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(54) **HEALTHCARE CAREGIVER BEHAVIOR COACHING SYSTEM AND METHOD**

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A61B 5/00	(2006.01)

(52) **U.S. Cl.**

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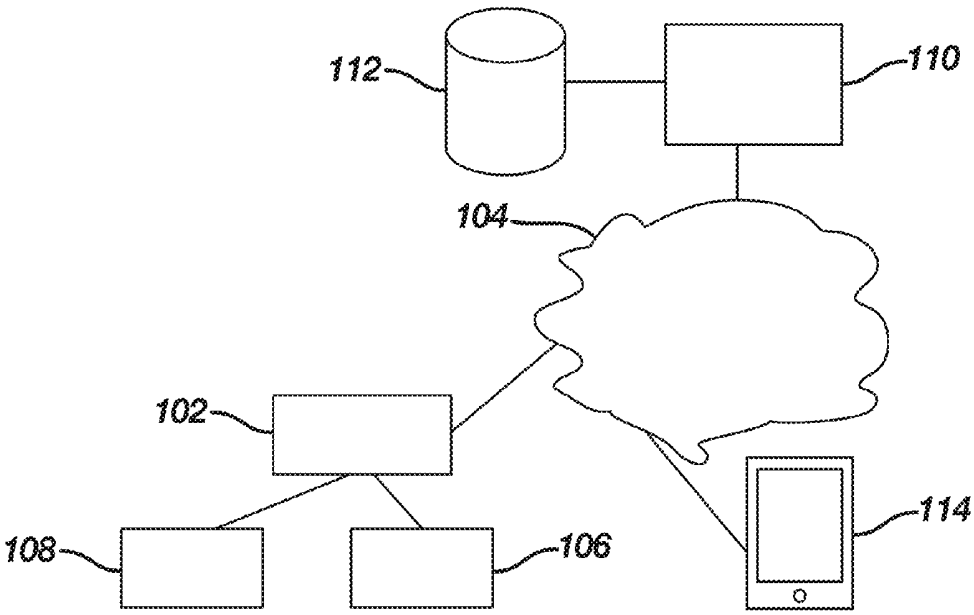
(57) **ABSTRACT**

A health care system for a caregiver to monitor and manage sleep metric, patterns and quality for an infant, including: a) a base station in communication with a network, b) one or more sensors in communication with the base station, c) a caregiver communication device in communication with the network; and d) a remote server and associated data store in communication with the network. The remote server is operative to: 1) access information from the information store indicating caregiver typing traits, 2) receive information from the sensors indicating a sleep quality for the infant, 3) receive information from the caregiver communication device indicating a caregiver perception of sleep quality for the infant, 4) recommend at least one caregiver action as a function of the caregiver typing traits, the sleep quality measures and the caregiver perception of the sleep quality; and 5) transmit the recommended action to the caregiver communication device.



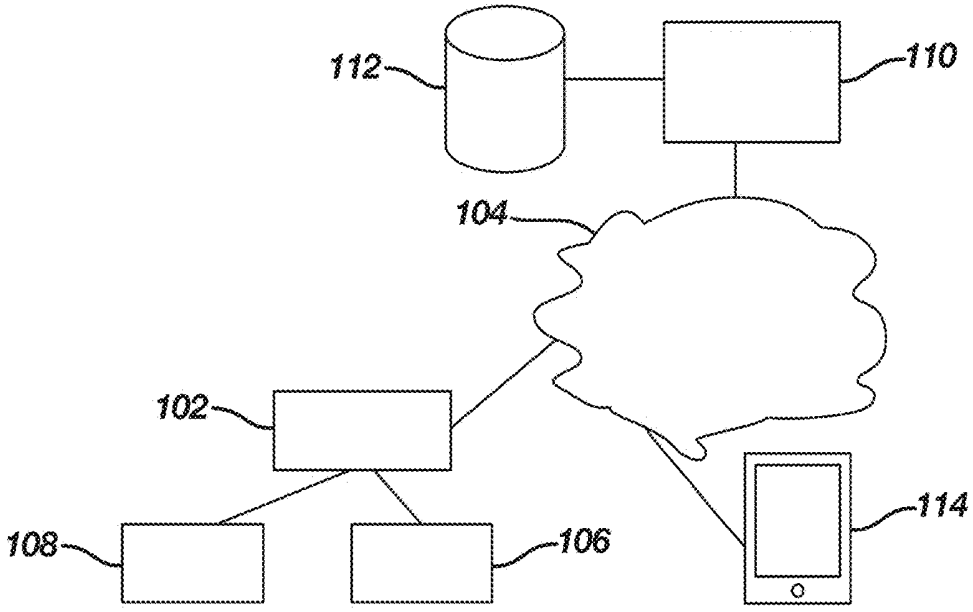


FIG. 1

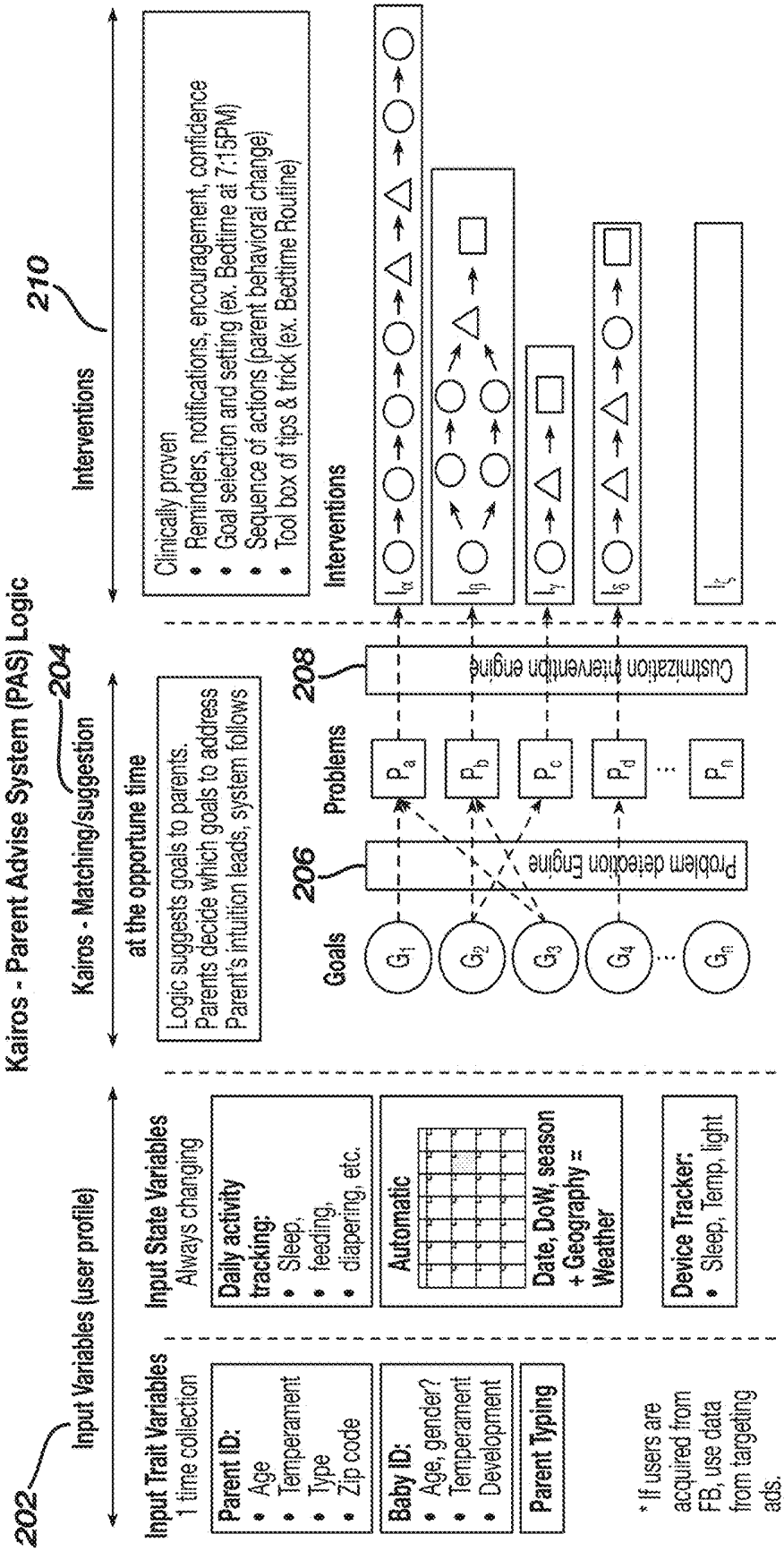

Kairos - Parent Advise System (PAS) Logic
202
Input Variables (user profile)
Kairos - Matching/suggestion
204
at the opportune time
Interventions
210
Input Trait Variables
1 time collection
Parent ID:
• Age
• Temperament
• Type
• Zip code
Baby ID:
• Age, gender?
• Temperament
• Development
Parent Typing
* If users are acquired from FB, use data from targeting ads.
Input State Variables
Always changing
Daily activity tracking:
• Sleep,
• feeding,
• diapering, etc.
Automatic
Date, DoW, season + Geography = Weather
Device Tracker:
• Sleep, Temp, light
Logic suggests goals to parents.
Parents decide which goals to address
Parent's intuition leads, system follows
Goals
206
Problem detection Engine
Problems
208
Customization intervention engine
Clinically proven
• Reminders, notifications, encouragement, confidence
• Goal selection and setting (ex. Bedtime at 7:15PM)
• Sequence of actions (parent behavioral change)
• Tool box of tips & trick (ex. Bedtime Routine)
Interventions

FIG. 2A

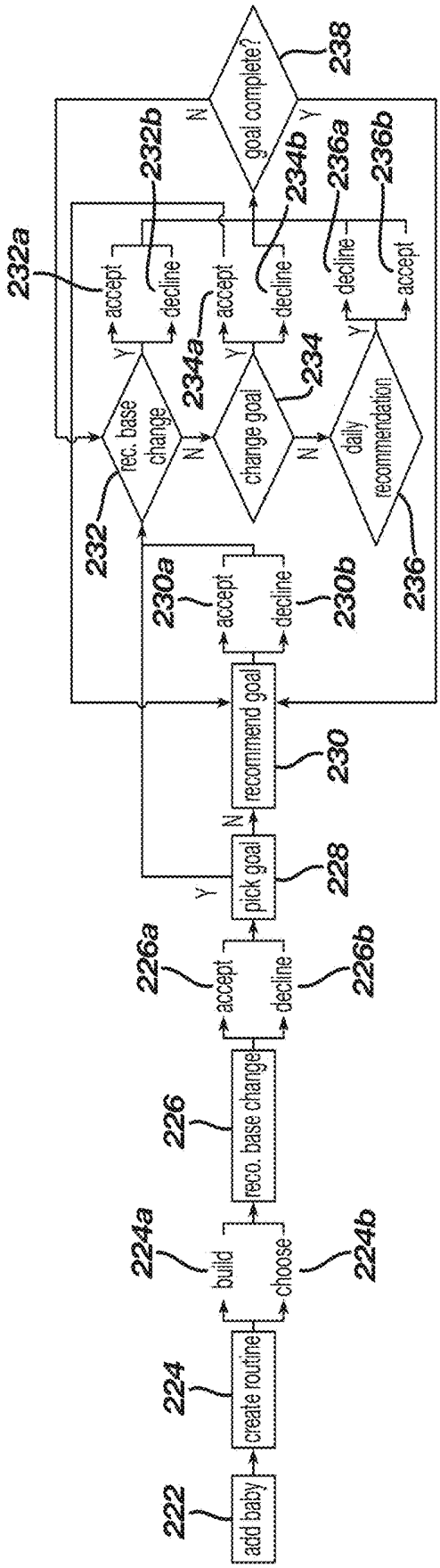

add baby
222
create routine
224
build
choose
224a
224b
reco. base change
226
accept
decline
226a
226b
pick goal
228
recommend goal
230
accept
decline
230a
230b
rec. base change
232
accept
decline
232a
232b
change goal
234
accept
decline
234a
234b
daily recommendation
236
decline
accept
236a
236b
goal complete?
238
Y
N

FIG. 2B

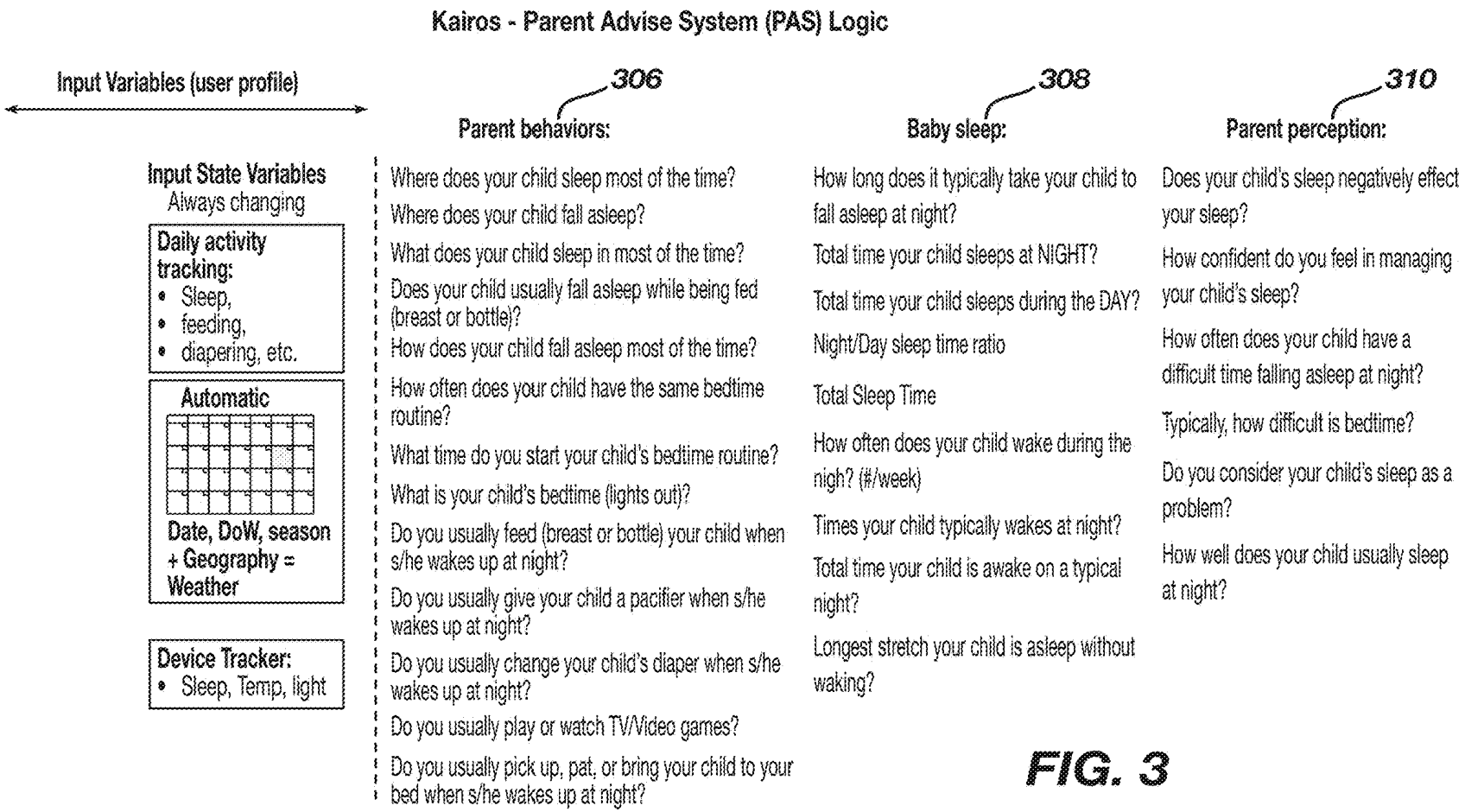

Kairos - Parent Advise System (PAS) Logic
Input Variables (user profile)
Input State Variables
Always changing
Daily activity tracking:
• Sleep,
• feeding,
• diapering, etc.
Automatic
Date, DoW, season + Geography = Weather
Device Tracker:
• Sleep, Temp, light
306
Parent behaviors:
Where does your child sleep most of the time?
Where does your child fall asleep?
What does your child sleep in most of the time?
Does your child usually fall asleep while being fed (breast or bottle)?
How does your child fall asleep most of the time?
How often does your child have the same bedtime routine?
What time do you start your child's bedtime routine?
What is your child's bedtime (lights out)?
Do you usually feed (breast or bottle) your child when s/he wakes up at night?
Do you usually give your child a pacifier when s/he wakes up at night?
Do you usually change your child's diaper when s/he wakes up at night?
Do you usually play or watch TV/Video games?
Do you usually pick up, pat, or bring your child to your bed when s/he wakes up at night?
308
Baby sleep:
How long does it typically take your child to fall asleep at night?
Total time your child sleeps at NIGHT?
Total time your child sleeps during the DAY?
Night/Day sleep time ratio
Total Sleep Time
How often does your child wake during the nigh? (#/week)
Times your child typically wakes at night?
Total time your child is awake on a typical night?
Longest stretch your child is asleep without waking?
310
Parent perception:
Does your child's sleep negatively effect your sleep?
How confident do you feel in managing your child's sleep?
How often does your child have a difficult time falling asleep at night?
Typically, how difficult is bedtime?
Do you consider your child's sleep as a problem?
How well does your child usually sleep at night?

FIG. 3

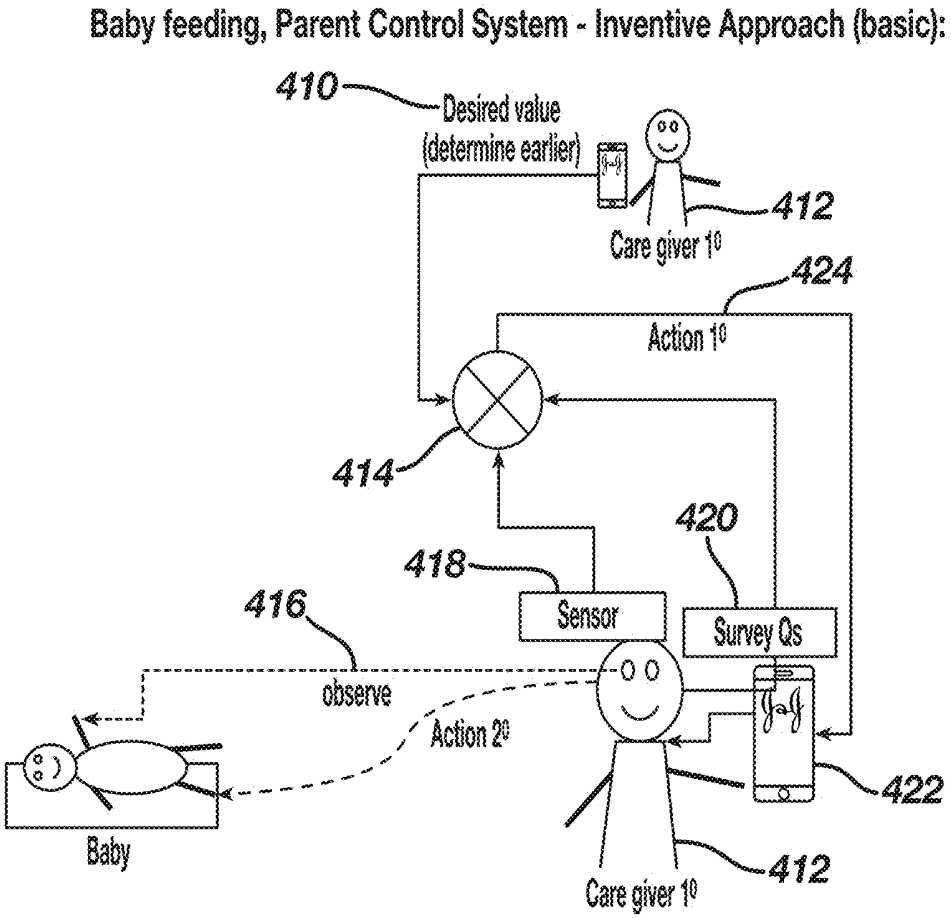

Baby feeding, Parent Control System - Inventive Approach (basic):
410
Desired value
(determine earlier)
412
Care giver 1⁰
424
Action 1⁰
414
420
418
Sensor
Survey Qs
416
observe
Action 2⁰
422
Baby
412
Care giver 1⁰

FIG. 4A

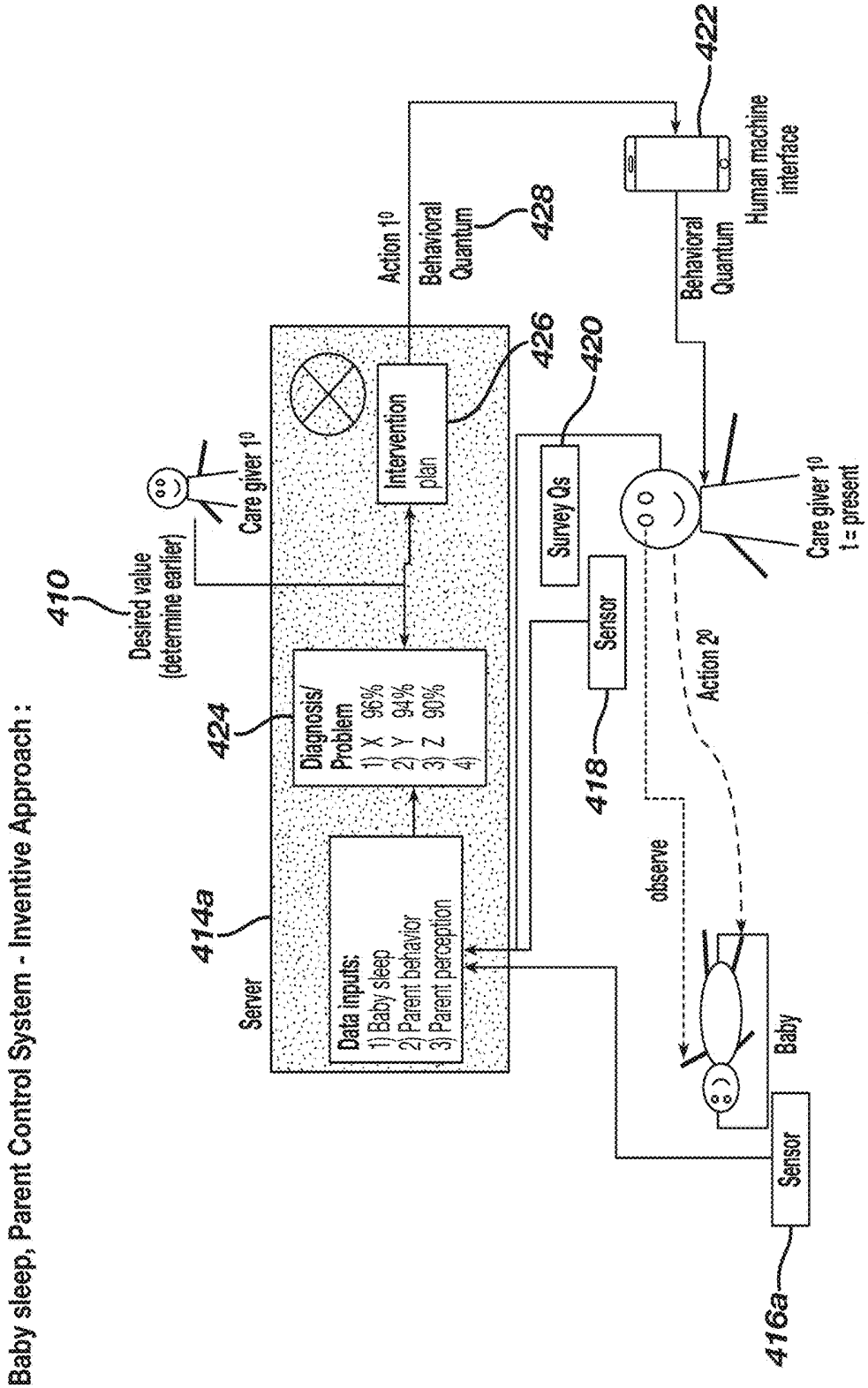

Baby sleep, Parent Control System - Inventive Approach :
410
Desired value (determine earlier)
Care giver 1⁰
Server
414a
Data inputs:
1) Baby sleep
2) Parent behavior
3) Parent perception
424
Diagnosis/ Problem
1) X 96%
2) Y 94%
3) Z 90%
4)
Intervention plan
426
Action 1⁰
Behavioral Quantum
428
422
Human machine interface
Behavioral Quantum
420
Survey Qs
Sensor
418
Action 2⁰
observe
Care giver 1⁰ t = present
Baby
Sensor
416a

FIG. 4B

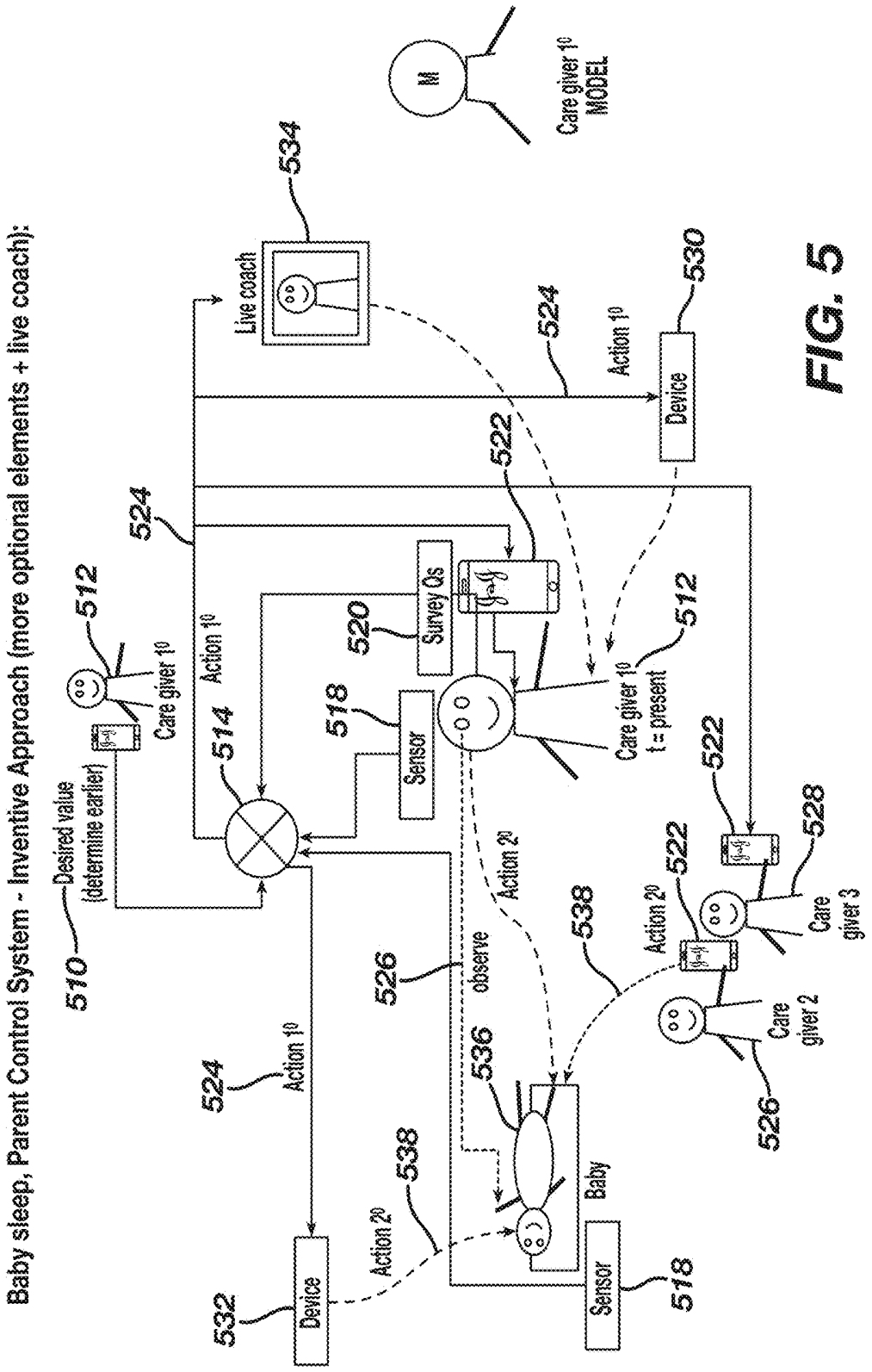
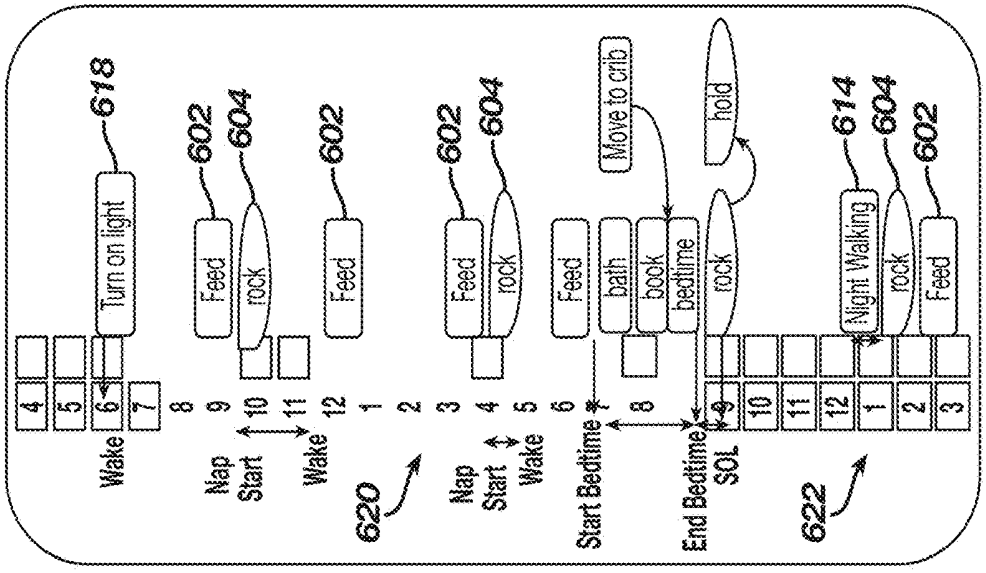

Baby sleep, Parent Control System - Inventive Approach (more optional elements + live coach):
Care giver 1⁰ MODEL
534
Live coach
524
Action 1⁰
530
Device
522
524
512
Care giver 1⁰
Action 1⁰
520
Survey Qs
512
Care giver 1⁰ t = present
518
Sensor
514
Desired value (determine earlier)
510
522
528
Care giver 3
Action 2⁰
522
538
Action 2⁰
526
observe
Care giver 2
526
536
524
Action 1⁰
538
Action 2⁰
Baby
532
Device
Sensor
518

FIG. 5


618
Turn on light
602
604
Feed
rock
602
Feed
602
604
Feed
rock
Move to crib
hold
614
604
602
Night Walking
rock
Feed
Wake
Nap Start
Wake
620
Nap Start
Wake
Start Bedtime
End Bedtime
SOL
622
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
8
9
10
11
12
1
2
3

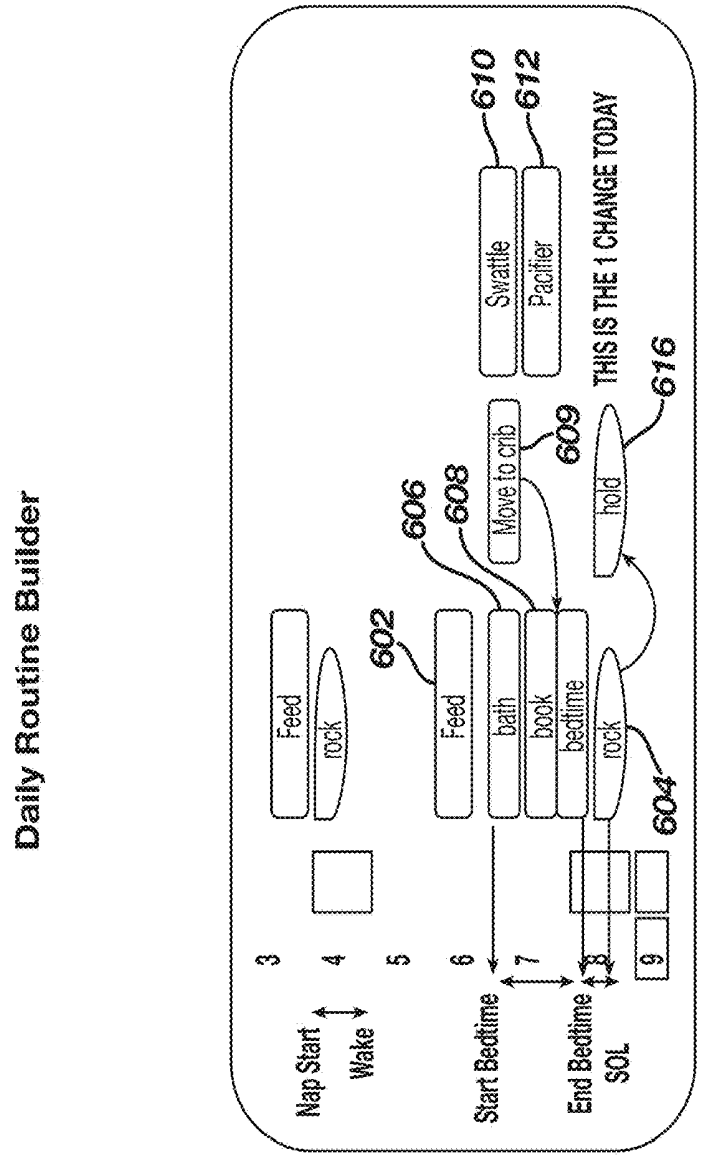

Daily Routine Builder
610
612
Swattle
Pacifier
THIS IS THE 1 CHANGE TODAY
616
606
608
609
Move to crib
hold
602
Feed
rock
Feed
bath
book
bedtime
rock
604
Nap Start
Wake
Start Bedtime
End Bedtime
SOL
3
4
5
6
7
8
9

FIG. 6A

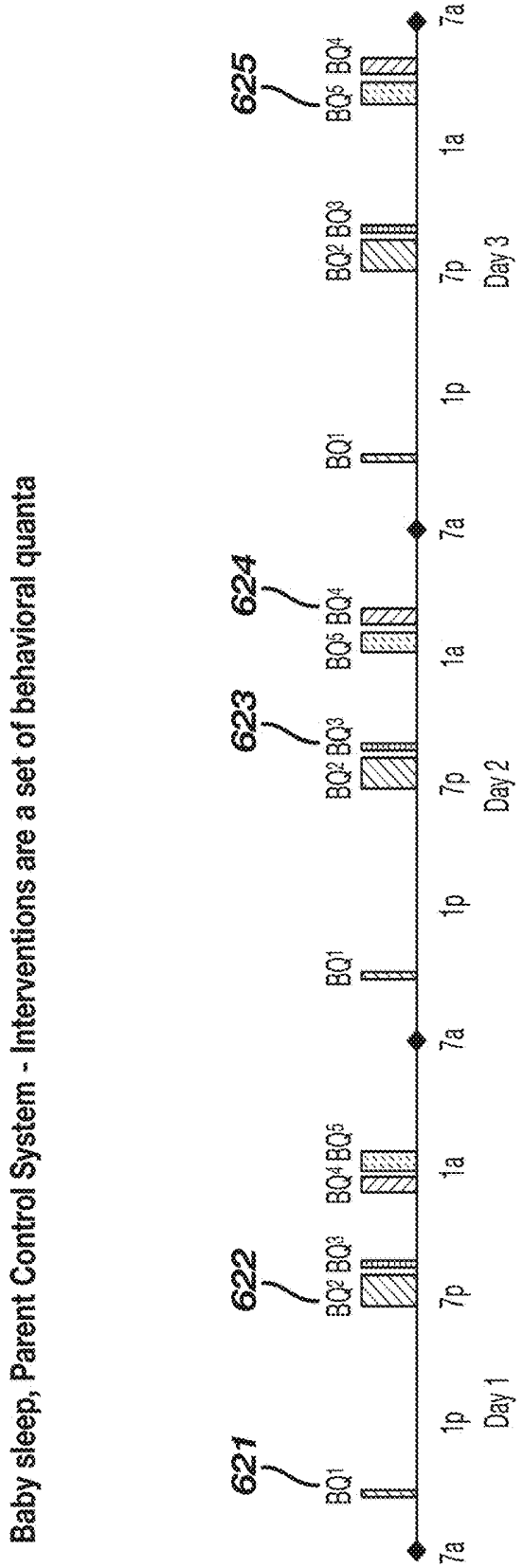

Baby sleep, Parent Control System - Interventions are a set of behavioral quanta
621
622
623
624
625
BQ1
BQ2 BQ3
BQ4 BQ5
7a
1p
7p
1a
Day 1
Day 2
Day 3

FIG. 6B

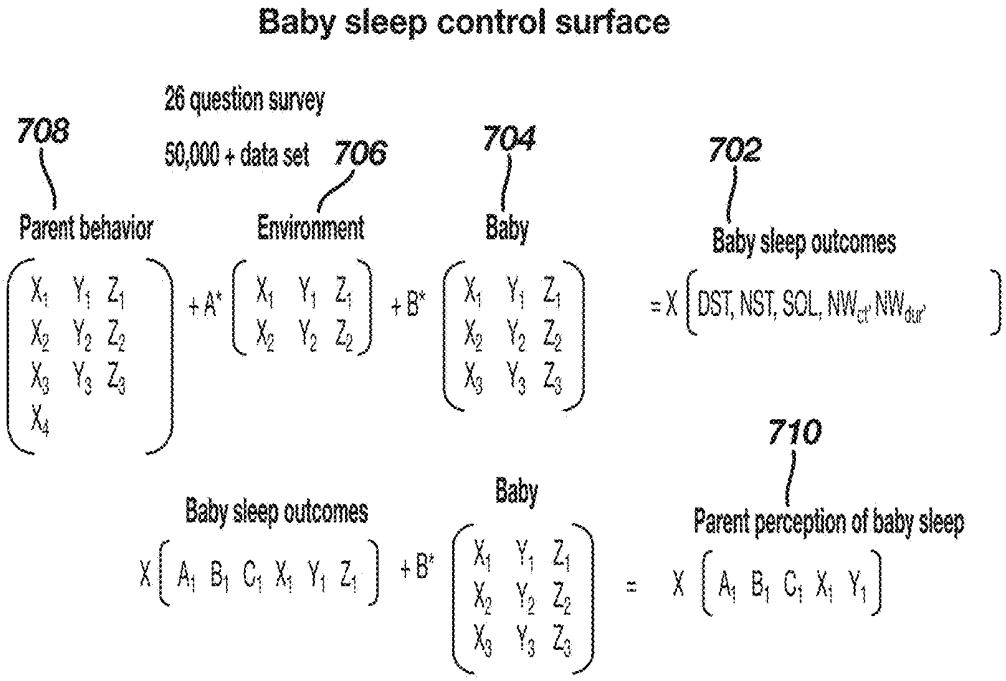

Baby sleep control surface
26 question survey
50,000 + data set
708
706
704
702
Parent behavior
Environment
Baby
Baby sleep outcomes
DST, NST, SOL, NW_ct, NW_dur
710
Baby sleep outcomes
Baby
Parent perception of baby sleep

FIG. 7

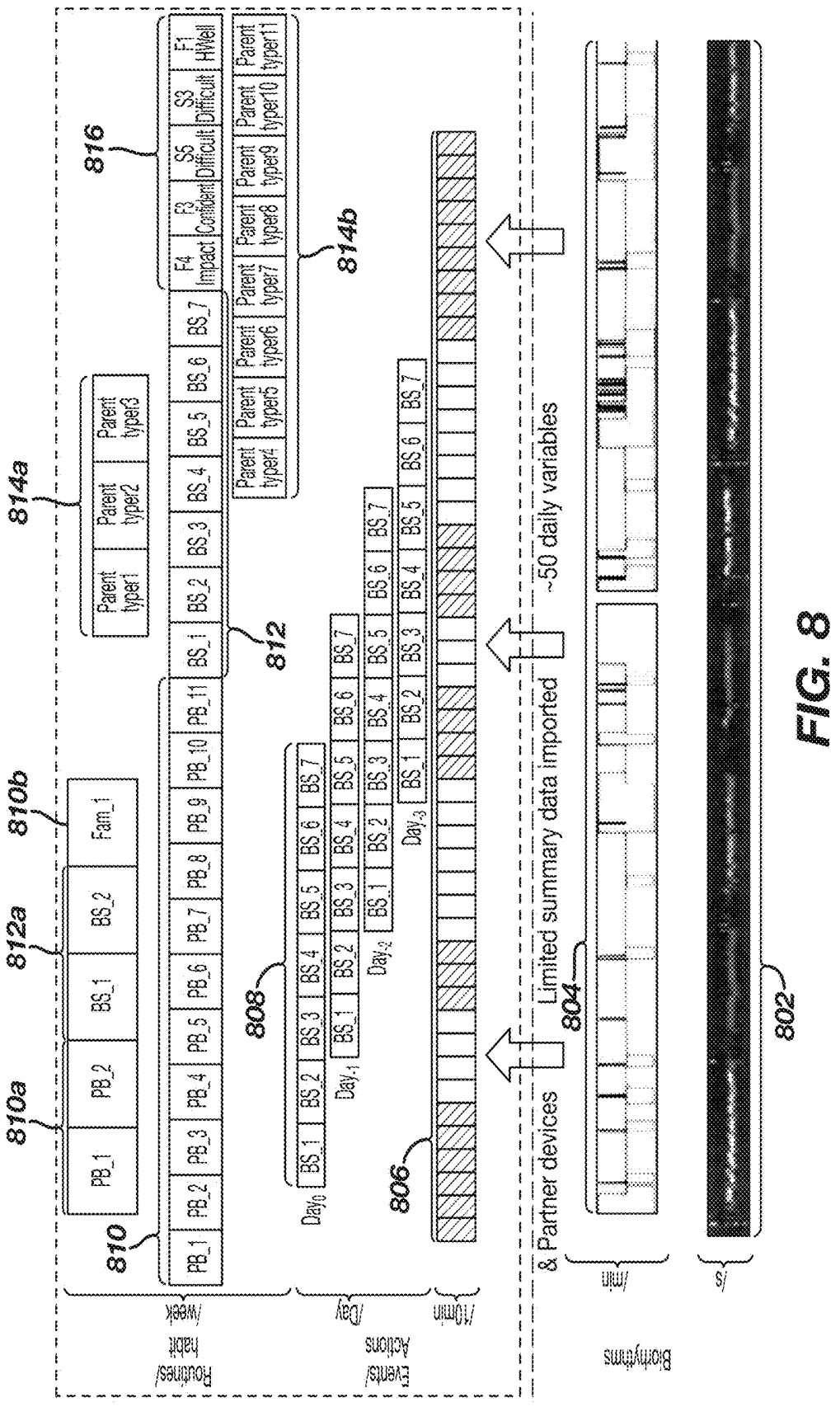

Routines/ habit /week
Events/ Actions
/Day
/10min
Biomyétms
/min
/s
& Partner devices
Limited summary data imported
~50 daily variables
804
802
806
808
812
812a
810
810a
810b
814a
814b
816
PB_1
PB_2
PB_3
PB_4
PB_5
PB_6
PB_7
PB_8
PB_9
PB_10
PB_11
BS_1
BS_2
BS_3
BS_4
BS_5
BS_6
BS_7
Fam_1
Parent typer1
Parent typer2
Parent typer3
Parent typer4
Parent typer5
Parent typer6
Parent typer7
Parent typer8
Parent typer9
Parent typer10
Parent typer11
F1 HiWell
S3 Difficult
S5 Difficult
F3 Confident
F4 Impact
Day0
Day1
Day2
Day3

FIG. 8

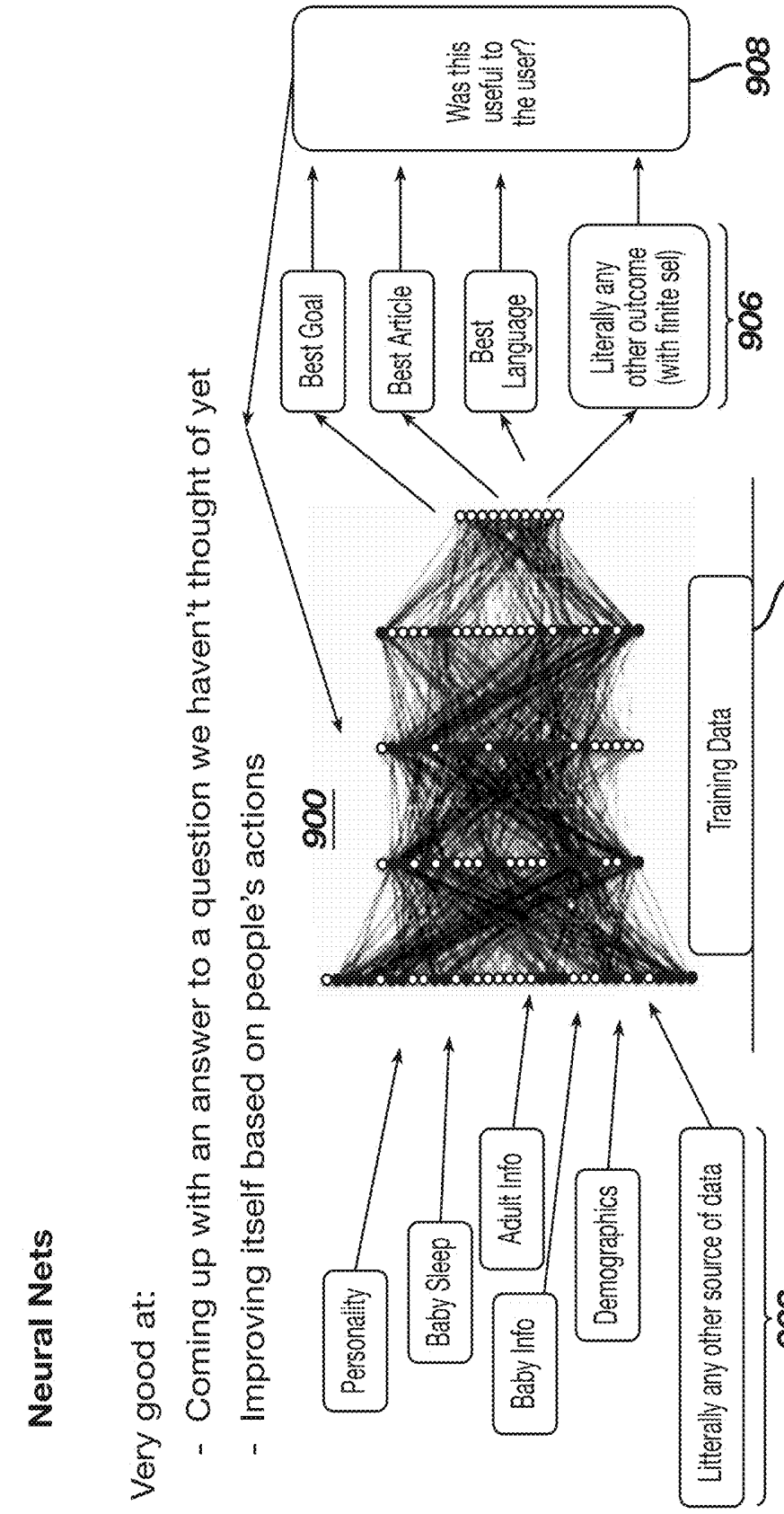

Neural Nets
Very good at:
- Coming up with an answer to a question we haven't thought of yet
- Improving itself based on people's actions
Personality
Baby Sleep
Baby Info
Adult Info
Demographics
Litterally any other source of data
902
900
Training Data
904
Best Goal
Best Article
Best Language
Literally any other outcome (with finite set)
906
Was this useful to the user?
908

FIG. 9

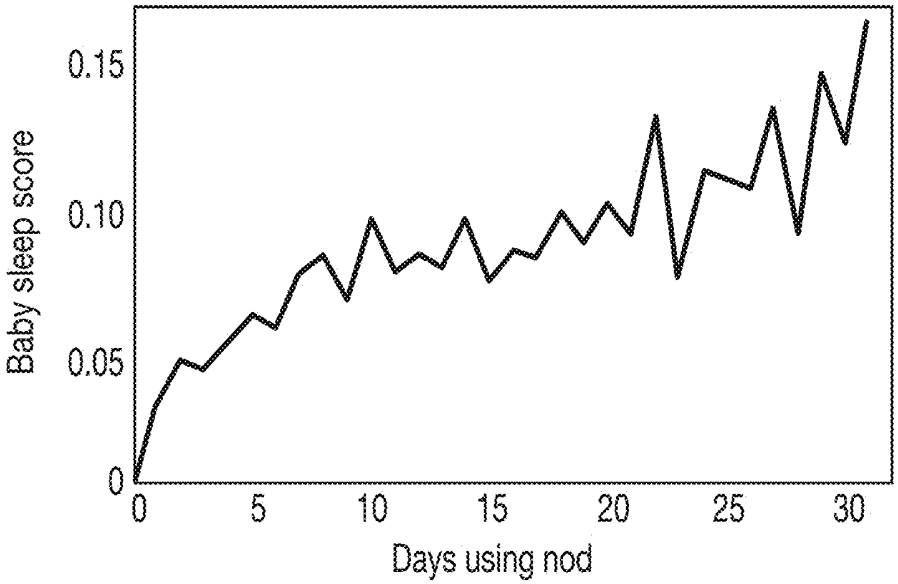


FIG. 10

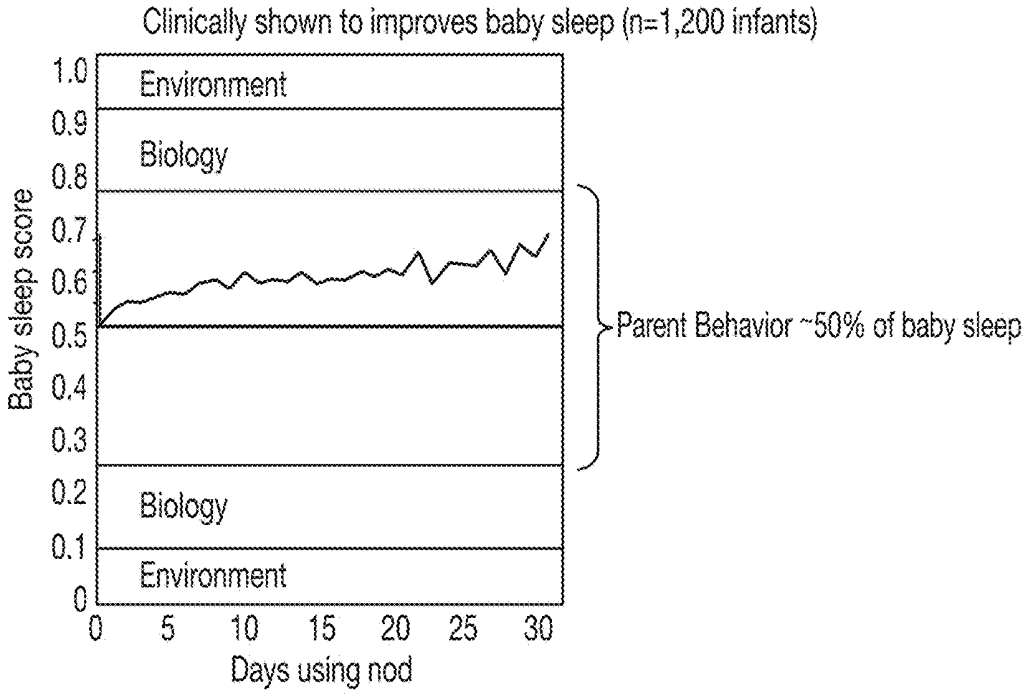

Clinically shown to improves baby sleep (n=1,200 infants)
Environment
Biology
Parent Behavior ~50% of baby sleep
Biology
Environment
Baby sleep score
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
Days using nod

FIG. 11

HEALTHCARE CAREGIVER BEHAVIOR COACHING SYSTEM AND METHOD

FIELD OF THE INVENTION

[0001] This disclosure pertains to a system and method for coaching actions taken by caregivers, and more particularly, to a system and method for coaching caregivers managing the daily routines of infants, for example, as these routines may influence sleep quality characteristics including for example circadian rhythms and diurnal patterns.

BACKGROUND

[0002] For new parents, managing baby sleep is an important and high priority and need. Common areas for need and questions of parents include: getting their babies to fall asleep at bedtime, establishing a sleep routine or schedule, and helping their babies stay asleep through the night.

[0003] Managing baby's sleep is inherently a hard problem. When babies are first born, they have not yet developed circadian rhythms, and do not distinguish night from day. As such, in the early years of life, babies sleep at all times (both night and day), and usually in short bouts. Typically, new parents are strongly motivated to help their babies sleep through the night, and often seek assistance in obtaining such outcomes.

[0004] U.S. Published Application No. 20150094830 A1 to Rest Devices, Inc. ("Network-Based Care System"), which is hereby incorporated by reference in its entirety herein, discloses a computerized health/sleep monitor that monitors biometric data of an infant to determine infant conditions relating to sleep quality (for example, such as the infant being awake or asleep, the infant being irritated, fussy or crying, or the infant being hungry). The monitor sends associated information via a network to an event server that evaluates whether or not to alert a caregiver via a caregiver's personal communication device (for example, via the caregiver's mobile phone, personal computer or tablet device)

[0005] WO2017196695 to Udisense, Inc. discloses a video monitoring system configured to hold a camera head in a fixed location and orientation above a crib.

[0006] U.S. Published Application No. 20160293042 to Smilables, Inc. discloses mechanisms and processes for monitoring an infant's emotional state. In one example, a system includes an infant monitoring hub that has an infant monitoring device interface and a hub processor. The infant monitoring device interface receives measurement data transmitted wirelessly from an infant monitoring device associated with a first infant. The hub processor compares the measurement data to a development model to determine if an emotional state associated with the measurement data reaches an undesirable level and generates a notification for a caregiver associated with the first infant if the emotional state reaches an undesirable level.

[0007] U.S. Published Application No. 20170043118 to Happiest Baby, Inc. discloses a sleep-aid device that includes a main moving platform that moves in a variable manner with accompanying variable sound generation, the sound and motion under the control of a control system and adapted to calm a fussy baby, induce sleep, and maintain sleep under normal conditions.

[0008] U.S. Published Application No. 20170055898 to Awardables, Inc. discloses systems and apparatus, including computer programs encoded on a computer storage medium, for determining sleep stages and sleep events using sensor data.

[0009] U.S. Pat. No. 8,562,511 to Koninklijke Philips N.V. discloses a system for inducing a subject to fall to sleep that includes a control unit connected to a breathing rate measuring unit and a light pattern generator, for controlling the light pattern generator such that the generated light pattern has a pattern frequency substantially between the measured breathing frequency and a pre-selected desired frequency.

[0010] U.S. Pat. No. 8,532,737 to Cervantes discloses an apparatus for automatically monitoring sleep, including a video recorder for recording live images of a subject sleeping, including a transmitter for transmitting the recorded images in real-time to a mobile device, and a computing device communicating with the transmitter, including a receiver for receiving the transmitted images in real-time, a processor for analyzing in real-time the received images and for automatically inferring in real-time information about the state of the subject, and a monitor for displaying in real-time the information inferred by said processor about the state of the subject.

[0011] U.S. Pat. No. 9,530,080 to Joan and Irwin Jacobs Technion-Cornell Institute discloses systems and methods for monitoring babies with cameras using a centralized computation and storage center that allows using visual output signals for computer vision and machine learning analysis and high-level reasoning of baby movements.

[0012] U.S. Pat. No. 9,572,376 to Nested Bean Inc. discloses a wearable or swaddling accessory blanket provides gentle pressure on the side and/or on the thoracic area of an infant to mimic the human hold.

[0013] Upon receiving such alerts, a caregiver may experience anxiety in attempting to determine whether caregiver action is needed, and if so, what actions would be most appropriate and effective for meeting caregiving goals. Accordingly, it would be beneficial to provide caregivers with specific advice that is directed to meeting their caregiver goals and well-matched to their individual preferences and tendencies in order to minimize caregiver anxiety.

SUMMARY

[0014] By way of example, aspects of the present disclosure are directed to a health care system and method for coaching a caregiver that monitors and manages sleep quality for an infant. The caregiver may be a parent, grandparent, guardian or other individual responsible for the health and well-being of the infant.

[0015] According to aspects of the present disclosure, the health care system described herein preferably includes: a) a base station in communication with a network, b) one or more sensors in communication with the base station that are configured to monitor sleep-relevant characteristics of the infant and environmental conditions in proximity to the infant, c) a caregiver communication device in communication with the network; and d) a remote server and associated data store in communication with the network. The remote server is operative to: 1) access information from the information store indicative of caregiver typing traits for the caregiver, 2) receive information from the sensors via the base station indicative of one or more measures of sleep quality for the infant, 3) receive information from the caregiver communication device indicative of a caregiver perception of sleep quality for the infant, 4) recommend at

least one action to be taken by the caregiver as a function of the caregiver typing traits, the sleep quality measures and the caregiver perception of the sleep quality for the infant; and 5) transmit the recommended action to the caregiver communication device for execution by the caregiver.

[0016] According to another aspect of the present disclosure, the remote server may thereafter be preferably operative to: a) confirm that the recommended caregiver action was applied, b) receive updated information from the sensors indicative of one or more measures of a current sleep quality for the infant, c) receive updated information from the caregiver communication device indicative of a current caregiver perception of sleep quality for the infant, d) receive an updated caregiver perception of the sleep quality for the infant; and e) evaluate the effectiveness of the recommended action in improving the caregiver's perception of sleep quality.

[0017] This SUMMARY is provided to briefly identify some aspects of the present disclosure that are further described below in the DESCRIPTION. This SUMMARY is not intended to identify key or essential features of the present disclosure nor is it intended to limit the scope of any claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] A more complete understanding of the present disclosure may be realized by reference to the accompanying drawing in which:

[0019] FIG. **1** depicts a health care system according to aspects of the present disclosure;

[0020] FIGS. **2**A and **2**B illustrate information flows for setting caregiver goals and providing caregiver advice according to aspects of the present disclosure;

[0021] FIG. **3** provides examples of data gathered in support of input state variables according to aspects of the present disclosure;

[0022] FIGS. **4**A and **4**B provide schematic diagrams illustrating information flows in a health care system according to aspects of the present disclosure;

[0023] FIG. **5** provides a schematic diagram illustrating a flow of information in a health care system according to additional aspects of the present disclosure;

[0024] FIGS. **6**A and **6**B provide an illustration of a daily routine builder for managing infant sleep quality interventions, and a related schedule of behavioral quanta;

[0025] FIG. **7** depicts element of large data set modeling of infant and caregiver behaviors in accordance with aspects of the present disclosure;

[0026] FIG. **8** depicts a data assimilation hierarchy for managing the large data set modeling depicted in FIG. **7**; and

[0027] FIG. **9** depicts an analysis engine for analyzing the data in the data hierarchy of FIG. **8**.

[0028] FIG. **10** shows the relative change in baby sleep score after use of the infant digital sleep coaching system of the invention.

[0029] FIG. **11** shows the significance of the results of baby sleep score after use of the infant digital sleep coaching system of the invention.

DETAILED DESCRIPTION

[0030] The following merely illustrates the principles of the disclosure. It will thus be appreciated that those skilled in the art will be able to devise various arrangements which, although not explicitly described or shown herein, embody the principles of the disclosure and are included within its spirit and scope.

[0031] Furthermore, all examples and conditional language recited herein are principally intended expressly to be only for pedagogical purposes to aid the reader in understanding the principles of the disclosure and the concepts contributed by the inventor(s) to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions.

[0032] Moreover, all statements herein reciting principles, aspects, and embodiments of the disclosure, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any elements later developed that perform the same function, regardless of structure.

[0033] Unless otherwise explicitly specified herein, the drawings are not drawn to scale.

[0034] In accordance with aspects of the present disclosure, a health care system and method are disclosed for assisting a caregiver who is tasked, for example, to monitor sleep quality for an infant. The caregiver may in this case be a parent, grandparent, day care worker or any other person tasked with monitoring and influencing the sleep quality for the infant. The health care system and method may, for example, be directed to multiple caregivers having sequential or simultaneous responsibility over a defined time period for providing infant care.

[0035] FIG. **1** presents a high level schematic diagram illustrating a health care system according to aspects of the present disclosure. The system of FIG. **1** includes a base station **102** in communication with a network **104**, and also in communication with biometric sensor(s) **106** for monitoring certain biologic condition(s) of the infant and environmental sensor(s) **108** for monitoring certain environmental conditions in proximity to the infant (not shown). Biologic conditions may, for example, include heart and breathing rate, movement and other sleep-related indicators useful for determining whether the infant is asleep, awake, irritated, fussy, crying and so on. The environmental conditions, for example, may include temperature, sound types and levels, light coloration, patterns and intensity, odors and other indicators useful for influencing a state of the infant. A suitable base station and sensor configuration for this purpose may be obtained, for example, from Rest Devices, Inc. of Boston, Mass. See, e.g., U.S. Published Applications Nos. 20130197387; 20140213937 (now abandoned); 20150060720 (now abandoned); 20150105608 (now abandoned); and 20150094830.

[0036] A remote server **110** is also in communication with the network **104**, and may be operative for example to access information stored in an information store **112** indicating one or more caregiver typing traits for at least one caregiver. The remote server **110** receives information from the sensors **106**, **108** via the base station **102** to be interpreted as indicating one or more measures of sleep quality for the infant,

[0037] The caregiver is also able by means of a caregiver communication device **114** to communicate with the remote server **110** via the network **104**. For example, the caregiver communication device **114** may be by a smartphone, tablet computer, personal computer or other device that can be

identified to the caregiver and be configured to communicate with the network **104**. The caregiver may, for example, communicate with the remote server **110** via the network **104** or another alternate network to provide a caregiver perception of sleep quality for the infant.

[0038] Based on the stored caregiver typing traits, the biologic and environmental conditions, the caregiver perception and certain goals of the caregiver with respect to the infant's sleep quality, the remote server **110** is operative to recommend at least one action to the caregiver to be taken in support of managing or improving infant sleep quality.

[0039] FIG. **2**A illustrates an information flow for the remote server **110** according to aspects of the present invention. Server **110** begins by establishing certain input variables at step **202** that pertain to the infant and the caregiver. For example, the server **110** may collect information to identify the caregiver (for example, a parent) according to age, general temperament, and location (for example, zip code). The infant may be similarly characterized by age, gender, temperament and developmental stage. This information may be referred to generally as identified input trait variables, which are static and require collection once or only infrequently.

[0040] In addition to the input trait variables, certain information indicative of daily activities of the infant (for example, sleep, feeding and diapering) may be gathered together with information about the season, geography and weather, and local environmental conditions (for example, temperature and light profiles) via the base station **102** and sensors **106**, **108**, This information may be referred to collectively as identified input state variables, which are dynamic and require ongoing, periodic collection.

[0041] An important category of input trait variables is directed to parent or caregiver typing variables. These are used to characterize different groups of caregivers according to the kinds of infant care interventions they may be comfortable and capable of providing, thereby increasing the likelihood that interventions coached by the inventive system will be carried out by the caregivers. In one embodiment in accordance with the present disclosure, caregiver typing is accomplished by causing the remote server **110** to transmit and administer a caregiver questionnaire to the caregiver via the caregiver communication device **114**. Information indicative of the answers that the caregiver provides to the questionnaire are stored by the remote server **110** in the information store **112**. As illustrated below, the questions administered to determine caregiver typing variables may preferably be provided with discrete answers ("options") to facilitate easy compilation by the remote server **110**:

Name	Question	options
FA1	Where does your child sleep most of the time?	Own Room, Parent's Room, Sibling's or others room, Other room of the house
FA2	What does your child sleep in most of the time?	Crib, Own bed (any size), Parent's bed, Bassinet/Seat/Swing
FA3	Does your child usually fall asleep while being fed (breast or bottle)?	Yes, No
FA4	How does your child fall sleep most of the time?	While being rocked or held, In a swing of stroller, While watching television, On his/her own
FA5	Where does your child fall asleep?	In own bed, In parents bed, Crib
SR1	How often does your child have the same bedtime routine?	Never, 1-2 nights per week, 3-4 nights per week, 5-6 nights per week, Every night
SR2	What time do you start your child's bedtime routine?	clock time: XX:XX AM/PM
SD1	What is your child's bedtime (lights out)?	clock time: XX:XX AM/PM
NW3	Do you usually feed (breast of bottle) your child when s/he wakes up at night?	Yes, No
NW4	Do you usually give your child a pacifier when s/he wakes up at night?	Yes, No
NW5	Do you usually change your child's diaper when s/he wakes up at night?	Yes, No
NW6	Do you usually play or watch TV/Video games?	Yes, No
NW7	Do you usually pick up, pat, or bring your child to your bed when s/he wakes up at night?	Yes, No
SRc	(SD1-SR2)	time: XX Hr: XX Min

[0042] Examples of additional caregiver typing questions are provided in Appendix 1. The aforementioned questions, those in Appendix 1, and those set forth below may be referred to generally as "metrics", or "sleep metrics", and may include or demonstrate quality of sleep. "Patterns" may reflect how the questions, or a subset of these questions occur and/or reoccur throughout the course of a day, and from day to day.

[0043] Examples of information gathered for determining the second category of variables (input state variables) are illustrated in FIG. **3**. Information gathered may include tracking of the infant's daily activities (sleeping, feeding, diapering and so on); information about the date, season, day of the week and weather; and information about environmental conditions proximate to the infant (for example, temperature, sound and light). The significance of these variables can be evaluated, for example by querying the caregiver with regard to associated caregiver behaviors **306**, baby sleep parameters **308**, and caregiver perception factors **310**. As illustrated below, the questions administered to determine baby sleep parameters **308** may preferably be provided with discrete answers to facilitate easier compilation by the remote server **110**:

Name	Question	options
SOL	How long does it typically take your child to fall asleep at night?	time: XX Hr: XX Min
NTS	Total time your child sleeps at NIGHT?	time: XX Hr: XX Min
DTS	Total time your child sleep during the DAY?	time: XX Hr: XX Min
NW1	How often does your child wake during the night? (#/week)	3 nights a week or more, Less than 3 nights a week, Never
NW2	Times your child typically wakes at night?	0, 1, 2, 3, 4, 5 or more

-continued

Name	Question	options
NW8	Total time your child is awake on a typical night?	time: XX Hr: XX Min
NW9	Longest stretch your child is asleep without waking?	time: XX Hr: XX Min
TSTc	(NTS + DTS)	time: XX Hr: XX Min
NDRc	(NTS/DTS)	time: XX Hr: XX Min

[0044] Returning to FIG. **2**A, the server **210** employs a goal/problem-driven approach (i.e., the right or opportune moment, "Kairos") **204** to determine suitable interventions to be taken by a caregiver to improve infant sleep quality. Caregivers begin by setting goals for infant sleep quality. A problem detection engine **206** correlates the goals with known problems based on an analysis of the input variables **202**. Caregivers prioritize the goals based, for example, on their intuition, beliefs and individual preferences. For high priority goals and high impact problems, a customization intervention engine **208** selects certain interventions (for example, reminders, notifications, and encouraging messages) for action by the caregiver.

[0045] FIG. **2**B further illustrates an exemplary process by which goals evolve. At step **222**, a new infant is added to a goal setting regime, which may be implemented for example as a software-guided planning system. An infant routine is created at step **224**, either built by scratch at step **224***a* or based on existing templates at step **224***b*. Base on the selected routine, a base change to an element of the routine is recommended at step **226**. The caregiver may accept or decline this recommendation at steps **226***a*, **226***b*, respectively. At step **228**, the caregiver may select a particular goal, or rely on the system to suggest a goal at step **230**. The caregiver accepts or rejects the recommended goal at steps **230***a*, **230***b*, respectively.

[0046] Once a goal is selected, a further base change is recommended by the system at step **232**, which can be accepted or declined at steps **232***a*, **232***b*, respectively. If not accepted, the system suggests a goal change at step **234**, which can be accepted or declined at steps **234***a*, **234***b* respectively. If the change is not accepted, the system may recommend a daily objective as an alternative at step **236**, which can be accepted or declined at steps **236***a*, **236***b*, respectively. If the goal has been completed at step **238**, system returns to step **230** to suggest a new goal. Otherwise, the system returns to step **232** to recommend a further base change.

[0047] Recommended changes may stimulate a variety of actions to adjust the infant's environment and routine, for example, such as:

[0048] Set/encourage consistent bedtime:

[0049] Light source changes lighting—intensity, wavelength, direction change over the course of the day.

[0050] Speaker turns on/changes sounds—Specific songs or ambient sounds are triggered or play at bedtime.

[0051] Set/encourage consistent bedtime routine:

[0052] Physical chart in baby's room with bedtime routine check list—for reminder of instructions for additional care givers

[0053] Baby bath product as part of bedtime bath

[0054] Baby lotion product as part of bedtime massage

[0055] Books are part of bedtime routine—books that promote positive sleep messages. Many children's books themes involve resistance to sleep—not a positive bedtime message

[0056] Release of fragrance at specific time (or human triggered).

[0057] Help child self sooth back to sleep at night-triggered events that the system does automatically after noticing that the baby has waken in the middle of the night

[0058] Auto pacifier dropped into crib.

[0059] Speaking that play care-givers voice, songs or ambient sounds.

[0060] Movement of mobiles

[0061] Release of fragrance

[0062] FIG. **4**A provides a schematic diagram illustrating a flow of information in a health care system described in accordance with aspects of the present disclosure; A control characteristic or condition **410** is established by a primary caregiver **412**, for example, by the goal/problem-driven approach **204** of FIG. **2**. A comparator **414** (implemented, for example, as the remote sever **110** of FIG. **1**) compares the control characteristic **410** with an observation **416** of the primary caregiver **412**, who acts effectively as a sensor **418** and provides the observation to the comparator **414** by answering a series of survey questions **420** presented at a caregiver communication device **422**. The comparator (for example, realized by the remote server **110** of FIG. **1**), applies the goal/problem-driven approach **204** of FIG. **2** to determine a caregiver intervention to be instructed through the caregiver communication device **422** as action **424**. This cycle is repeated while the observation **416** by the caregiver **412** indicates a deviation from the control characteristic **410**.

[0063] Comparator **414** is further illustrated as implemented by server **414***a* in FIG. **4**B. Server **414***a* gathers biometric and other sensory data via sensor(s) **416**(*a*) placed in the vicinity of the infant, which may for example be used to determine infant sleep patterns. Server **414***a* also gathers data from sensor(s) **418** that indicate(s) parent or caregiver behaviors (for example, such as parent responses to queries administered by the caregiver communication device **422** to determine whether recommended interventions were administered, and parent location and movement data provided by GPS sensors incorporated in the caregiver communication device **422**). Sensor(s) **418** may also provide data indicative of parent or caregiver perceptions of care (for example, via surveys administered via the caregiver communication device **422**).

[0064] By means further described with reference to FIGS. **4**A and **4**B herein, the server **414***a* applies the data inputs gathered by the server **414***a* to produce a probabilistic diagnosis **424** of potential problems which may for example be preventing infant sleep characteristics and parent perception from reaching values consistent with the identified goals. Through further analysis of data as described by way of example with reference to FIGS. **4**A and **4**B, server **414***a* selects an intervention plan **426** including one or more behavioral quanta **428** expressed as actions to be taken by the parent or caregiver for the purpose of carrying out an intervention. These behavioral quanta or actions may be displayed, for example, to the caregiver via the caregiver communication device **422**. In this "closed loop" system, actions taken by the caregiver influence infant sleep characteristics in a direction towards or away from desired

values and goals **410**, thereby providing a basis for adjusting the associated intervention plan **426** and behavioral quanta **428**.

[0065] In accordance with additional aspects of the present disclosure, FIG. **5** provides a schematic diagram illustrating an alternate flow of information in the described health care system. A control characteristic or condition **510** is established by a primary caregiver **512**, for example, by the goal/problem-driven approach **204** of FIG. **2**. A comparator **514** (implemented, for example, as the remote sever **110** of FIG. **1**) compares the control characteristic **510** with an observation **516** of the primary caregiver **512**, who acts effectively as a sensor **518** and provides the observation to the comparator **514** by answering a series of survey questions **520** presented at a caregiver communication device **522**. Additional sensors **518** (for example, including one or more of biometric sensors **106** and environmental sensors **108** of FIG. **1**) are provided in proximity to an infant **532** for assessing characteristics indicative of or capable of influencing infant sleep quality.

[0066] The comparator **514** (again realized, for example, by the remote server **110** of FIG. **1**), applies the goal/problem-driven approach **204** of FIG. **2** to determine a caregiver intervention to be instructed through the caregiver communication device **522** as action **524**. In addition, action **524** may be instructed to devices **530**, **532** for implementation. For example, if the action **524** is intended to be performed by primary caregiver **512** immediately after the primary caregiver wakes from a period of sleep, device **530** may be provided in proximity to primary caregiver **512** to open curtains to sunlight, to play certain audio sounds that are wakeful, or the like. Device **530** may be provided in proximity to the infant **532** for performing an action **538** that may support a caregiver intervention (for example, providing the infant **532** with a pacifier or initiating the movement of a mobile in combination with a soothing sound). For example, if the action **524** instructs the primary caregiver **512** to rock the infant **530** in order to urge the infant **532** to cease crying, action **538** may in addition be applied in advance by device **532** in support of caregiver action **524**. This cycle continues to be repeated while the observation **516** by the caregiver **512** indicates a deviation from the control characteristic **510**.

[0067] In addition to primary caregiver **512**, secondary caregivers **526**, **528** may assist primary caregiver **512** concurrently with primary caregiver **512** or at alternate times when primary caregiver **512** is unavailable, and be provided with caregiver communication devices **522** to receive instructions concerning caregiver interventions. Secondary caregivers **526**, **528** will most likely be taking action directed to the control characteristics **510** established by primary caregiver **512**. For example, in order to progress to a control characteristic **510** that is intended to encourage infant sleep after 8:00 PM in the evening, secondary caregivers **526**, **528** may undertake a supporting action **538** directed to bathe the infant **532** at 7:00 PM.

[0068] Secondary caregivers **526**, **528** may have parent typing characteristics that differ from the primary caregiver **512**. For example, this might be expected in the case where primary caregiver **512** is a parent of the infant **532**, and secondary caregivers **526**, **528** are grandparents of the infant **532**. With reference to FIGS. **2** and **3**, parent typing may therefore be preferably performed by administering separate surveys to each of the primary caregiver **512** and secondary caregivers **526**, **528** to account for differences in caregiving tendencies and styles among the various caregivers. In this case, customization intervention engine **208** of FIG. **2** may select interventions **210** that are accordingly tailored to the caregiving tendencies and styles of each on-duty caregiver.

[0069] As illustrated in FIG. **5**, in addition to actions **524** that may be instructed at caregiver communication device **522** as text-based instructions, notifications and reminders, action **524** may be instructed at caregiver communication device **522** by a "live" human coach (for example, by means of direct a FACETIME, SKYPE or other audio/video link), or alternatively by means of an interactive avatar that is animated by remote server **110** of FIG. **1**. Some caregivers may find they are more at ease with this approach to receiving intervention instruction and additional guidance than with text-based instructions. The avatar may be implemented as an available array of many adviser/expert avatars (in effect, a "Many Face God" engine) having distinct styles, selectable to match with the caregiver's typing characteristics.

[0070] FIG. **6**A provides an illustration of a daily routine builder for managing infant sleep quality interventions according to aspects of the present disclosure. Experience suggests that a managed routine is essential to stabilizing and promoting good infant sleep quality. In accordance with aspects of the present disclosure, the primary caregiver is able to assemble and record a daily routine with the assistance of the remote server **110** of FIG. **1** via the caregiver communication device **114**. For example, as illustrated in FIG. **6**A, tasks that may be repeatedly scheduled over the course of a day and over successive days may include feedings **602**, rockings **604**, bathings **606**, and readings **608**. Daylight timeline **621** and night timeline **622** (FIG. **6**B) provide a baseline against which the tasks may be arrayed and scheduled.

[0071] The daily routine builder may preferably include transitional tasks to assist the infant in moving from one state to another. For example, FIG. **6**A illustrates task **618**, which instructs the caregiver to turn on a light in proximity to a sleeping infant at 6:00 AM to assist in moving the infant from a sleeping to wakeful state. Similarly, Task **614** instructs the caregiver to move the infant from a sleeping to a wakeful state at 1:00 AM in order to administer rocking **604** and feeding **602**.

[0072] As further illustrated in FIG. **6**A, the remote server **110** of FIG. **1** may instruct the primary caregiver to alter a pre-existing daily routine in order to promote an improvement to infant sleep quality in line with caregiver goals established, for example, as shown at step **204** of FIG. **2**. For example, in order to promote an example goal of achieving a more rapid transition by the infant to a sleeping state, the former routine beginning at 7:00 PM of bathing **606**, reading **608** and rocking **604** is modified to introduce an action **609** to move the infant from being held to being placed in a crib, with the option of introducing coordinated actions to swaddle the infant **610** and to provide the infant with a pacifier **612** as the infant is being placed in the crib. As a follow-up, a rocking action **604** previously performed by the primary caregiver is replaced with a holding action **616** by the caregiver in combination with action to swaddle the infant **610** and action to provide the pacifier **612**. In this manner, actions to alter the behavior of the infant (and, in some cases, to alter the behavior of the caregivers) are introduced in a gradual, non-disruptive manner.

[0073] FIG. **7** depicts element of large data set modeling of infant and caregiver behaviors in accordance with aspects of the present disclosure. This large data set may be stored, for example, in the information store **112** of FIG. **1**, and interpreted by the remote server **110** in order to select caregiver actions that are correlated with desired infant sleep outcomes. As illustrated in FIG. **7**, the large data set may be interrogated by the remote serve **110** of FIG. **1** to determine likely sleep outcomes **702** (for example, including daytime sleep (DST), nighttime sleep (NST), sleep onset latency (SOL), night waking count (NW_{ct}) and night waking duration (NW_{dur})).

[0074] Remote server **110** may interrogate the data set to model outcomes **702** as a function of infant biologic conditions **704**, infant environmental conditions **706** in proximity to the infant, and caregiver behaviors **708**. Caregiver perception of sleep outcomes may also be modeled by the remote server **110** as a function of sleep outcomes **702** and infant biologic conditions **704**. As a result of this modeling, the remote server **110** of FIG. **1** can operate caregiver behavior data **708** customization intervention engine **208** of FIG. **2** to select interventions **210** that are tailored to the caregiving tendencies and styles the caregiver and likely to demonstrate the sleep outcomes **702** of FIG. **7** and caregiver perception **710** that are consistent with caregivers goals.

[0075] In some aspects, it may be beneficial to provide ongoing and frequent evaluation and feedback to caregiver through Bayesian behavioral methods. The use of these Bayesian (i.e., hypothesis is updated as more information becomes available) methods allows for diagnosis, feedback and intervention in real-time and in non-linear ways. In linear methods, such as a decision tree approach, a series of questions or identifications is navigated one by one, where a first response must be received or acknowledged before a second response can be obtained. Through non-linear methods, interventions and guidance may be provided in a quicker and more robust fashion. Non-linear methods also account for biological changes in the infant as well as the caregiver, such as aging or disease, and also account for cognitive changes whereby the participants learn and modify their own behavior over time.

[0076] One method of the present invention uses ongoing and frequent gathering of information, probabilistically determining a most likely diagnosis, and providing feedback. This method includes receiving data, including human behaviors and resultant biological processes. The receipt of this data allows for probabilistic diagnosis and probabilistic determination of high impact questions to be asked or data to be gathered based upon the probability evaluated. This allows for real-time modification of the system, and ongoing reassessment or retargeting of the behavior quantum based upon the frequent tracking. Frequency of tracking or inquiring may be every second, every minute, every hour, every half day, every day, or at other desired intervals.

[0077] Care regarding infants sometimes involves rapid change of different mechanisms and therefore it would be helpful to rapidly change and update the problem or goal of a control system. In particular, babies are developing rapidly and tend to change their behaviors on the time scale of days or weeks. Additionally, caregivers are rapidly learning new skills and developing expertise and new perspectives, also often on the time scale of days or weeks. Ideally an effective behavioral control system would update its learning, its data gathering, and/or its interventional recommendations hourly, daily, or weekly.

[0078] The action of the control system may be dependent on the process output or result; where feedback from the process variables may be used to alter the control system over time. In this case the action of the control system would be influenced by either ongoing caregiver behavior or the observed baby sleep. A closed loop control system involving a probabilistic determination of problems or goals (e.g., with new set points), which are suggested to and confirmed by the primary user, may be beneficial. For example, in this closed loop system, after a desired goal or problem has been established, the system then initiates a closed loop control process to move toward the desired outcome by establishing and reinforcing behavior change.

[0079] The probabilistic determination of the problem or goal of the target individual is then matched to behavioral quantum. The behavioral quantum is understood as involving a discrete and explicit behavioral change packet of action(s) for a particular goal or target outcome that is delivered for implementation at and over a particular time period. This concept is illustrated by FIG. **6**B, which depict a series of behavioral quanta (BQ) **621-625** defining actions to be administered by a caregiver over a three-day period. Each of the three days in this period begins with the administration of BQ^1 **621** at approximately 9:30 AM, which may, for example, represent a caregiver intervention to wake an infant. Similarly, BQ^2 **622** and BQ^3 **623** are administered in succession each day, beginning at approximately 7:00 PM. BQ^2 and BQ^3 may, for example, represent caregiver interventions to feed and rock the infant, respectively.

[0080] BQ^4 **624** and BQ^5 **625** are administered somewhat differently from BQ^1 **621**, BQ^2 **622** and BQ^3 **623**. On Day 1, BQ^4 **624** and BQ^5 **625** are administered in succession starting at about 1:00 AM, On Day 2, the order of administration is reversed (BQ^5 is administered before BQ^4), and on Day 3, the start time for the initially-administered BQ^5 is advanced to 3:00 AM. BQ^4 and BQ^5 may, for example, represent caregiver interventions to feed and rock the infant, respectively. With a goal to extend the infant's period of nighttime sleep, BQ^4 and BQ^5 may for example represent caregiver interventions to feed and walk the infant, respectively. Beginning on Day 2, the order of administration of BQ^4 and BQ^5 is reversed, based on an analysis of data suggesting that initially walking rather than feeding the infant effectively extends the time between successive feedings to promote longer sleep cycles.

[0081] Returning to FIG. **7**, the aforementioned Bayesian behavioral method may include a closed loop control system, which relies upon continual or repeated monitoring of progress towards a particular goal. As such, the behavioral change toward that goal can be increased or slowed down as needed, or the behavioral quantum can be switched for a new behavioral quantum as necessary. In typical clinical settings, behavioral therapy usually includes open loop control systems, where after a goal is determined a behavioral change is then implemented, but without continual monitoring toward that goal. The probabilistic approach with continual feedback and modification allows the system to be changed and the behavioral quanta to be taken into account to provide for effective intervention. There may be more than one behavioral quanta that may effectively solve an individual problem or aid in the attainment of the

individual goal, and also multiple different problems may be solved (or goals reached) by an individual behavior quantum. The behavioral quantum that is recommended to the caregiver can be drawn from an outside goal group without changing the overall goal, and the caregiver need not be made aware of the modification. Such changing may be made during use, at regular and/or irregular intervals, such as daily or biweekly. In this way, novel behavioral therapy techniques can be developed and tailored to a caregiver.

[0082] FIG. **8** depicts a data assimilation hierarchy for managing the large data set modeling depicted in FIG. **7**. The hierarchy is introduced as a mechanism for quantizing and reducing a large volume of data for a population of infants to a size and form that is suitable for data analysis. With reference for example to FIGS. **4**A, **4**B and **5**, biometric data including biorhythm data **802** is collected for each infant via infant sensors **416***a*, **518**, and indicates a sleep/awake state for an infant. This sleep/awake state information may be sampled and collected by comparators **414**, **514** (implemented by server **110** of FIG. **1**), for example, at a rate of 12 times per minute. Server **110** is then operative to process this information to produce quantized data **804** that establishes sleep/wake states, for example, at 1 to 5 minute intervals, and then further reduces this data to event data **806** that assigns sleep/wake states in 10 minute intervals.

[0083] The event data **806** is analyzed to produce daily summary data **808**, which may be characterized for example by seven distinct "baby sleep" variables BS_**1** through BS_**7**, selected for example from among baby sleep parameters **308** as depicted in FIG. **3**. Summary data **808** may be accumulated daily for each of a period of days, with the variables BS_**1** through BS_**7** calculated by the server **110** as a function of one or more of event data **806**, quantized data **804**, biorhythm data **802** and caregiver data (for example, as provided via sensor(s) **418** and/or survey questions **420** as depicted in FIG. **4**A).

[0084] Data describing caregiver routines and habits for the infant is also collected and assembled by the server **110**. For example, summary data **810** may be accumulated on a weekly basis for parent behavior variables PB_**1** through PB_**11**, selected for example from parent behavior variables **306** as depicted in FIG. **3**. Weekly summary data **812** characterizing baby sleep variables BS**1**_**1** through BS_**7** may be assembled from the daily summary data **808** characterizing these variables. The most significant data summarizing parent behavior and baby sleep characteristics may be extracted, for example, as parent behavior data **810***a* and baby sleep data **812***a*, respectively. From this data, additional data **810***b* may be prepared for certain "family" variables Fam_**1** (for example, including behaviors and trends among multiple infant caregivers and/or multiple infants cared for by a common caregiver).

[0085] In addition, parent or caregiver perceptions of infant sleep and caregiving effectiveness may be obtained as summary data **816** (for example, as provided via caregiver surveys **420**, **520** as illustrated in FIGS. **4**A, **4**B and **5**). Caregiver surveys may also serve as the source of data for summary data **814***a*, **814***b*, for example, characterizing caregiver type traits Parent typer1—Parent typer9. Appendix 1 provides sample survey questions that may be used to assess caregiver type traits Parent typer1—Parent typer9.

[0086] FIG. **9** depicts an analysis engine for analyzing the data described with reference to FIG. **8**. The analysis engine is preferably implemented as a neural network **900**, which applies at least a portion of the large-scale data set of infant and caregiver information acquired according to the data assimilation hierarchy of FIG. **8**. This portion of the data is used as training data **904** for building probabilistic models for determining best infant sleep goals, interventions and outcomes **906** based on baby sleep data **812** and parent behavior data **810** of FIG. **8**. Best goals, interventions and outcomes **906** are used, for example, to perform the probabilistic diagnosis **424** and produce the associated intervention plan **426** depicted in FIG. **4**B. Feedback **908** based on the effectiveness of intervention plan **426** (for example, as evaluated via survey questionnaires **420** of FIG. **4**B) is preferably applied to further train the network **900**.

Introduction: Baby Sleep Score

[0087] One primary method to interpret infant sleep is the Brief Infant Sleep Questionnaire (BISQ) for assessment of sleep patterns (0-36 months). Previously BISQ scoring was done via clinical interpretation, but remains difficult given that infant sleep is highly variable and age dependent. We developed and validated a novel scoring method for the infant sleep questionnaire (BISQ-R), and implemented into our digital sleep coaching system to determine clinical efficacy.

Methods: Baby Sleep Score

[0088] To develop the scoring method, we analyzed 33,835 BISQ submissions (1-36 mos; 52.2% boys; 83.0% mothers) from the Johnson's® Bedtime® Sleep App. Three subscales were created for the BISQ-R: Baby Sleep (5 items—night wake duration, sleep onset latency, longest stretch, night wake duration, and total night sleep variables), Parent Perception (3 items), and Parent Behavior (11 items). To normalize each item, continuous data tables (124,500 data points) were generated based on infant age and type of response. Each item was coded to a specific score (0 to 1), and subscales were weight averaged. Implementation and validation of the scoring system was conducted to confirm reliability and convergence.

Results: Baby Sleep Score

[0089] BISQ-R Baby Sleep scores were normalized across all ages, and significantly correlated with Parent Perception scores ($R2=0.379$, $p<0.001$). There was a strong logarithmic relationship between Parent Behavior and Baby Sleep, which increased with age ($R2=0.91$, $p<0.001$).

Conclusion: Baby Sleep Score

[0090] We developed the BISQ-R, an infant sleep scoring system for clinical, research, and digital use. Construct validity of the BISQ-R resulted in convergent findings between Baby Sleep, Parent Perception, and Parent Behavior scores. The results were published. See R A Gould, J A Mindell, E S Leichman, Russel Michael Walters, "Normalized Scoring System for the Brief Infant Sleep Questionnaire (BISQ)", April 2018Sleep 41(suppl_1):A285-A285. DOI: 10.1093/sleep/zsy061.765.

Methods: Digital Sleep System

[0091] We next implemented the BISQ-R into our infant digital sleep coaching framework, to clinically validate real-time use of the system. Caregivers of 1200 young

children (0-36 months) used the infant digital sleep coaching system (via a free and publicly available smartphone application). We analyzed changes in infant sleep patterns over time, with baseline beginning at day 1 of use, and the final endpoint 30 days later (4-weeks total).

Results: Digital Sleep System

[0092] Overall, Implementation of the BISQ-R within our infant digital sleep coaching system revealed a mean increase of 0.15 (15%) in Baby Sleep score over a 30-day period, compared to baseline ($p<0.001$). Additionally, Parent Perception of infant sleep outcomes significantly improved, as meaningful results were seen even after only 5 days.

Conclusion:

[0093] Implementation of the BISQ-R within our infant digital sleep coaching system revealed robust clinical efficacy. Both Baby Sleep score and Parental Perception significantly increased over a 30-day period when compared to baseline measurements. The results were published. See R A Gould, J A Mindell, E S Leichman, Russel Michael Walters, "Normalized Scoring System for the Brief Infant Sleep Questionnaire (BISQ)", April 2018Sleep 41(suppl_1):A285-A285. DOI: 10.1093/sleep/zsy061.765}

Methods: Digital Sleep System

[0094] We next implemented the BISQ-R into our infant digital sleep coaching framework, to clinically validate real-time use of the system. Caregivers of 1200 young children (0-36 months) used the infant digital sleep coaching system (via a free and publicly available smartphone application). We analyzed changes in infant sleep patterns over time, with baseline beginning at day 1 of use, and the final endpoint 30 days later (4-weeks total).

Results: Digital Sleep System

[0095] Overall, Implementation of the BISQ-R within our infant digital sleep coaching system revealed a mean increase of 0.15 (15%) in Baby Sleep score over a 30-day period, compared to baseline ($p<0.001$). Additionally, Parent Perception of infant sleep outcomes significantly improved, as meaningful results were seen even after only 5 days.

Conclusion:

[0096] Implementation of the BISQ-R within our infant digital sleep coaching system revealed robust clinical efficacy. Both Baby Sleep score and Parental Perception significantly increased over a 30-day period when compared to baseline measurements.

Results:

[0097] 1200 caregivers used our infant digital sleep coaching system for their infant, and progress was tracked over time. Baby Sleep score and Parent Perception was assessed over 30 days, and compared to baseline at day 1. The relative change in baby sleep score is shown in FIG. **10**.

[0098] Implementation of the BISQ-R within our infant digital sleep coaching system revealed a mean increase of 0.15 (15%) in Baby Sleep score over a 30-day period, compared to baseline ($p<0.001$). This is highly significant as parent behavior controls ~50% of the Baby Sleep score, while other factors such as biology and environment also contribute. The significance of the results is shown in FIG. **11**.

CONCLUSION

[0099] It will be understood that, while various aspects of the present disclosure have been illustrated and described by way of example, the invention claimed herein is not limited thereto, but may be otherwise variously embodied according to the scope of the claims presented in this and/or any derivative patent application. It should noted, for example, that although the examples provided in the specification are specificaly directed to caregiver management of infant sleep quality, these same principles may be readily applied to many other caregiver applications. For example, the disclosed invention could additionally be applied managing elder care quality administered in a nursing home or other assisted living facility by a variety of individual caregivers.

Appendix 1: Sample Caregiver Typing Questions

Do you and your partner both help with night feedings? *

- Yes (or we plan to).
- No, just one of us gets up for feedings.

What's your favorite genre of music? *

- Jazz
- Classical
- Hip Hop / R&B
- Pop / Top 40
- Classic Rock (60s/70s/80s)
- Country
- House / DJ
- Alternative Rock
- Reggae

What best describes where you live? *

- City (anything from Louisville to LA)
- Town (anything from small town to suburb)
- Rural (anything from forest to farmland)

Which best describes your employment? *

- Employed full-time
- Employed part-time
- Not currently employed, and looking
- At home with kids

Where does your baby sleep? *

- In your bed.

- In your bedroom, but in their own bassinet or crib.
- In his/her own room.
- Other

If you're in the car by yourself, what would you most rather listen to? *

- The sweet sound of silence
- NPR
- Local radio
- Sirius/XM radio
- My own music (CD's, Spotify etc.)
- A podcast

Which of the following best describes you? *

- Mother
- Father
- Caregiver (nanny, grandparent, etc.)

What is your most frequent coffee shop order? *

- An espresso drink (latte, cappuccino, etc.)
- Drip hot coffee
- Iced coffee of any kind
- Black tea
- Chai tea
- Herbal tea
- Nothing - I don't like any of that stuff

What subject in school were you best at? *

- Art
- Math
- History
- Science
- Writing/Reading
- Music
- Recess (obviously)

On a scale of 1-10, how good is your memory? *

Scale

Where do you primarily get your news? *

- NPR
- CNN
- Fox
- MSNBC
- BBC/International
- Google News
- Major newspaper online or print (NY Times, LA Times, Washington Post, etc.)
- Local newspaper
- Local TV News
- Facebook
- Other social media

Do you own your primary residence? *

- Yes, I own it
- No, I rent

Which is your favorite superhero? *

- Superman
- Batman
- Wonder Woman
- Storm
- Wolverine
- Spider Man
- Iron Man
- Captain America
- Supergirl

I generally believe most strongly that::

•Crying babies should be picked up immediately.

•Crying babies should be ignored for a few minutes.

•If you pick up a baby when it cries the baby will be spoiled.

•Babies cry to manipulate you.

•Babies cry for no reason.

It is most often true that I feel:

•I hate it when my baby cries.

•It makes me sad when my baby cries.

•It makes me angry when my baby cries.

Parenting is an adventure.

5 point scale (agree – disagree)

Parenting is hard work.

5 point scale (agree – disagree)

Parenting is fun.

5 point scale (agree – disagree)

What are the Goal for your child? (rank order of top 4)

- To live a life according to god.
- To be wealthy
- To have a good life like my own
- To have a better life than my own
- To be successful at whatever they pursue
- To be safe
- To be healthy
- To be happy

As a parent, my role is to:

- Protect my child from risk
- Expose my child to new experiences

Understanding my role as a mother or father is central to understanding who I am. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

AXIS 1: WELL-BEING

EPDSinst Please choose the answer which comes closest to how you have felt IN THE PAST 7 DAYS, not just how you feel today.

EPDS05 I have felt scared or panicky for no very good reason.

- ❍ Yes, quite a lot
- ❍ Yes, sometimes
- ❍ No, not much
- ❍ No, not at all

EPDS07 I have been so unhappy that I have had difficulty sleeping.

- ❍ Yes, most of the time
- ❍ Yes, sometimes
- ❍ Not very often
- ❍ No, not at all

EPDS08 I have felt sad or miserable.

- ❍ Yes, most of the time
- ❍ Yes, quite often
- ❍ Not very often
- ❍ No, not at all

EPDS09 I have been so unhappy that I have been crying.

- ❍ Yes, most of the time
- ❍ Yes, quite often
- ❍ Only occasionally
- ❍ No, never

SWLS Below are statements that you may agree or disagree with. Using the scale below, indicate your agreement with each item using the scale below. Please be open and honest in your responding.

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
The conditions of my life are excellent (SWLS_02)	❍	❍	❍	❍	❍	❍	❍
I am satisfied with my life (SWLS_03)	❍	❍	❍	❍	❍	❍	❍

Anxiety Over the past two weeks, how often have you been bothered by any of the following problems?

	Not at all	Some of the days	Over half the days	Nearly every day
Not able to stop or control worrying	❍	❍	❍	❍

(Anxiety_2) Worrying too much about different things (Anxiety_3)	❍	❍	❍	❍
Trouble relaxing (Anxiety_4)	❍	❍	❍	❍

PSS The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate how often you felt or thought a certain way using the scale below.

	Never	Almost never	Sometimes	Fairly often	Very often
In the last month, how often have you felt that things were going your way? (PSS_05)	❍	❍	❍	❍	❍
In the last month, how often have you felt that you were on top of things?	❍	❍	❍	❍	❍

(PSS_08) In the last month, how often have you been angered because of things that were outside of your control? (PSS_09)	○	○	○	○	○

I worry a lot about making the 'right' choices as a parent (Mindsets_07)	❍	❍	❍	❍	❍	❍	❍

AXIS 2: TENSIONS

Tensions Below are tensions that some moms may feel. How strongly do you feel each tension? Please use a 0 to 10 scale where 0 represents "Not at All" and 10 represents "Very."

	0 = Not at all	1	2	3	4	5	6	7	8	9	10 = Very
I love you [baby]...but I don't know you. (Tensions_intuit)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
I need connection...but my relationships have been disrupted. (Tensions_connect)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
I am a new me...but the world expects the old me. (Tensions_ID)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

AXIS 3: MATERNAL IDMaternalID Please rate how well each of the follow statements describe you:	1 = Not at all true of me	2	3	4	5	6	7 = Extremely true of me
In general, being a mother is an important part of my self-image (MaternalID_01)	❍	❍	❍	❍	❍	❍	❍
Understanding my role as a mother is central to understanding who I am (MaternalID_04)	❍	❍	❍	❍	❍	❍	❍
If someone asked me to describe myself, the first thing I would tell them about is being a mother (MaternalID_07)	❍	❍	❍	❍	❍	❍	❍

Overall, being a mother is the most fulfilling aspect of my life (MaternalID_08)	❍	❍	❍	❍	❍	❍	❍
Sometimes, I wish I was not a mother (MaternalID_09)	❍	❍	❍	❍	❍	❍	❍

AXIS 4: MATERNAL RESILIENCE

Mindsets When it comes to parenting, people can have many different viewpoints and beliefs. Using the scale below, indicate to what extent you agree with each of the following statements. Please be open and honest in your responding.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
No matter how good of a parent you are, you can always learn more or learn better ways to parent (Mindsets_02)	❍	❍	❍	❍	❍	❍	❍

You can always substantially change how good you are at parenting (Mindsets_03)	❍	❍	❍	❍	❍	❍	❍
Making mistakes is an important part of learning how to be a great parent (Mindsets_06)	❍	❍	❍	❍	❍	❍	❍
I expect to make some mistakes as a parent—it doesn't change anything about how good of a parent I am (Mindsets_11)	❍	❍	❍	❍	❍	❍	❍

parentratings Rate how much you agree with each of the following statements:

	disagree	disagree somewhat	neither agree nor disagree	agree somewhat	agree
Parenting is hard work (parentingis_hardwork)	❍	❍	❍	❍	❍
Parenting is fun (parentingis_fun)	❍	❍	❍	❍	❍

AXIS 5: MATERNAL PRESSURES

Mindsets When it comes to parenting, people can have many different viewpoints and beliefs. Using the scale below, indicate to what extent you agree with each of the following statements. Please be open and honest in your responding.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
'Mother's intuition' is something people are born with that can't be changed much (Mindsets_01)	❍	❍	❍	❍	❍	❍	❍
Some people are 'naturals' at parenting, and some are not –you can learn some, but it's not often that people change (Mindsets_09)	❍	❍	❍	❍	❍	❍	❍
It is important	❍	❍	❍	❍	❍	❍	❍

to me to seek out expert opinions and others' advice before making parenting decisions (Mindsets_13)							

PACOTIS_impact Using the 0-10 scale below, indicate to what extent each of the following statements accurately describes your actions, thoughts, or feelings in the context of interacting with your child. Please be open and honest in your responding. Use the following scale to rate each statement by dragging the slider bar:

_____ My behavior has little effect on the intellectual development of my baby

_____ My behavior has little effect on the development of emotions (ex. happiness, fear, anger) in my baby

_____ My behavior has little effect on how my baby will interact with others in the future

PACOTIS_overprotect Using the 0-10 scale below, indicate to what extent each of the following statements accurately describes your actions, thoughts, or feelings in the context of interacting with your child. Please be open and honest in your responding. Use the following scale to rate each statement by dragging the slider bar:

_____ I insist upon keeping my baby close to me at all times, within my eyesight and in the same room as I am

_____ When I leave my baby with a babysitter, I miss him/her so much that I cannot enjoy myself

AXIS 6: CONFIDENCE IN MATERNAL INTUITION

cimi2 What percentage of the time does your baby prefer relaxing and gentle interactions (e.g., cooing or singing to the baby) versus more exciting interactions (e.g., tickling, peekaboo)?

- ❍ 100% of the time prefers relaxing interactions
- ❍ 90% of the time prefers relaxing interactions, 10% of the time prefers exciting interactions
- ❍ 80% of the time prefers relaxing interactions, 20% of the time prefers exciting interactions
- ❍ 70% of the time prefers relaxing interactions, 30% of the time prefers exciting interactions
- ❍ 60% of the time prefers relaxing interactions, 40% of the time prefers exciting interactions
- ❍ 50% of the time prefers relaxing interactions, 50% of the time prefers exciting interactions
- ❍ 40% of the time prefers relaxing interactions, 60% of the time prefers exciting interactions
- ❍ 30% of the time prefers relaxing interactions, 70% of the time prefers exciting interactions
- ❍ 20% of the time prefers relaxing interactions, 80% of the time prefers exciting interactions
- ❍ 10% of the time prefers relaxing interactions, 90% of the time prefers exciting interactions
- ❍ 100% of the time prefers exciting interactions

MaternalIntuition_02 How confident are you in your answer above? Please use the following scale, where 1 represents "Not At All Confident" and 7 represents "Very Confident".

_____ **How confident are you in your answer above?**

cimi3 When your baby stops nursing/drinking from his/her bottle suddenly, what percentage of the time is it due to being full versus feeling gassy or restless?

- ○ 100% of the time stops drinking due to fullness
- ○ 90% of the time stops drinking due to fullness, 10% of the time due to feeling gassy or restless
- ○ 80% of the time stops drinking due to fullness, 20% of the time due to feeling gassy or restless
- ○ 70% of the time stops drinking due to fullness, 30% of the time due to feeling gassy or restless
- ○ 60% of the time stops drinking due to fullness, 40% of the time due to feeling gassy or restless
- ○ 50% of the time stops drinking due to fullness, 50% of the time due to feeling gassy or restless
- ○ 40% of the time stops drinking due to fullness, 60% of the time due to feeling gassy or restless
- ○ 30% of the time stops drinking due to fullness, 70% of the time due to feeling gassy or restless
- ○ 20% of the time stops drinking due to fullness, 80% of the time due to feeling gassy or restless
- ○ 10% of the time stops drinking due to fullness, 90% of the time due to feeling gassy or restless
- ○ 100% of the time stops drinking due to feeling gassy or restless

MaternalIntuition_03 How confident are you in your answer above? Please use the following scale, where 1 represents "Not At All Confident" and 7 represents "Very Confident".

_____ How confident are you in your answer above?

cimi4 When your baby cannot sleep, what percentage of the time is it due to something about the baby's environment (e.g., too much light, too hot or cold) versus something the baby is feeling (e.g., baby feeling hungry, baby having a stuffy nose, baby's tummy feeling upset, etc).

- ○ 100% of the time it is due to something about the environment
- ○ 90% of the time it is due to the environment, 10% of the time due to something the baby is feeling
- ○ 80% of the time it is due to the environment, 20% of the time due to something the baby is feeling
- ○ 70% of the time it is due to the environment, 30% of the time due to something the baby is feeling
- ○ 60% of the time it is due to the environment, 40% of the time due to something the baby is feeling
- ○ 50% of the time it is due to the environment, 50% of the time due to something the baby is feeling
- ○ 40% of the time it is due to the environment, 60% of the time due to something the baby is feeling
- ○ 30% of the time it is due to the environment, 70% of the time due to something the baby is feeling
- ○ 20% of the time it is due to the environment, 80% of the time due to something the baby is feeling
- ○ 10% of the time it is due to the environment, 90% of the time due to something the baby is feeling
- ○ 100% of the time it is due to something the baby is feeling

MaternalIntuition_04 How confident are you in your answer above? Please use the following scale, where 1 represents "Not At All Confident" and 7 represents "Very Confident".

_____ **How confident are you in your answer above?**

PACOTIS_efficacy Using the 0-10 scale below, indicate to what extent each of the following statements accurately describes your actions, thoughts, or feelings in the context of interacting with your child. Please be open and honest in your responding. Use the following scale to rate each statement by dragging the slider bar:

_____ I feel that I am very good at calming my baby down when he/she is upset, fussy, or crying

_____ I feel that I am very good at attracting the attention of my baby.

We claim:

1. A health care system directed to a caregiver that monitors sleep metrics, patterns and quality for an infant, the system comprising:

a base station in communication with a network;

one or more sensors in communication with the base station, the one or more sensors configured to monitor sleep-relevant characteristics of the infant and environmental conditions in proximity to the infant;

a caregiver communication device in communication with the network; and

a remote server in communication with the network,

wherein the remote server is operative to:

access stored information indicating one or more caregiver typing traits for the caregiver,

receive information from the sensors via the base station indicative of one or more measures of sleep metrics, patterns and quality for the infant,

receive information from the caregiver communication device indicative of a caregiver perception of sleep metrics, patterns and quality for the infant, and

recommend at least one intervention from an array of possible interventions to be acted on for the caregiver, the recommended intervention selected as a function of the one or more caregiver typing traits, the one or more sleep quality measures and the caregiver perception of the sleep metrics, patterns and quality for the infant; and

transmit the recommended intervention to the caregiver communication device.

2. The health care system of claim **1**, wherein the one or more sensors comprise biometric sensors for sensing biometric data of the infant.

3. The health care system of claim **1** or claim **2**, wherein sensor and question inputs, server and algorithms, communication to the care giver, and care givers interventions constitute a closed loop control system.

4. The health care system of any of the above claims, wherein the one or more biometric sensors are disposed on one or more of a blanket, a mattress or clothing of the infant.

5. The health care system of any of the above claims, wherein the one or more biometric sensors are disposed on one or more of non-contact sensors such as video or radar.

6. The health care system of any of the above claims, wherein at least one of the biometric sensor and the question inputs comprises answers to data entry questions entered through a personal computing device.

7. The health care system of any of the above claims, wherein the one or more sensors comprise environmental sensors.

8. The health care system of claim **7**, wherein the one or more environmental sensors monitor one or more of a temperature, light level or sound profile in proximity to the infant.

9. The health care system of any of the above claims, wherein the remote server is further operative to determine the one or more caregiver typing traits as a function of a caregiver survey administered by the remote server.

10. The health care system of any of the above claims, wherein the recommended intervention is further selected as a function of a predetermined sleep quality goal.

11. The health care system of claim **10**, wherein the remote server is operative to determine and/or diagnose at least one problem based on the quality goal and the one or more caregiver typing traits, the one or more sleep metric, patterns and quality measures and the caregiver perception of the sleep quality for the infant, and the recommended intervention is identified as impacting the at least one problem.

12. The health care system of any of the above claims, wherein the system is directed to a plurality of caregivers that monitor sleep quality for the infant, and the remote server is operative to recommend at least one action to each of the plurality of caregivers as a function of the caregiver typing traits of the respective caregiver.

13. The health care system of any of the above claims, wherein the remote server is further configured to select one or more coaching suggestions to be provided to the caregiver in association with the recommended action, the one or more coaching suggestions being selected as a function of the caregiver typing traits.

14. The health care system of claim **13**, wherein the one or more coaching suggestions are selected from the group consisting of reminder messages, encouragement messages, alarms, and environmental changes in proximity to the caregiver.

15. The health care system of any of the above claims, further comprising:

an environmental control device for controlling one or more of the temperature, light level or sound profile in proximity to the infant,

wherein the remote server is further configured to:

recommend at least on environmental change based on one or more of the one or more caregiver typing traits, the one or more sleep quality measures and the caregiver perception of the sleep quality for the infant, and

transmit the recommended environmental change to the environmental control device.

16. The health care system of claim **15**, wherein the remote server is further operative to recommend a sequence of caregiver actions and environmental changes over the course of a day, the sequence defining a daily routine for the infant.

17. The health care system of claim **15** or claim **16**, wherein the remote server is operative to alter at least one of the sequence of caregiver actions and environmental changes, and recommend the altered sequence over the course of a subsequent day.

18. The healthcare system of any of the above claims, wherein the remote server is operative to:

confirm that the recommended caregiver action was applied;

receive updated information from the sensors indicative of one or more measures of a current sleep quality for the infant,

receive updated information from the caregiver communication device indicative of a current caregiver perception of sleep quality for the infant,

receive an updated caregiver perception of the sleep quality for the infant;

evaluate the effectiveness of the recommended action in improving to caregiver perception of sleep quality.

19. The healthcare system of any of claims **15-17**, wherein the remote server is operative to:

confirm that the environmental change was applied;

receive updated information from the sensors indicative of one or more measures of a current sleep quality for the infant,

receive updated information from the caregiver communication device indicative of a current caregiver perception of sleep quality for the infant,

receive an updated caregiver perception of the sleep quality for the infant;

evaluate the effectiveness of the environmental change in improving to caregiver perception of sleep quality.

20. A method for directing a caregiver that monitors sleep quality for an infant, the system comprising the steps of:

monitoring one or more sensors for sleep-relevant characteristics of the infant and environmental conditions in proximity to the infant;

accessing stored information indicating one or more caregiver typing traits for the caregiver;

accessing information from a caregiver communication device indicative of a caregiver perception of sleep quality for the infant;

recommending at least one action for the caregiver, the recommended action selected as a function of the one or more caregiver typing traits, the one or more sleep quality measures and the caregiver perception of the sleep quality for the infant; and

transmitting the recommended action to the caregiver communication device

21. The health care system of claim **11**, wherein the determination and/or diagnosis produces a probabilistic analysis of a plurality of potential problems based on the quality goal and the one or more caregiver typing traits.

22. The health care system of claim **21**, wherein the probabilistic analysis is based on quality goal, caregiver typing trait, sleep patterns, sleep metrics, quality measure, caregiver perception and caregiver intervention information for a population of caregivers and infants.

23. The health care system of claim **21**, wherein the probabilistic analysis provides recommended caregiver goals based on the potential problems.

24. The health care system of claim **11** or claim **21**, wherein the determination and/or diagnosis is conducted approximately daily.

25. The health care system of any of the above claims, wherein the recommended intervention is associate with a set of behavioral quanta.

26. The health care system of any of claim **11**, **21** or **24**, wherein the probabilistic analysis is performed by a trained neural network,

* * * * *

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摘要(译)

一种用于护理人员监视和管理婴儿的睡眠度量，模式和质量的医疗保健系统，包括：a）与网络通信的基站，b）与基站通信的一个或多个传感器，c）a护理人员与网络通信的通信设备; d）远程服务器和与网络通信的相关数据存储。远程服务器用于：1）从信息存储器访问信息，指示护理人员输入特征，2）从传感器接收指示婴儿睡眠质量的信息; 3）从护理人员通信设备接收指示护理人员对睡眠的感知的信息婴儿的质量，4）根据看护者的打字特征，睡眠质量测量和护理人员对睡眠质量的感知，推荐至少一个看护者的动作; 5）将推荐的动作发送给护理人员通信设备。