

Evidence-based milestone ages as a framework for developmental surveillance

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Developmental surveillance is the process of monitoring child development over time to promote healthy development and to identify possible problems. Standardized developmental screeners have greater sensitivity than milestone-based history taking. Unfortunately, Canadian screening guidelines, to date, are sparse, logistical barriers to implementation have slowed uptake of screening tests and physicians continue to rely on milestones. When using clinical impression as a framework for surveillance, clinicians may not know when to consider a milestone delayed because developmental attainments exist within an age range and there is an absence of referenced percentiles on available published tables, which are particularly problematic for the cognitive and social-emotional sectors, which are less familiar to physicians. A novel, five-sector milestone framework with upper limits, referenced to the best available level of evidence, is presented. This framework may be used in teaching and may help physicians to better recognize failed milestones to facilitate early identification of children at risk for developmental disorders.

Key Words: *Child development; Evidence-based practice; Surveillance*

Developmental surveillance is monitoring a child's development over time to promote healthy development and identify children who may have developmental problems (1). Anticipatory guidance helps parents anticipate the next developmental stage and manage developmentally appropriate behaviours (2). Office surveillance of child development is essential for early identification and treatment of developmental disorders; however, adequate training for this important triage task is lacking, especially in the cognitive and social-emotional sectors. Developmental milestones are specific skill attainments occurring in a predictable sequence over time, reflecting the interaction of the child's developing neurological system with the environment. Skills can be grouped in sectors of development: gross motor, fine motor (including self-care), communication (speech, language and nonverbal), cognitive and social-emotional. We present a novel, five-sector framework with referenced milestones representing current best evidence, compiled from original source materials, such as standardized tests, wherever possible (developmental sector headings follow an easy to remember order according to the mnemonic 'Gotta Find Strong Coffee Soon'. Mnemonic created by Peter MacPherson, medical student, University of Alberta [Edmonton, Alberta] Faculty of Medicine and Dentistry). The framework makes explicit cognitive and social-emotional development so that clinicians may better understand the early signs of important developmental conditions, such as autism and intellectual disability. We also describe developmental trajectories – important themes emerging over each stage that affect child behaviour.

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Les âges probants des étapes de développement comme cadre de surveillance

La surveillance du développement désigne le processus pour suivre l'évolution de l'enfant au fil du temps afin de promouvoir un développement sain et de repérer des problèmes possibles. Les outils standardisés de dépistage des troubles du développement sont plus sensibles que les antécédents fondés sur les étapes du développement. Malheureusement, jusqu'à présent, les lignes directrices canadiennes en matière de dépistage sont rares, et des obstacles logistiques à leur mise en œuvre en ont ralenti l'adoption. Par conséquent, les médecins continuent de se fier aux étapes du développement. Lorsqu'ils recourent à l'impression clinique comme cadre de surveillance, les cliniciens ne savent peut-être pas quand envisager le retard d'une étape du développement parce que leur atteinte se produit dans une plage d'âge et que les percentiles ne sont pas précisés dans les tableaux publiés, ce qui se révèle particulièrement problématique pour les secteurs cognitif et socioémotif, moins connus des médecins. Un nouveau cadre d'étapes du développement en cinq secteurs comportant des limites supérieures est présenté, d'après la meilleure qualité des preuves. Ce cadre peut être utilisé pour l'enseignement et peut aider les médecins à mieux reconnaître les étapes non atteintes pour faciliter le dépistage précoce des enfants vulnérables à des troubles du développement.

Our clinically relevant 'red flags' milestone chart uses the uppermost published age limits for items (as opposed to median age, which is frequently used for novice learners) so that a missed milestone will usually be clearly delayed and require further action. Developmental screening instruments have standardized protocols, scoring validated on population samples, and published properties of sensitivity and specificity; they are significantly more sensitive than clinical impression for identifying risk of child developmental and behavioural difficulties, and can be used to supplement developmental surveillance (1). It remains a topic of debate in Canada when to use general screeners for all developmental sectors versus sector-specific tests for specific disorders. While not a screening guideline, the present article includes screening information and referral recommendations. Regardless of whether screeners are used, we propose that milestone ages used during surveillance be evidence-based, as in Table 1.

DEVELOPMENTAL SURVEILLANCE AND SCREENING

Traditionally, surveillance is accomplished through inquiring about parental concerns, developmental milestones and behaviour, and by observing the child during the physical examination and history. Observations can be opportunistic or skills can be elicited with props (eg, bubbles, dolls). Surveillance is a process that may be performed during well-child visits, specialty consultations or public health immunization visits; it is not a standardized

TABLE 1
Birth to five years 'red flags'* developmental milestones chart for quick office reference

| Age | Gross motor† | Fine motor | Speech-language | Cognitive | Social-emotional |
|----------------------------|--|---|---|--|--|
| Newborn | Moro, positive support primitive reflexes (3) Flexed posture (4) | Hand grasp primitive reflex (3) | Root, suck primitive reflexes (5) Orients to sound (6) Smiles to voice (6) Variable cries (6) | Visual focal length ~10" (7) Turns to visual stimuli (8) Prefers human face (eyes), contrast, colours, high pitched voice (7,8) | Cries when infant cries (empathy) (8) |
| Two months | Head up 45° in prone (4) | Holds placed rattle (9) | Gurgles (6) | Follows horizontal arc (9) | Awake more during day (7) |
| Four months | Asymmetrical tonic neck primitive reflex (3) Lifts chest in prone (4) | Brings hands together in midline (4) Extends straight arms toward rattle, supine (9) Reaches and grasps rattle (9) | Coos (6) | Watches hands (8) Explores environment by looking around (8) Anticipates routines (7) Looks to find caregiver (7) | Calms when spoken to, picked up, sucking or looking (7,8) Enjoys eye contact (8) Facial expressions of joy, anger, sadness, distress, surprise (8) Self-soothes to sleep (7,8) |
| Six months | Primitive reflexes gone (3) Pulls to sit (4) Sits tripod (4) | Shakes rattle (9) Holds cube between two hands, holds one cube in each hand, ulnar-palmar grasp (4 th and 5 th fingers), radial-palmar grasp (1 st and 2 nd fingers) (9) | Looks toward person talking to him (6) Vocalizes to answer (5,6) Laughs (5,6) | Bangs objects together (10) Trial and error problem solving (8) Looks for dropped object (11) | Predictable schedule (7) Smiles to initiate engagement and respond (12) Back-and-forth engagement through facial expressions and eye contact; shares enjoyment (joyful looks) (12) Prefers familiar people (8) Shows interest in other infants (empathy) (8) |
| Nine months | Postural reflexes present (3) Rolls both ways (4) Sits well (4) | Transfers, radial-digital grasp (thumb with 1 st and 2 nd fingers, no palm), touches cheerio with finger, raking pincer grasp (9) | Looks to familiar named object, inhibits to 'no' (10) Vocalizes to initiate (6) | Object permanence (8) Explores caregiver's face (8) Searches for hidden toy (8) | Attachment development established (8) |
| 12 months | Gets to sit (4) Crawls‡ (4) Pulls to stand (4) Walks with one hand held (9) Catches rolling ball (9) | Pincer grasp (9) Voluntary cube release, into cup (9) Holds bottle (13) | Turns to name, understands routine commands (6) Babbles (6) or gestures intentionally for behaviour regulation (request: reach, point, up; refusal: push, arch away) and social interaction (attention seeking: move arms and legs; social game: imitate clapping; representational: bye-bye) (14) | Looks for object not seen hidden (8) Trial and error exploration (8,10) 'Cause and effect' toys (pushes button to see pop up or pulls string to hear sounds) (8) | Plays pat-a-cake (14) Peekaboo (initiates by putting blanket over head) (10,14) Gives to infants (empathy) (8) Joint attention: gives or shows by extending object to comment (10,14) |
| 18 months | Gets to standing, walks alone (narrow-based, heel-toe gait) (9) Walks up and down stairs, with railing (9) | Inserts shapes, stacks two to three cubes (9) Scribbles: fist (9) Self-feeds (fingers) (13) | Follows one-step commands, points to six body parts (6,10) 15 Words: labels, requests combined with gesture (gives, takes hand to bring toward, object) (10,14) Claps from excitement, hugs stuffed animal (representational), shakes head 'no' (refusal) (14) | Follows visible displacements (11) Imitates using real props (sweeps with broom, bangs with hammer) (11) Functional object use (brushes own hair with brush, pushes toy car) (14) | Imitates peers (10) Joint attention: points to comment, seek information (14) Uses transitional object to self-calm (8) Temper tantrums (11) |
| 24 months (Two years) | Runs, jumps, kicks (9) Throws ball overhand three feet forward (9) Walks up stairs marking time, no railing (9) | Copies vertical line (9) Stacks six cubes (9) Uses spoon, helps dress (13) | 50 words, two-word phrases (10) Talks instead of gestures (5) Nods 'yes,' blows kisses, 'shh', 'highfive' (representation) (14) Speech 50% intelligible to strangers (5) | Symbolic representation, simple pretend (toy broom, toy cup to self/doll, pushes car to work) (8) Strategies without rehearsal (11) Tries to make toys work (8) | Social referencing (8) Comforts others (empathy) (8) Joint attention: points to clarify word approximations (14) Parallel play (8) 'No', 'Mine' (8) |
| 36 months (Three years) | Pedals tricycle (11) Walks down stairs marking time, no railing (9) Walks up stairs alternating feet, no railing (9) | Copies horizontal line, circle (9) Stacks 10 cubes (9) Uses spoon well and fork, drinks from open cup, removes socks and shoes, undresses, indicates voided (13) | Follows two-step commands (6) Three to four word sentences, sequential narratives (5,6) What, who, where, why? (5) Speech 75% intelligible (5) | Object constancy (7,8), symbolic pretend play (stick as broom, doll feeds self block, gives car gas then washes windows) (8) Names one colour, counts two objects, sorts shapes, completes three-four piece puzzle, compares two items ('bigger') (10,11) | Separates easily, initiates peer interactions, shares (7,8,10) Role play (eg, 'house', 'doctor') (8) Understands rules (8) |

TABLE 1 – CONTINUED
Birth to five years 'red flags'* developmental milestones chart for quick office reference

| Age | Gross motor [†] | Fine motor | Speech-language | Cognitive | Social-emotional |
|------------------------|---|---|--|--|---|
| 48 months (Four years) | Hops (9) Walks down stairs alternating feet, no railing (9) Walks backward in line (9) | Copies cross, draws two-to-four-part person (7,9) Cuts paper in half (9) Dresses no buttons, indicates need to void (13) | Follows three-step commands (6) Complex sentences (5) Reports on past events, creates imaginary roles (5) Word play, jokes, teasing (6) | Theory of mind, time concept (8) Generalizes rules (8) Self-talks to problem solve (8) Counts four objects, understands opposites (7,8) | Preferred friend (8) Offers sympathy to peers (empathy) (8) Elaborate fantasy play (eg, 'superhero') (7,8) Usually compliant (8) |
| 60 months (Five years) | Catches ball (9) Balance one foot 10 s (9) Sit-ups (9) Skips (9) | Copies square, draws 10-part person, colours between lines, tripod pencil grasp (7,9) Washes and dries hands thoroughly (13) | Recalls parts of a story (7) Narratives have plot (5) Future tense (6) Speech 100% intelligible (5) | Names four colours (7) Preliteracy/numeracy/writing skills: rhymes (5), counts 10 objects (7), writes name (5) | Plays away from parent, more elaborate discussion of emotions (6,8) Insists on group rules (7) |

Numbers in parentheses refer to reference(s). *Milestone ages quoted are based on the oldest age, wherever documented by evidence, by which the skill should have been achieved; [†]Developmental sector headings follow an easy-to-remember order according to the mnemonic 'Gotta Find Strong Coffee Soon'. Mnemonic created by Peter MacPherson, medical student, University of Alberta (Edmonton, Alberta), Faculty of Medicine and Dentistry; [‡]Some typically developing infants never go through a crawling stage (7)

assessment with definitive results but rather a starting point. A systematic review examining the identification of developmental-behavioural problems in primary care (15) notes that more than 75% of children with problems are correctly identified by good developmental screening instruments, compared with a pick-up rate of less than 54% by paediatric providers; surveillance without screening fails to identify a substantial number of children with developmental disorders.

There is no Canadian recommendation for universal screening during developmental surveillance aside from a general screener (for all developmental sectors), based on the Ontario model, at the enhanced 18-month well-baby visit (www.cps.ca/english/statements/ECD/ECD11-01.htm) and an autism-specific screener between 18 and 24 months of age for children with increased risk for autism. The Rourke Baby Record (www.cfpc.ca or www.cps.ca) recommends the Modified Checklist for Autism in Toddlers (M-CHAT, www.mchatscreen.com) when there are failed items on social/emotional/communication inquiry, a sibling with autism, or developmental concern by a caregiver or physician. An Alberta pilot project has been completed using the Ages and Stages Questionnaire (ASQ, www.brookespublishing.com).

Expert consensus from the American Academy of Pediatrics (AAP) (1) recommends that all primary care providers perform developmental surveillance at each well-child visit by asking caregivers about any developmental, learning or behavioural concerns, performing a physical examination and observing development. AAP guidelines also recommend that a general screener be used both when concerns arise during surveillance and routinely at the nine-, 18-, and 24- or 30-month visit, based on the likelihood of disorders being identified by nine (motor), 18 (communication), and 24 or 30 months (cognitive). There is currently no universally accepted screener. The following examples are completed by parents or nonphysician staff (then reviewed by the physician) and have moderate-to-high levels of sensitivity and specificity. General instruments include the Parents' Evaluation of Developmental Status (PEDS, www.pedstest.com) and the ASQ. The PEDS is shorter and easier to administer (16) but is 'failed' more often than the ASQ (17), while the ASQ is preferred by paediatric residents for learning normal development in continuity clinics (16). The Communication and Symbolic Behavior Scales Developmental Profile Infant-Toddler Checklist (CSBS-DP

IT-Checklist, www.brookespublishing.com) is a communication screener for children six to 24 months of age, which includes language, nonverbal communication, and object use, and may facilitate early detection of language delay, autism and global developmental delay (18). Unlike screeners that rely on parent concerns, the CSBS-DP IT-Checklist may detect possible developmental disorders before parents are aware of problems.

Screener use in Canada remains controversial given the paucity of research on identification of developmental delays (15) and the cost-benefit ratio of screening programs relative to earlier diagnosis (19). Autism-specific screeners can generate false negative results but also identify children with early signs of autism before they are of concern to parents or clinicians (19). Although a systematic review noted that surveillance without screening instruments achieved specificity (approximately or >70%) comparable with screeners, concern exists that false positive screener results may lengthen wait lists for definitive assessment, increase demand on clinician time and generate parental anxiety (15). Practical barriers appear to preclude screener use, including concerns about insufficient intervention resources (www.cps.ca/english/statements/ECD/ECD11-01.htm). Uptake in the United States since the AAP guidelines were published has been low; approximately three-quarters of children at high risk for developmental or behavioural problems have not undergone screening (20). Even practices using screeners have been less successful at making and tracking referrals (17). European recommendations focus on surveillance using milestones, and screeners when concerns arise (www.cps.ca/en/documents/position/enhanced-well-baby-visit). On the other hand, high-risk American children are more likely to receive needed services after positive screens (20), which may support the AAP recommendation that screening be used to facilitate early intervention.

Concerns arising from developmental surveillance (parental concerns, missed milestones or positive screeners) cannot be ignored. Interventions should begin while awaiting definitive diagnosis (Table 2). For example, when more than one developmental sector is affected, the child would be referred to an early intervention program (birth to five years of age) or a specialized preschool program (two to five years of age), for both assessment and treatment. Clinicians, such as speech-language pathologists, audiologists and psychologists, specifically trained to work with children,

TABLE 2
Management of concerns arising from developmental surveillance*

| Developmental sector of concern | Management |
|---|--|
| Deficient performance in any sector | Hearing, vision screens Lead screen if mouthing or pica Early Intervention Program or specialized preschool program for sector-specific evaluations and treatment services by therapists, psychologist, and/or teacher Paediatrician referral |
| Communication skills (Consider speech-language impairment) | Speech-language pathologist, audiologist |
| Multiple sectors (Consider intellectual disability, cerebral palsy) | Psychologist for tests of intellectual abilities and adaptive functioning, speech-language, and/or physical and occupational therapist Consider developmental paediatrician, neurologist |
| Communication and social-emotional skills (Consider autism spectrum disorder or language impairment with mental health difficulties) | Psychologist, speech-language pathologist, mental health therapist Consider developmental paediatrician, neurologist |
| Motor skills (Consider movement disorder) | Physical or occupational therapist Developmental paediatrician, neurologist |
| Self-help skills | Parent training, consider social worker |
| Academic skills (Consider learning disabilities [eg, reading, math in context of average intellectual abilities]) | Psychologist for tests of intellectual abilities and academic achievement |
| Social-emotional skills (Consider mental health condition) | Psychologist, mental health therapist |
| Strengths in multiple areas (Consider intellectual giftedness, academic talent) | Psychologist |
| Colour-naming task | Colour-blindness test if fails to point to named colours |

*Adapted with permission from reference 21

provide sector-specific assessment and intervention. Mental health services referral may be indicated for social-emotional difficulties. Information on community resources that promote development can be sought through the Canadian Paediatric Society (www.cps.ca/en/issues-questions/early-child-development). The child should undergo developmental evaluation by a paediatrician, or by a family physician or nurse practitioner with expertise in developmental paediatrics. Medical and family histories and physical examination will evaluate risk factors for, and etiology of, developmental and behavioural disorders. Specific disorders are diagnosed by performing a detailed interview and through observation of development and behaviour. Common comorbidities, such as sleep, nutritional, behavioural, psychiatric and other medical difficulties, must be identified. Finally, a referral for tertiary level multidisciplinary assessment including developmental paediatrics or paediatric neurology must be considered for delays in multiple developmental sectors or abnormalities on motor examination, suggesting the possibility of disorders such as autism or cerebral palsy.

DEVELOPMENTAL TRAJECTORIES

Understanding trajectories enables interpretation of parent concerns and anticipatory guidance (2). Typical child development has changed little over time and is described in excellent

textbooks (21), which compile knowledge from primary studies not easily accessed by many clinicians. The following summary of trajectories can be used as a quick-reference during surveillance and as a tool for trainees (7,8).

Newborn

Senses are highly attuned to the caregiver’s face, voice and touch. Baby already uses actions to achieve a goal. His or her behavioural cues (crying, gazing, imitation) elicit responsive care and sensory stimulation, which in turn activate genes to promote brain plasticity (especially between zero and six years of age) and hypothalamic-pituitary-adrenal axis and autonomic function. Responsive care enables a calm, alert processing state (self-regulation) for engagement and interaction and, with repetition, creates memory and attachment (close emotional relationship with caregiver). Attachment grows throughout childhood, makes the child seek his or her caregivers when uncomfortable and models other attachments later in life. The quality of parent-child exchanges influences lifetime communication, cognitive abilities, physical health, emotional regulation and caring behaviour (7,8,12,22).

One to two months

When the caregiver responds supportively to feeding cues and is emotionally available for interactions, baby learns he will be treated with attention and respect. Most infants display evening irritability at two to 16 weeks, probably mediated by decreasing central nervous system ability to modulate responses to environmental stimuli (7,23).

Three to four months

Baby is delightful, engaging caregivers in playful interactions (verbal, tactile, motor) – creating mastery of these skills, positive emotional state and sense of self-effectiveness. Parental depression may place baby at risk for developmental compromise (7).

Six months

While baby is sitting supported, its freed-up hands can reach and grasp, enabling sensorimotor exploration (six to 12 months of age). Baby also learns through vision and mouthing, preferring novelty (7,22).

Nine months

Object permanence (knowing objects exist when out of sight) makes attachment possible. Stranger and separation anxiety and night-wakings emerge because baby can envision and miss his caregivers. Baby explores from his caregiver’s ‘secure base’ and, through 24 months, checks back with his caregiver before moving forward. Object constancy (understanding objects will reappear and maintaining a memory long enough to be able to retrieve it at any time) emerges (7,8,22).

12 months

Toddler’s joy is apparent when he can ambulate independently and choose what to explore. First word appears between eight and 14 months of age. Gesture number, variety and frequency predict later language levels; representational gestures are experience dependent. Age of independent walking does not predict other areas of development unless delayed beyond 18 months (7,14,5).

18 months

Toddler shows excitement about exploring but increased separation anxiety with previously accepted situations. He clings to caregivers to refuel his determination to do things independently. Between one and two years of age, toddlers begin simple pretend play, first directed to self and then toward a doll or stuffed toy.

TABLE 3
Birth to 12 months 'red flags' developmental milestones chart – levels of evidence

| Age | Gross motor | Fine motor | Speech-language | Cognitive | Social-emotional |
|-------------|--|--|---|---|--|
| Newborn | Moro, asymmetrical tonic neck, positive support primitive reflexes (3) (E) Flexed posture (4) (A) | Hand grasp primitive reflex (3) (E) | Root, suck primitive reflexes (5) (E) Orients to sound (0–3 months) (6) (E) Variable cries (0–3 months) (6) (E) | Visual focal length ~10 in (7) (E) Turns to visual stimuli (8) (E) Prefers human face (eyes), contrast, colours, high pitched voice (7,8) (E) | Cries when infant cries (empathy) (8) (E) |
| Two months | Head up 45° in prone (0.5 months, 2 months) (4) (A) | Holds placed rattle (9) (C) | Gurgles (0–3 months) (6) (E) | Follows horizontal arc (9) (C) | Awake more during day (7) (E) |
| Four months | Asymmetrical tonic neck primitive reflex develops (1–3 months) (3)(E) Lifts chest in prone (2.5 months, 4 months) (4) (A) | Brings hands together in midline (2.5 months, 4 months) (4) (A) Extends straight arms toward rattle, supine (3 months) (9) (C) Reaches and grasps rattle (9) (C) | Coos (2–4 months) (6) (E) | Watches hands (0–3 months) (8) (E) Explores environment by looking around (0–3 months) (8) (E) Anticipates routines (3 months) (7) (E) Looks to find caregiver (3 months) (7) (E) | Calms when spoken to, picked up, sucking, or looking (0–3 months) (8) (E) Enjoys eye contact (0–3 months) (8) (E) Facial expressions of joy, anger, sadness, distress, surprise (0-3 months) (8) (E) Self-soothes to sleep (3–4 months) (7,8) (E) |
| Six months | Primitive reflexes gone (3) (E) Pulls to sit (3.5 months, 5 months) (4) (A) Sits tripod (4.5 months, 6 months) (4) (A) | Shakes rattle (9) (C) Holds cube between 2 hands (9) (C) (BLOCKS) Holds one cube in each hand (9) (C) (BLOCKS) Ulnar-palmar grasp (4 th and 5 th fingers), radial-palmar grasp (1 st and 2 nd fingers) (9) (C) (BLOCKS) | Looks toward person talking to him (3–6 months) (6) (E) Vocalizes to answer (3–6 months) (5,6) (E) Laughs (3–6 months) (5,6) (E) | Bangs objects together (3–6 months) (10) (D) Trial and error problem solving (0–6 months) (8) (E) Looks for dropped object (4–6 months) (11) (D) | Predictable schedule (3–6 months) (7) (E) Smiles to initiate engagement and respond (3–6 months) (12) (E) Back-and-forth engagement through facial expressions and eye contact; shares enjoyment (joyful looks) (3–6 months) (12) (E) Prefers familiar people (3–6 months) (8) (E) Shows interest in other infants (empathy) (8) (E) |
| Nine months | Postural reflexes present (4–9 months) (3) (E) Rolls both ways (6 months, 8.5 months) (4) (A) Sits well (6.5 months, 8 months) (4) (A) | Transfers (7 months) (9) (C) (BLOCK) Radial-digital grasp (thumb with 1 st and 2 nd fingers, no palm) (7 months) (9) (C) (BLOCKS) Touches Cheerio* with finger (7 months) (9) (C) Raking pincer grasp (8 months) (9) (C) | Looks to familiar named object (6-8 months), inhibits to 'no' (6–9 months) (10) (D) Vocalizes to initiate (6–8 months) (6) (E) | Object permanence (7 months) (8) (E) Explores caregiver's face (7 months) (8) (E) Searches for hidden toy (7 months) (8) (E) | Attachment development established (7 months) (8) (E) |
| 12 months | Gets to sit (9 months, 11 months) (4) (A) Crawls† (9 months, 11 months) (4) (A) Pulls to stand (8 months, 10 months) (4) (A) Walks with one hand held (9) (C) Catches rolling ball (9) (C) | Pincer grasp (11 months) (9) (C) Voluntary cube release (10 months), into cup (11 months) (9) (C) (BLOCKS) Holds bottle (6 months, 12 months) (13) (B) | Turns to name (8–12 months), understands routine commands (8-12 months) (6) (E) Babbles (6–10 months) (6) (E) or gestures intentionally for behaviour regulation (BUBBLES) (request: reach, point, up; refusal: push, arch away) and social interaction (attention seeking: move arms and legs; social game: imitate clapping; representational: bye-bye) (9–12 months) (14) (E) | Looks for object not seen hidden (8) (E) Trial and error exploration (6–12 months) (8) (E) 'Cause and effect' toys (pushes button to see pop-up or pulls string to hear sounds) (6–12 months) (8) (E) | Plays pat-a-cake (14) (E) Peek-a-boo (initiates by putting blanket over head) (9–12 months) (10,14) (D,E) (TOWEL) Gives to infants (empathy) (6) (E) Joint attention: gives or shows by extending object to comment (9–12 months) (10,14) (D,E) |

Numbers in parentheses indicate reference(s). Words in capital letters in parentheses are suggestions of props to elicit skills. *General Mills, Canada; †Some typically developing infants never crawl (7). A High-quality evidence (4), based on 90th percentile (ie, age by which 90% of children have mastered this gross motor skill). Ages in brackets represent the 50th and 90th percentiles; B High-quality evidence (13), based on 90th percentile (ie, age by which 90% of children have mastered this self-care skill). Ages in brackets represent the oldest age from the 50th percentile age range and the oldest age from the 90th percentile age range; C High-quality evidence (9), based on 50th percentile (ie, age by which 50% of children have mastered this gross or fine motor skill). Ages in brackets represent the 50th percentile age range; D Low- (10) or moderate- (11) quality evidence, based on 'oldest age' by which the communication, cognitive or social-emotional skill has been typically mastered. No percentiles provided. Age range in brackets; E Low-quality evidence (3,5-8,12,14), based on 'oldest age' by which the cognitive or social-emotional skill has been typically mastered. No percentiles provided. Age range in brackets

TABLE 4
18 months to five years 'red flags' developmental milestones chart – levels of evidence

| Age | Gross motor | Fine motor | Speech-language | Cognitive | Social-emotional |
|-------------------------|--|---|---|---|--|
| 18 months | Gets to standing, walks alone (narrow-based, heel-toe gait) (11.5–14.5 months) (9) (C) Walks up (15–16 months) and down (17–18 months) stairs, with railing (9) (C) | Inserts shapes (17–18 months) (9) (C) Stacks two to three cubes (15–16 months) (9) (C) (BLOCKS) Scribbles (14 months): fist-d (15–16 months) (9) (C) (MARKER) Self-feeds (fingers) (6 months, 18 months) (13) (B) | Follows one-step commands (12–18 months) (6) (E), points to six body parts (15–18 months) (10) (D) 15 Words: labels (15–18 months), requests combined with gesture (gives object [12–15 months], takes hand to bring toward object [15–18 months]) (10, 14) (D, E) Claps from excitement, hugs stuffed animal (12–15 months) (representational), shakes head 'no' (15–18 months) (refusal) (14) (E) | Follows visible displacements (14–15 months) (11) (D) Imitates using real props (sweeps with broom, bangs with hammer) (15–18 months) (11) (D) Functional object use (brushes own hair with brush, pushes toy car) (12–15 months) (14) (E) | Imitates peers (12–15 months) (10) (D) Joint attention: points to comment (12–15 months), seek information (15–18 months) (14) (E) (MOBILE) Uses transitional object to self-calm (8) (E) Temper tantrums (11) (D) |
| Two years (24 months) | Runs (19–20 months), jumps (23–24 months), kicks (15–24 months) (9) (C) Throws ball overhand three feet forward (19–20 months) (9) (C) Walks up stairs marking time, no railing (23–24 months) (9) (C) | Copies vertical line (23–24 months) (9) (C) (MARKER) Stacks six cubes (21–22 months) (9) (C) Uses spoon (18 months, 24 months), helps dress (shirt 12 months, 24 months; pants 18 months, 24 months) (13) (B) | 50 Words, two-word phrases (21–24 months) (10) (D) Talks instead of gestures (18–24 months) (5) (E) Nods 'yes,' blows kisses, 'shh,' 'highfive' (18–24 months) (representational) (14) (E) Speech 50% intelligible to strangers (18–24 months) (5) (E) | Symbolic representation (12–24 months) (8) (E) Strategies without rehearsal (12–24 months) (11) (D) Tries to make toys work (12–24 months) (8) (E) Simple pretend play (toy broom, toy cup to self/doll, pushes car to go to work) (13–24 months) (8) (E) (DOLL, CUP) | Social referencing (12–24 months) (8) (E) Comforts others (empathy) (12–24 months) (8) (E) Joint attention: points to clarify word approximations (18–24 months) (14) (E) Parallel play (13–24 months) (8) (E) 'No', 'Mine' (19–24 months) (8) (E) |
| Three years (36 months) | Pedals tricycle (24–30 months) (11) (D) Walks down stairs marking time, no railing (25–26 months) (9) (C) Walks up stairs alternating feet, no railing (35–36 months) (9) (C) | Copies horizontal line (27–28 months), circle (33–34 months) (9) (C) (MARKER) Stacks 10 cubes (29–30 months) (9) (C) (BLOCKS) Uses spoon well (24 months, 30 months) and fork (24 months, 36 months), drinks from open cup (<18 months, 30 months), removes socks and shoes (18 months, 30 months), undresses (24 months, 36 months), indicates voided (bladder 24 months, 36 months) (bowel 24 months, 30 months) (13) (B) | Follows two-step commands (24–36 months) (6) (E) three-to-four word sentences (24–36 months), sequential narratives (30–36 months) (5, 6) (E) What, who, where, why? (24–36 months) (5) (E) Speech 75% intelligible (5) (E) | Object constancy (2–3 years) (7, 8) (E) Symbolic pretend play (stick as broom (25–30 months), feeds doll invisible object, doll feeds self), two-step (car goes to garage to get gas and then windows washed) (31–36 months) (8) (E) Names one colour (10) (D), counts two objects, sorts shapes, completes three-to-four piece puzzle, compares two items ('bigger') (30–36 months) (11) (D) | Separates easily, initiates peer interactions (7, 8) (E), shares (2–3 years) (10) (D) Role play (eg 'house', 'doctor') (31–36 months) (11) (D) Understands rules (24–36 months) (8) (E) |
| Four years (48 months) | Hops (47–48 months) (9) (C) Walks down stairs alternating feet, no railing (43–44 months) (9) (C) Walks backward in line (45–46 months) (9) (C) | Copies cross (39–40 months) (9) (C), draws two-to-four-part person (7) (E) (MARKER) Cuts paper in half (37–38 months) (9) (C) Dresses no buttons (pants 30 months, 42 months) (shirt 36 months, 48 months), indicates need to void (30 months, 42 months) (13) (B) | Follows three-step commands (36–48 months) (6) (E) Complex sentences (42–48 months) (5) (E) Reports on past events, creates imaginary roles (42–48 months) (5) (E) Word play, jokes, teasing (36–48 months) (6) (E) | Theory of mind, time concept (3–4 years) (8) (E) Generalizes rules (3–4 years) (8) (E) Self-talks to problem-solve (3–4 years) (8) (E) Counts four objects, understands opposites (3–4 years) (7, 8) (E) | Preferred friend (3–4 years) (8) (E) Offers sympathy to peers (empathy) (42–48 months) (5) (E) Elaborate fantasy play (eg, 'superhero') (3–4 years) (7, 8) (E) Usually compliant (3–4 years) (8) (E) |
| Five years (60 months) | Catches ball (33–52 months) (9) (C) Balance one foot 10 s (59–60 months) (9) (C) Sit-ups (59–60 months) (9) (C) Skips (57–58 months) (9) (C) | Copies square (49–50 months) (9) (C), draws 10-part person (7) (E), colours between lines (59–60 months) (9) (C), tripod pencil grasp (49–50 months) (9) (C) (MARKER) Washes and dries hands thoroughly (42 months, 54 months) (13) (B) | Recalls parts of a story (7) (E) Narratives have plot (48–60 months) (5) (E) Future tense (48–60 months) (6) (E) Speech 100% intelligible (48–60 months) (5) (E) | Names four colours (7) (E) Preliteracy/numeracy/writing skills: rhymes (2–5 years) (5) (E), counts 10 objects (7) (E), writes name (2–5 years) (5) (E) | Plays away from parent, more elaborate discussion of emotions (4–5 years) (6, 8) (E) Insists on group rules (7) (E) |

Numbers in parentheses indicate reference(s). Words in capital letters in parentheses are suggestions of props to elicit skills. B High-quality evidence (13), based on 90th percentile (ie, age by which 90% of children have mastered this self-care skill). Ages in brackets represent the oldest age from the 50th percentile age range and the oldest age from the 90th percentile age range; C High-quality evidence (9), based on 50th percentile ie age by which 50% of children have mastered this gross or fine motor skill. Range in brackets represents 50th percentile; D Low- (10) or moderate- (11) quality evidence, based on 'oldest age' by which the communication, cognitive or social-emotional skill has been typically mastered. No percentiles provided. Age range in brackets; E Low-quality evidence (5-8, 14), based on 'oldest age' by which the cognitive or social-emotional skill has been typically mastered. No percentiles provided. Age range in brackets

Temper tantrums result from rapid acquisition of gross motor and receptive language skills with ongoing limitations in expressive communication, motor dexterity, attention, delaying gratification and cooperation with playmates (7,8,11,22).

Two years

Major growth in cognition and language represents the transition from infancy to childhood. By 30 months of age, preschoolers demonstrate symbolic pretend play by assigning imaginary properties to objects and using figures as agents of their own action. Tantrums, aggression and noncompliance peak (7,8).

Three years

Learning cooperative play is the goal; group experience is crucial. The preschooler feels remorse and may try restitution (thinks of what he could do to make up for misbehaviour), and describes emotions and the situations eliciting them. Imaginary play enables social-emotional and cognitive growth (expression of negative feelings, wish fulfillment, processing of day's events). Bedtime fears and nightmares occur. He is not capable of lying; 'inaccurate talk' reflects his real perceptions (6-8).

Four years

Child develops self-identity outside the family and asks for detailed information about his environment. A child who does not have friends (overly shy, bullies) needs help; peers recognize when a child is not socially well-adjusted. Between four and six years of age, he displays increased emotional regulation over anger and aggression, and learns to resolve conflicts with discussion by acting assertively while respecting peers' rights. He shows strong attachment for the opposite sex caregiver, with gradual emergence of sex-specific behaviour (group physical games for boys, turn-taking role-play for girls) (7,8).

Five years

School readiness includes strong social-emotional capacity (self-confidence, self-control, communication and cooperation), motivation to learn (curiosity) and intellectual skills. Between four and six years of age, he becomes able to take turns in conversation, listen to others' points of view and respond appropriately. Letter sounds and names are learned by seven years of age, and handedness is well-established by nine years of age (5,8,24-26).

EVIDENCE-BASED MILESTONE AGES

A comprehensive milestone chart with evidence-based ages can be of tremendous value in surveillance, helping parents learn about child development (50th percentile milestones) and teaching residents how to quickly identify typical versus atypical development (90th percentile) (27). Traditionally, clinicians do not know when to consider a milestone delayed because typical ages of developmental attainments (different across sources) exist within a range, and referenced percentiles are lacking on clinically available charts. The developmental skills of one-half of children fall below the 50th percentile, which could result in parents falsely concluding that their child is delayed or being falsely reassured when their child experiences mild to moderate delays (27). Residents and clinicians need to know when to be concerned; therefore, upper limits of the range have more utility for surveillance (27).

Tables 1 and 2 serve as an accessible office reference for milestones and management of concerns arising from surveillance. The milestone ages quoted are based on the oldest age by which the skill should have been achieved, using the best evidence-based upper thresholds currently available. Appropriate correction for gestational age would be needed for infants born before 37 weeks'

gestation. Table 1 could be used with the Rourke Baby Record; intervals match the Canadian well-child visit schedule for newborns through children five years of age. During developmental evaluation, age equivalents from each sector provide valuable information for differential diagnosis; eg, isolated language delay indicates risk for language-based learning disability, communication with social-emotional delays suggest possible autism and delays in all sectors identifies possible intellectual disability.

Tables 3 and 4 include the levels of evidence for uppermost age thresholds, to the extent that these are known. Evidence sources were recommended by physical, occupational, and speech-language therapists and psychologists. The Alberta Infant Motor Scale (AIMS) (4), Peabody Developmental Motor Scales (PDMS) (28), and Pediatric Evaluation of Disability Inventory (PEDI) (13) are well-validated, standardized, formal assessment tools, normed on large population samples, and used extensively clinically and in research literature (Levels A to C). The AIMS and PEDI identify the 90th percentile for gross motor and self-care skills, respectively (4,13). For example, walking independently is mastered by 90% of children at 14 months of age; this milestone is in the 18-months row of Table 1 because it will typically have been mastered between the 12- and 18-month well-child visits. The PDMS identifies the 50th percentile for gross and fine motor skills (28). The Hawaii Early Learning Profile (HELP) (29) and Rossetti Infant-Toddler Language Scale (10) assessments, based on the synthesis of other assessments or observations, are supported by much less evidence (Level D). Interestingly, clinically useful communication, cognitive and social-emotional milestone ages are from a small sample size (5) or are only available in textbooks or charts, that do not provide percentiles, nor do they usually match ages directly to references, precluding examination of the multiple original sources (Level E) (5-8). Tables 3 and 4 include suggestions of props to elicit skills. While lacking evidence, they are useful for teaching residents to recognize typical versus atypical milestone attainment and for developmental evaluation following risk identification.

Using milestone ages for developmental surveillance is a weak recommendation (www.canadiantaskforce.ca) based on the higher sensitivity of screening instruments and low evidence quality for several milestone ages; it is expected to miss detection of present problems. The high-quality evidence for gross motor and self-care skills at 90th percentile ages suggests they may be useful in identifying delays. Because there is some variability in typical development, clinical judgment must be used to determine the significance of delays in the context of the environment and interplay with development in the other sectors to decide on the appropriate clinical action (4,29). Despite the low-quality evidence for communication, cognitive and social-emotional ages, using them during history taking enhances the clinician's understanding of typical development in these traditionally less-familiar areas. As a surveillance tool, the red flags chart is expected to improve detection rates compared with not performing surveillance whatsoever. Surveillance is important, considering economic benefits from investing in early childhood development intervention (22). In the absence of Canadian guidelines on routine screeners outside the 18-month visit, we suggest in the meantime that clinicians consider using a screener when red flags are identified, to increase sensitivity and specificity thresholds for referral.

CONCLUSION

All paediatric clinicians should perform developmental surveillance to promote healthy development and identify children who may have developmental problems. Surveillance requires understanding of developmental trajectories and milestones. Ages of milestones

should be evidence-based to the extent possible and represent all developmental sectors. There are minimal guidelines available in Canada, to date, regarding the use of standardized developmental screening instruments, although such screeners increase the detection rate of children at risk of developmental disorders. Interventions can be initiated before definitive diagnostic assessment is complete.

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