:

'It is such a well designed and structured program. I believe it will be beneficial for educational purposes to assist junior doctors'

'. . . appreciate this effort to teach Paediatric trainees, this aspect of Paediatrics is so overlooked in the regular curriculum . . .'

Discussion

'Beyond Milestones' is a unique digital resource teaching observational expertise in the domains of normal child development. Critical observation encompasses 'how' rather than 'when' a child achieves the milestone and requires an understanding of the quality and sophistication of the skill. An expert paediatrician is videoed assessing children at key developmental ages less than 5 years. Video mimics the real-life situation, maintaining the interaction and immediacy of the clinical consultation[7] and is the preferred method of teaching developmental milestones.[9]

As an online resource, 'Beyond Milestones' is accessible and can be utilised at the convenience of the user, particularly important to community clinicians who may have limited accessibility to and time for training. The video footage with voice overlay, text summary and review provides a unique educational tool. The package includes participant involvement with the provision of self-assessment worksheets. This feature enhances it as an educational tool. For example, it could be incorporated into a university syllabus.

Paediatric trainees participated in a randomised controlled trial to evaluate the resource. Three major outcome measures, attitudes, knowledge and usefulness, assessed the efficacy of the resource. Confidence and satisfaction significantly improved post-education in the Teaching group. Knowledge of markers of development and observational expertise were enhanced in the Teaching group over time, and compared with the Control group, immediately post-teaching and at later assessment (mean 54 days). Using the IMMS scale of instructional design,[19] positive attitudes towards the resource were demonstrated. Qualitative data supported the findings related to increased confidence and usefulness.

Although every endeavour was made to accommodate busy participants, study attrition may have been influenced by video length and time commitment involved. However, real-time access to the online teaching package is unrestricted and self-assessment optional. This is likely to improve completion rates. Although we did not assess participant learning styles, aversion to computer-assisted learning may have also influenced attrition.

The resource has significant potential for use by a wide audience including medical students, allied health working with children, nursing staff and trainees in paediatrics and developmental medicine. The standard and depth of the teaching coupled with its interactive style make it applicable to those with a basic level of knowledge to those interested in more sophisticated and subtle teaching points. The introduction leads the beginner in an approach to assessment of the main domains of child development and provides important suggestions for the acquisition of a developmental kit appropriate to varying ages. In contrast, there are segments directed to the advanced learner. The emphasis, for example, on the rapid acquisition of new skills between 9 and 12 months with two children close in age, but contrasted in skills, provides rich material for the more experienced viewer. Repeated viewing is required to appreciate the many teaching points.

The resource is not intended to replace face-to-face teaching but to provide an adjunctive tool to training in child development. It provides a model the trainee can use to acquire and improve his/her own skills in everyday paediatric practice. It concentrates on the teaching of observational expertise important in developmental surveillance[10] and allows the user to build a systematic framework to assess development unobtrusively with minimal direction of the child in the consultation setting. This is the unique value of the resource.

The expert demonstrates strategies of engagement critical to the attainment of information. The videos capture free-play interaction between the child and examiner/caregiver, including times when the child becomes bored or refuses participation. Engagement may be achieved by distraction, switching a task or showing the flexibility to follow the child's lead. These skills cannot be acquired through familiarity with screening tools or developmental milestones.

Although the resource focuses on normal development, it is anticipated that the appreciation of the accepted usual evolution of skills will assist the user in the detection of abnormal or delayed acquisition of attainments. For example, the expert discusses the failure to achieve protodeclarative pointing that may be seen in children with autism. Insights such as these are seen throughout the teaching as the expert extrapolates from the normal to aspects of delayed or pathological development.

There is a concern that the medical curriculum is not providing quality developmental education.[1–3] One participant commented that *'this aspect of Paediatrics is so overlooked in the regular curriculum'*. This resource provides a teaching tool that addresses this critical training issue. 'Beyond Milestones' is available at <http://learnpaediatrics.org/beyondmilestones/ password: cunningham>.

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