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(54) **SYSTEM AND METHOD FOR PATIENT-CENTRIC GENERATIVE PATIENT REPORTED OUTCOMES**

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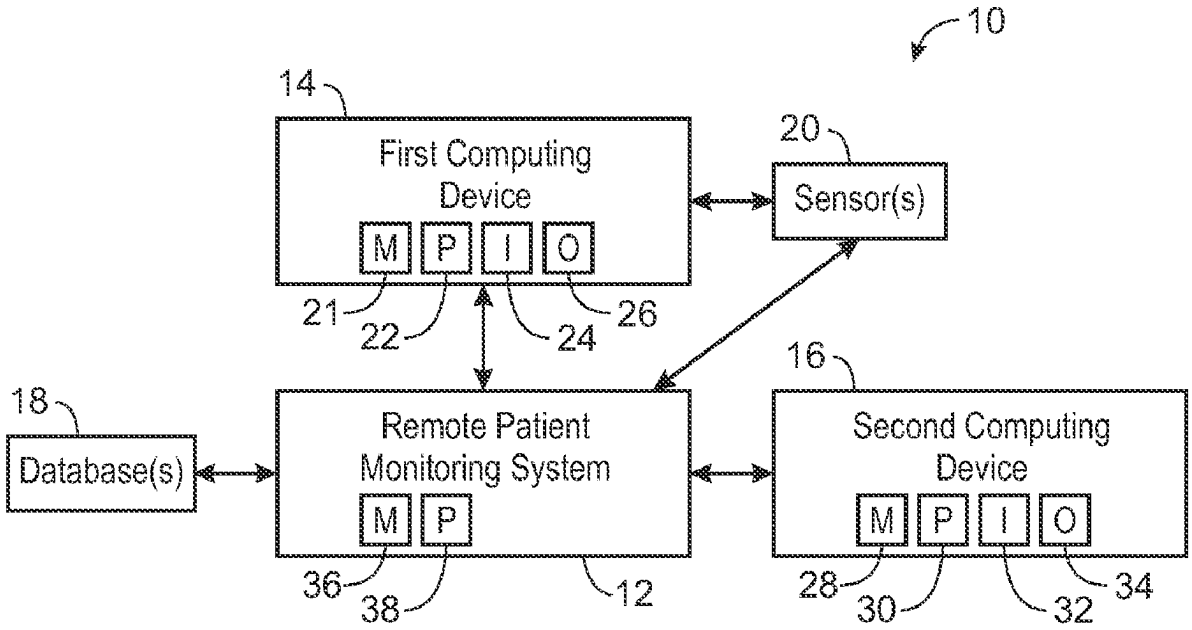
(57) **ABSTRACT**

A remote patient monitoring system includes a memory encoding processor-executable routines. The remote patient monitoring system also includes a processing system configured to access the memory and to execute the processor-executable routines, wherein the routines, when executed by the processing system, cause the processing system to perform actions. The actions include obtaining feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject. The actions also include obtaining past medical records of the subject. The actions further include obtaining a clinical guideline specific to a condition of the subject. The actions even further include generating, via a question generation module, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.



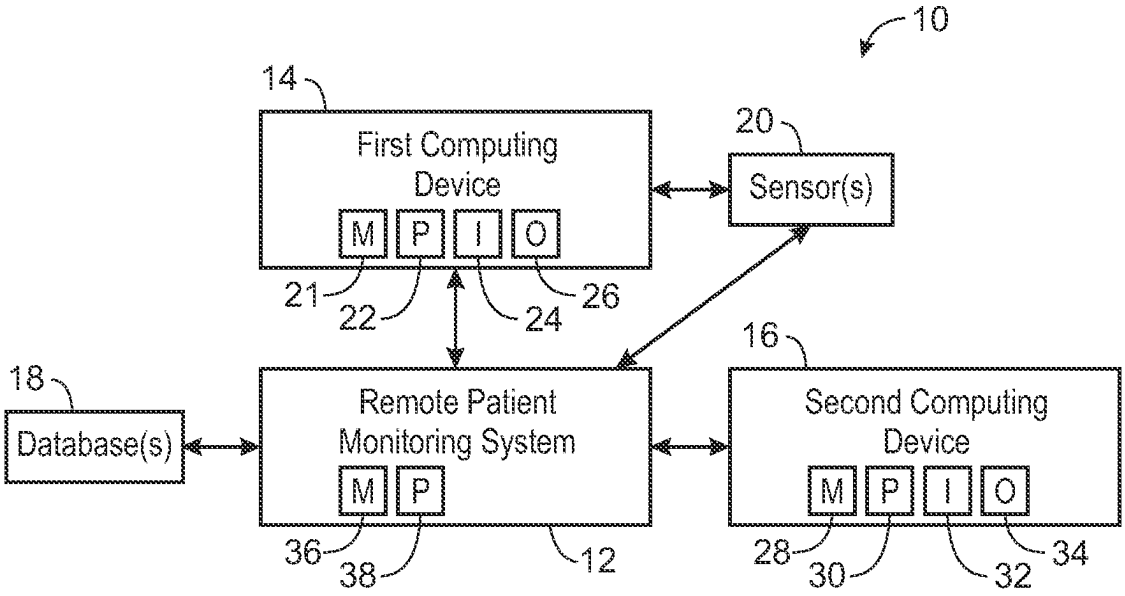

10
14
First Computing Device
M
P
I
O
21
22
24
26
20
Sensor(s)
16
18
Database(s)
Remote Patient Monitoring System
M
P
36
38
12
Second Computing Device
M
P
I
O
28
30
32
34

FIG. 1

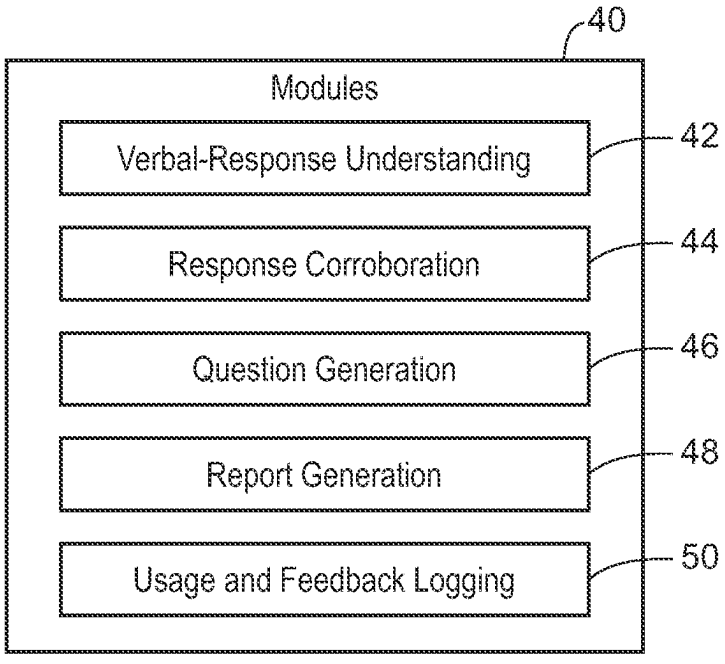

40
Modules
Verbal-Response Understanding
42
Response Corroboration
44
Question Generation
46
Report Generation
48
Usage and Feedback Logging
50

FIG. 2

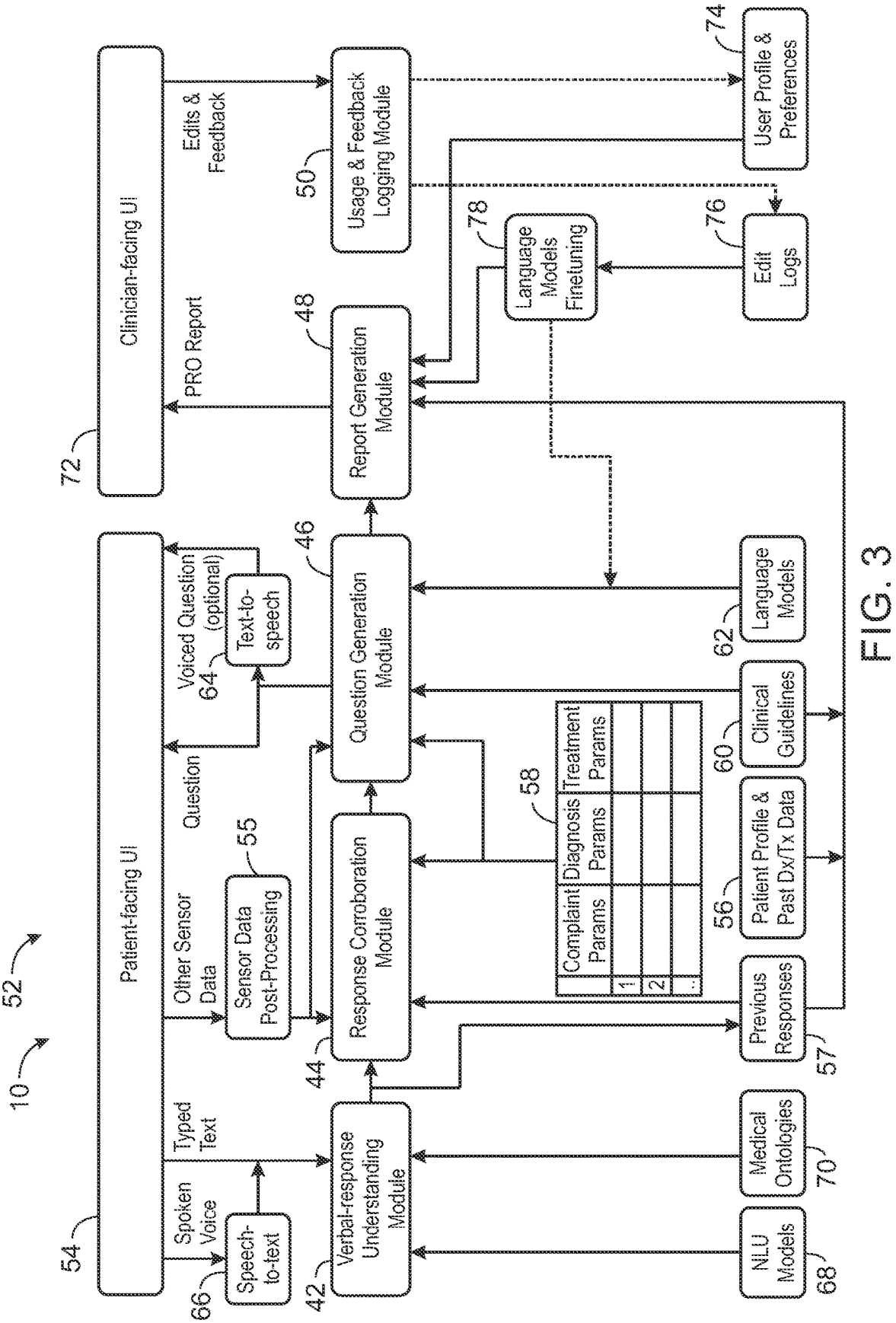

10
52
54
Patient-facing UI
Spoken Voice
Typed Text
66
Speech-to-text
42
Verbal-response Understanding Module
NLU Models
68
Medical Ontologies
70
Other Sensor Data
Sensor Data Post-Processing
55
Question
Voiced Question (optional)
64
Text-to-speech
44
Response Corroboration Module
Previous Responses
57
58
Complaint Params
Diagnosis Params
Treatment Params
1
2
46
Question Generation Module
56
Patient Profile & Past Dx/Tx Data
60
Clinical Guidelines
62
Language Models
72
Clinician-facing UI
PRO Report
Edits & Feedback
48
Report Generation Module
50
Usage & Feedback Logging Module
74
User Profile & Preferences
78
Language Models Finetuning
76
Edit Logs

FIG. 3

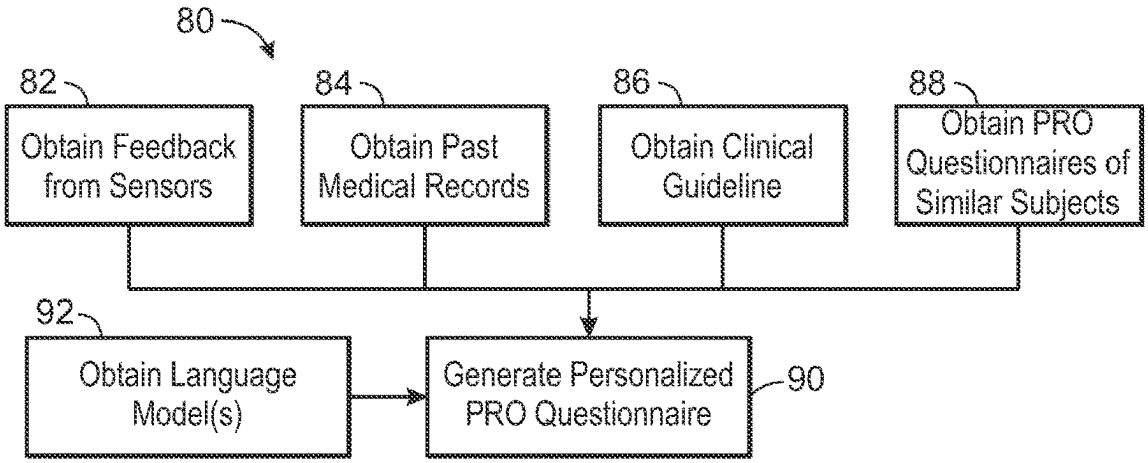


FIG.4

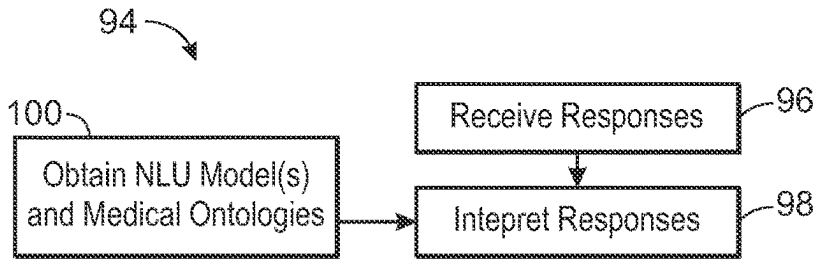


FIG.5

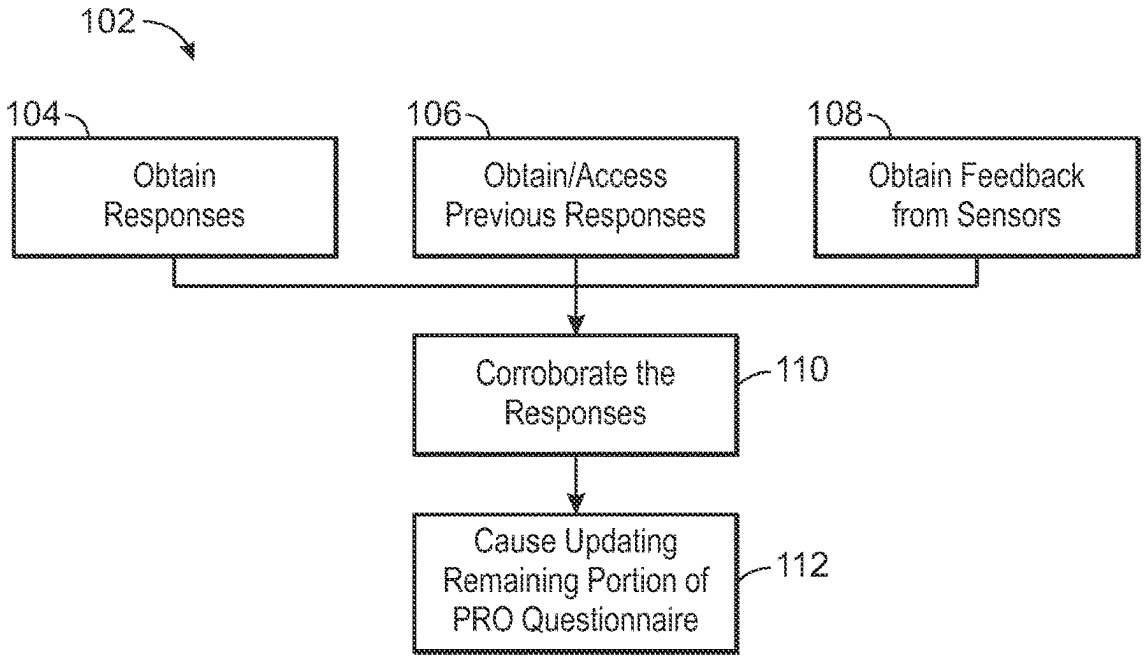


FIG.6

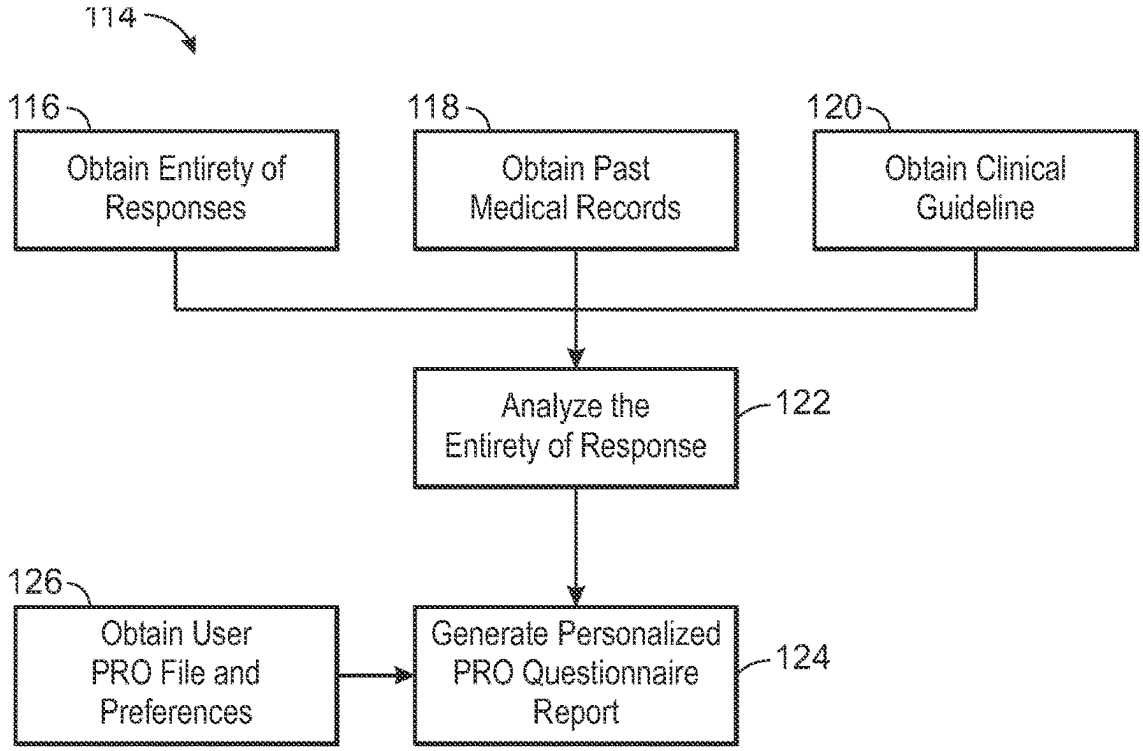

114
116
Obtain Entirety of Responses
118
Obtain Past Medical Records
120
Obtain Clinical Guideline
Analyze the Entirety of Response
122
126
Obtain User PRO File and Preferences
Generate Personalized PRO Questionnaire Report
124

FIG.7

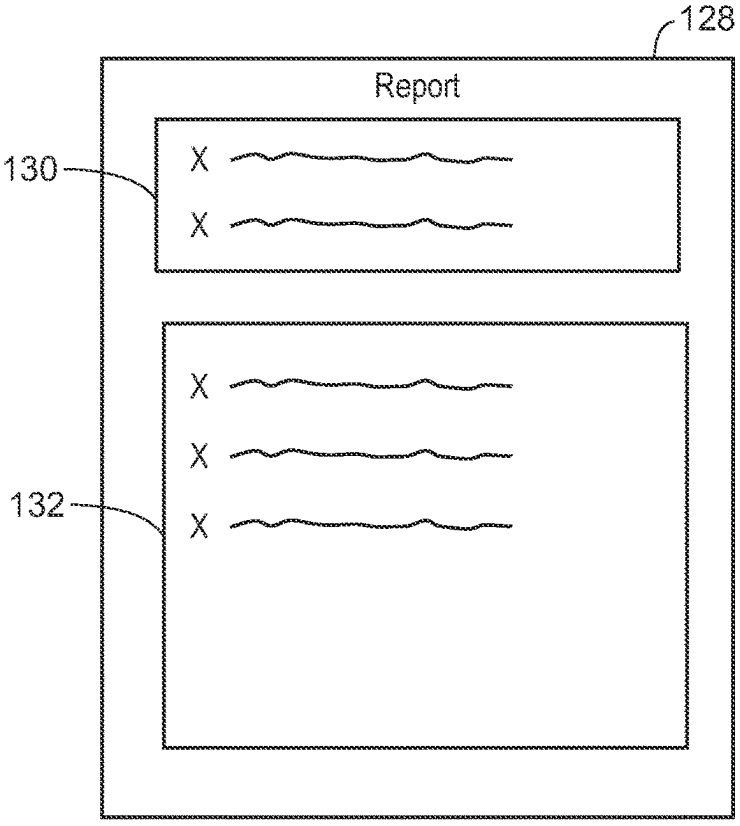

128
Report
130
X
X
X
X
X
132

FIG.8

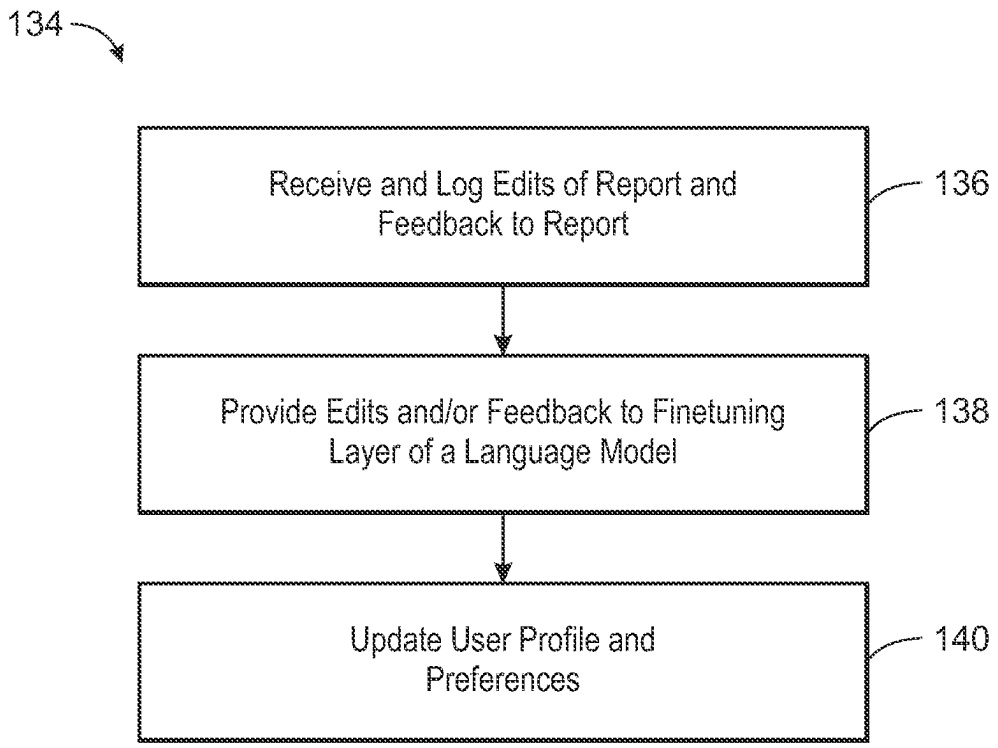

134
Receive and Log Edits of Report and Feedback to Report
136
Provide Edits and/or Feedback to Finetuning Layer of a Language Model
138
Update User Profile and Preferences
140

FIG.9

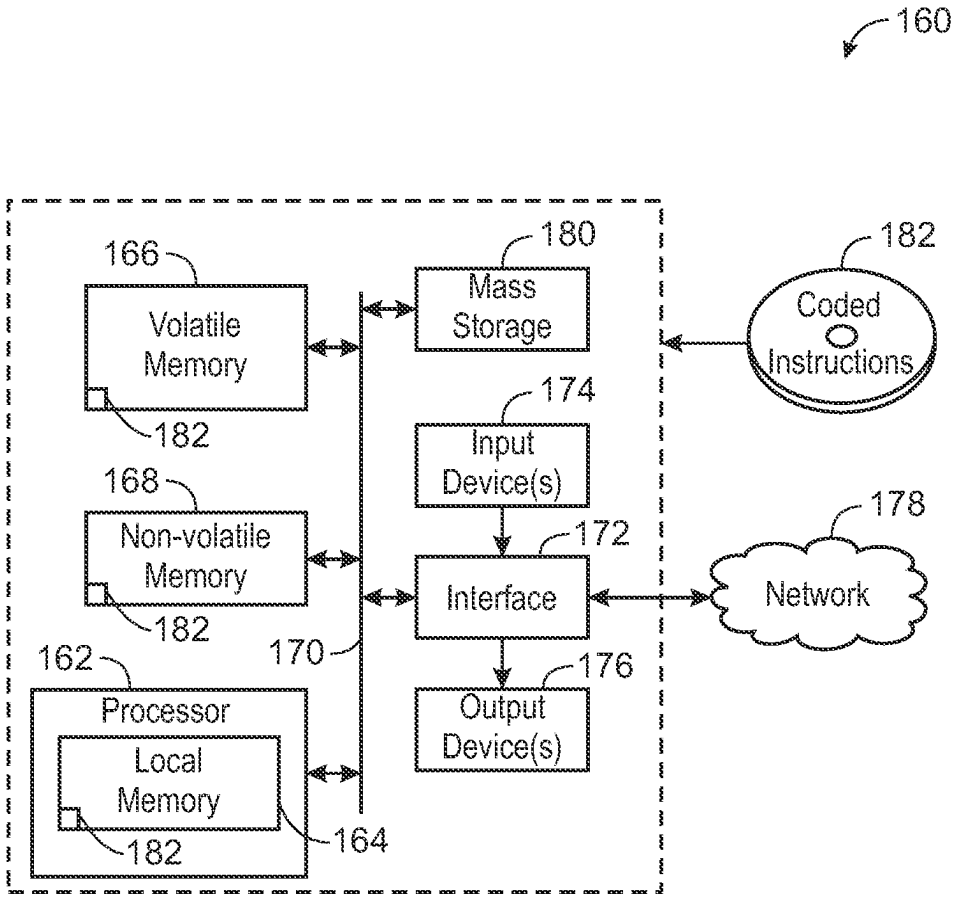

160
166
Volatile Memory
182
168
Non-volatile Memory
182
162
Processor
Local Memory
182
164
170
180
Mass Storage
174
Input Device(s)
172
Interface
176
Output Device(s)
182
Coded Instructions
178
Network

FIG. 10

SYSTEM AND METHOD FOR PATIENT-CENTRIC GENERATIVE PATIENT REPORTED OUTCOMES

BACKGROUND

[0001] The subject matter disclosed herein relates to a system and method for patient-centric generative patient reported outcomes.

[0002] Sometimes patients are recommended for remote patient monitoring after medical practitioners (e.g., oncologists) perform a risk assessment for a medical illness, disease, or condition after surgery or treatment (e.g., cancer treatment). The patient monitoring can be both objective and subjective. The subjective component includes sending questionnaires to patients to assess their quality of life and to determine the next steps during the course of their treatment. The current mechanism for remote patient monitoring includes static questionnaires that (in the case of cancer) are predetermined based on the cancer type of a patient or the questionnaire is designed by the oncologist specifically for the patient. These static questionnaires are limited in the parameters that are considered (e.g., limited to 1 or 2 parameters) which may impact the effectives of the remote monitoring. In addition, it may be difficult to keep up with changes or updates in guidelines for remote monitoring for the particular illness, disease, or condition. The manual generation of these questionnaires for each patient is a cumbersome as many reports and other data need to be looked at. Thus, the process of manually generating these questionnaires may substantially burden the medical practitioners and the medical facility (e.g., hospital, clinics, etc.).

BRIEF DESCRIPTION

[0003] A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

[0004] In one embodiment, a remote patient monitoring system is provided. The remote patient monitoring system includes a memory encoding processor-executable routines. The remote patient monitoring system also includes a processing system configured to access the memory and to execute the processor-executable routines, wherein the routines, when executed by the processing system, cause the processing system to perform actions. The actions include obtaining feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject. The actions also include obtaining past medical records of the subject. The actions further include obtaining a clinical guideline specific to a condition of the subject. The actions even further include generating, via a question generation module, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

[0005] In another embodiment, a computer-implemented method for remote patient monitoring is provided. The computer-implemented method includes obtaining, at a processing system, feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject. The computer-implemented method also includes obtaining, via the processing system, past medical records of the subject. The computer-implemented method further includes obtaining, via the processing system, a clinical guideline specific to a condition of the subject. The computer-implemented method even further includes generating, via a question generation module of the processing system, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

[0006] In a further embodiment, a non-transitory computer-readable medium, the computer-readable medium including processor-executable code that when executed by a processing system, causes the processing system to perform actions. The actions include obtaining feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject. The actions also include obtaining past medical records of the subject. The actions further include obtaining a clinical guideline specific to a condition of the subject. The actions even further include generating, via a question generation module, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] These and other features, aspects, and advantages of the present subject matter will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0008] FIG. **1** is a block diagram of a system for generating patient-centric patient reported outcomes, in accordance with aspects of the present disclosure;

[0009] FIG. **2** is a schematic diagram of a plurality of modules to be utilizing by a remote patient monitoring system, in accordance with aspects of the present disclosure;

[0010] FIG. **3** is a schematic diagram of an architecture for the system in FIG. **1**, in accordance with aspects of the present disclosure;

[0011] FIG. **4** is a flow chart of a method for generating a personalized patient reported outcome questionnaire, in accordance with aspects of the present disclosure;

[0012] FIG. **5** is a flow chart of a method for processing responses to a personalized patient reported outcome questionnaire, in accordance with aspects of the present disclosure;

[0013] FIG. **6** is a flow chart of a method for corroborating responses to a personalized patient reported outcome questionnaire, in accordance with aspects of the present disclosure;

[0014] FIG. **7** is a flow chart of a method for generating a personalized patient reported outcome questionnaire report, in accordance with aspects of the present disclosure;

[0015] FIG. **8** is a schematic diagram of a personalized patient reported outcome questionnaire report, in accordance with aspects of the present disclosure;

[0016] FIG. **9** is a flow chart of a method for utilizing clinician edits and feedbacks, in accordance with aspects of the present disclosure; and

[0017] FIG. **10** is a schematic diagram of an example processor platform for a portable computing device to be utilized with the disclosed techniques.

DETAILED DESCRIPTION

[0018] One or more specific embodiments will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0019] When introducing elements of various embodiments of the present subject matter, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements. Furthermore, any numerical examples in the following discussion are intended to be non-limiting, and thus additional numerical values, ranges, and percentages are within the scope of the disclosed embodiments.

[0020] Some generalized information is provided to provide both general context for aspects of the present disclosure and to facilitate understanding and explanation of certain of the technical concepts described herein.

[0021] The term processor, processing system, or processing unit, as used herein, refers to any type of processing unit that can carry out the required calculations needed for the various embodiments, such as single or multi-core: CPU, Accelerated Processing Unit (APU), Graphics Board, DSP, FPGA, ASIC or a combination thereof.

[0022] As used herein, the term "computing system" refers to an electronic computing device such as, but not limited to, a single computer, virtual machine, virtual container, host, server, laptop, and/or mobile device, or to a plurality of electronic computing devices working together to perform the function described as being performed on or by the computing system. As used herein, the terms "application", "application module" (or "module"), "engine", or "program", or "plugin" refers to one or more sets of computer software instructions (e.g., computer programs and/or scripts) executable by one or more processors of a computing system to provide particular functionality. Computer software instructions can be written in any suitable programming languages, such as C, C++, C#, Pascal, Fortran, Perl, MATLAB, SAS, SPSS, JavaScript, AJAX, and JAVA. Such computer software instructions can comprise an independent application with data input and data display aspects (e.g., modules). Alternatively, the disclosed computer software instructions can be classes that are instantiated as distributed objects. The disclosed computer software instructions can also be component software, for example JAVABEANS or ENTERPRISE JAVABEANS. Additionally, the disclosed applications or engines can be implemented in computer software, computer hardware, or a combination thereof.

[0023] As used herein, the terms "automatic" and "automatically" refer to actions that are performed by a computing device or computing system (e.g., of one or more computing devices) without human intervention. For example, automatically performed functions may be performed by computing devices or systems based solely on data stored on and/or received by the computing devices or systems despite the fact that no human users have prompted the computing devices or systems to perform such functions. As but one non-limiting example, the computing devices or systems may make decisions and/or initiate other functions based solely on the decisions made by the computing devices or systems, regardless of any other inputs relating to the decisions.

[0024] The present disclosure provides for systems and methods for remote patient monitoring In particular, the disclosed systems and methods provide for a guideline compatible questionnaire tool configured to automatically generate relevant questionnaires for a patient (e.g., subject) given based on (but limited to) patient history, objective monitoring, and previously answered questionnaires by the patient and other similar patients.

[0025] The disclosed systems and methods include obtaining feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject. The disclosed systems and methods also include obtaining past medical records of the subject. The disclosed systems and methods further include obtaining a clinical guideline specific to a condition of the subject. The disclosed systems and methods even further include generating, via a question generation module, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

[0026] In certain embodiments, the disclosed systems and methods include obtaining questionnaires of other subjects with a similar medical history to the subject. In certain embodiments, the disclosed systems and methods also include generating, via the question generation module, the personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, the clinical guideline, and the questionnaires of the other subjects.

[0027] In certain embodiments, the disclosed systems and methods include obtaining, at a response understanding module, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire. In certain embodiments, the disclosed systems and methods also include corroborating, via a response corroboration module, the one or more responses with past responses to questions by the subject, the feedback, and the past medical records of the subject. In certain embodiments, the disclosed systems and methods further include updating, via the question generation module, a remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the one or more responses with the past responses to questions by the subject, the feedback, and the past medical records of the subject.

[0028] In certain embodiments, the disclosed systems and methods include notifying, via the response corroboration module, the question generation module when the one or more responses are not consistent with the past responses to the questions by the subject, the feedback, and/or the past medical records of the subject. In certain embodiments, the disclosed systems and methods also include generating, via the question generation module, one or more follow-up questions to clarify any inconsistency when the one or more responses are not consistent with the past responses to the questions by the subject, the feedback, and/or the past medical records of the subject.

[0029] In certain embodiments, the disclosed systems and methods include obtaining, at a response understanding module, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire, wherein the one or more responses are outside a scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions. In certain embodiments, the disclosed systems and methods also include generating, via the question generation module, one or more follow-up questions based on the one or more responses. In certain embodiments, the disclosed systems and methods include analyzing, via the response understanding module, the one or more responses from the subject utilizing a natural language understanding model to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions.

[0030] In certain embodiments, the disclosed systems and methods include receiving, at a report generation module, an entirety of responses from the subject to the personalized patient reported outcome questionnaire. In certain embodiments, the disclosed systems and methods also include analyzing, via the report generation module, the entirety of the responses from the subject in the context of both the past medical records of the subject and the clinical guideline. In certain embodiments, the disclosed systems and methods further include generating, via the report generation module, a personalized patient reported outcome questionnaire report based on the analysis, wherein facts within the personalized patient reported outcome questionnaire report are ranked in terms of relevancy and novelty and presented in a concise manner.

[0031] In certain embodiments, the disclosed systems and methods include logging, via a usage and feedback logging module, edits to the personalized patient reported outcome questionnaire report. In certain embodiments, the disclosed systems and methods also include providing, via the usage and feedback logging module, the edits to a finetuning layer of a language model utilized by the question generation module in generating questions for subsequently generated personalized patient reported outcome questionnaires.

[0032] The disclosed embodiments provide for the digitization of guidelines (e.g., graphically) to enable the following of patient over time with respect to a condition. The disclosed embodiments enable the digitized guidelines to adapt to any changes in the structure which enables the clinician (e.g. oncologist) keep up with the latest updates in the guidelines without any effort from their end. The disclosed embodiments help find similar patients and questionnaires using patient histories and enable generating similar questionnaires for the patient of interest. The disclosed embodiments enable all elements of a patient's journey (and similar patient journeys) to be considered. The disclosed embodiments enable more accurate questionnaires to be sent to remote patients using an algorithm that takes into account the rich patient data and history. The disclosed embodiments enable the improvement in access and speed and delivery of care to the patient. The disclosed embodiments improve the efficiency and accuracy of remote patient monitoring and, thus, the quality of life of the patient. The disclosed embodiments reduce the burden on healthcare facilities and clinicians in generating the questionnaires. The disclosed embodiments also reduce cost saving across healthcare.

[0033] With the preceding in mind, and by way of providing useful context, FIG. **1** depicts is a block diagram of a system **10** for generating patient-centric patient reported outcomes. The system **10** may be utilized to follow a patient (e.g., subject) after any medical treatment or surgery in accordance with clinical guidelines specific to the condition (e.g., type of disease, type of cancer, type of surgery, type of treatment, etc.) of the subject. The system **10** includes a remote patient monitoring system **12** communicatively coupled to a first computing device **14**, a second computing device **16**, one or more databases **18**, and one or more sensors **20**.

[0034] The first computing device **14** (e.g., utilized by a patient (e.g., subject) includes a memory **21** and a processing system **22** (e.g., one or more processors). The first computing device **14** may be a laptop, tablet, smartphone, or other type of computing device. The first computing device **14** includes one or more input devices **24** (e.g., keyboard, touchscreen, microphone, etc.) to enable the patient to communicate with the remote patient monitoring system **12**. For example, the patient may answer questions for a patient reported outcome questionnaire (e.g., personalized patient reported outcome questionnaire) via the input devices **24**. The first computing device **14** also include or more output devices **26** (e.g., display, speaker, etc.).

[0035] In certain embodiments, the first computing device **14** may be in communication with the one or more sensors **20** coupled to and/or utilized on the patient to obtain feedback related to one or more health parameters or physiological parameters of the patient. The one or more sensors **20** are configured to measure these health parameters or physiological parameters. These parameters may include but are not limited blood pressure, temperature, glucose levels, oxygen saturation, respiration rate, heart rate, and/or any other parameter. The one or more sensors **20** may include but are not limited to a glucose monitor, a pulse oximeter, a heart rate monitor, or another type of sensor. The first computing device **14** may communicate the feedback from the sensors **20** to the remote patient monitoring system **12**. In certain embodiments, the one or more sensors **20** may additionally or alternatively communicate the feedback directly to the remote patient monitoring system **12**.

[0036] The second computing device **16** (e.g., utilized by medical practitioner or clinician (e.g., oncologist)) includes a memory **28** and a processing system **30** (e.g., one or more processors). The second computing device **16** may be a laptop, tablet, smartphone, or other type of computing device. The second computing device **16** includes one or more input devices **32** (e.g., keyboard, touchscreen, microphone, etc.) to enable the medical practitioner to communicate with the remote patient monitoring system **12**. For example, the medical practitioner may obtain a patient reported outcome questionnaire (e.g., personalized patient

reported outcome questionnaire) and edit and/or provide feedback for the patient reported outcome questionnaire. The second computing device **16** also include or more output devices **34** (e.g., display, speaker, etc.).

[0037] The remote patient monitoring system **12** includes a memory **36** and a processing system **38** (e.g., one or processors). The processing system **38** is configured to execute a plurality of modules stored within the memory **36** to perform a number of actions related to the patient-centric generative patient reported outcome questionnaires. The remote patient monitoring system **12** is configured to access data from the one or more databases **18**. The one or more databases **18** may include a patient database for storing past medical records of patients, patient profiles, previous responses to past patient reported outcome questionnaires, past patient reported outcome questionnaires for different types of patient profiles, and/or other patient specific data. In certain embodiments, the patient database may include a structural database that includes a number of parameters related to the patient (e.g., including complaint parameters, diagnosis parameters, and/or treatment parameters). In certain embodiments, the one or more databases **18** may store one or more natural language understanding models to help in analyzing and understanding patient responses to patient reported outcome questionnaires. In certain embodiments, the one or more databases **18** may store medical ontologies (e.g., for different areas in the medial field) to also help in analyzing and understanding patient responses to patient reported outcome questionnaires. In certain embodiments, the one or more databases **18** may store different types of clinical guidelines for a variety of different patient conditions. In certain embodiments, the one or more databases **18** may store language models to be utilized in generating questions for patient reported outcome questionnaires (and/or rephrasing questions).

[0038] The remote patient monitoring system **12** is also configured to obtain feedback from the one or more sensors **20** (e.g., coupled to the patient). The remote patient monitoring system **12** is further configured to obtain/receive past medical records of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, past treatment parameters, previous responses to patient reported outcome questionnaires, etc.). The remote patient monitoring system **12** is further configured to obtain/receive a clinical guideline specific to a condition of the patient. An example of guideline is the National Comprehensive Cancer Network® guidelines in oncology for different cancer types. The remote patient monitoring system **12** is even further configured to generate a personalized patient reported outcome questionnaire (e.g., compatible with clinical guideline) based at least on the feedback from the sensors **20**, the past medical records of the patient, and the obtained clinical guideline specific to the condition of the patient.

[0039] In certain embodiments, the remote patient monitoring system **12** is configured to obtain patient reported outcome questionnaires of other subjects with a similar medical history or patient profile to the patient. The remote patient monitoring system **12** may also be configured to generate the personalized patient reported outcome questionnaire utilizing one or more of these other questionnaires in conjunction with the feedback, the past medical records of the subject, and the obtained clinical guideline specific to the condition of the patient.

[0040] The remote patient monitoring system **12** is configured to provide questions from the personalized patient reported outcome questionnaire to the patient on the first computing device **14** and to receive and to receive and to interpret (e.g., understand) the patient's answers to the questions.

[0041] The remote patient monitoring system **12** is also configured to obtain/receive the responses from the patient to questions of the personalized patient reported outcome questionnaire and to corroborate the responses with past responses to questions by the patient, the feedback from the sensors **20**, and the past medical records of the subject. In certain embodiments, the remoter patient monitoring system **12** is configured to update the remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the present responses and the past responses, the feedback, and the past medical records of the subject.

[0042] In certain embodiments, the remote patient monitoring system **12** is configured to notify a question generation module when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject. In certain embodiments, the remote patient monitoring system **12** is configured to generate one or more follow-up questions to clarify any inconsistency when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject.

[0043] In certain embodiments, the obtained responses from the patient may be outside a scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions. In this scenario, the remote patient monitoring system **12** is configured to generate one or more follow-up questions based on these responses outside the scope. In certain embodiments, the remote patient monitoring system **12** may analyze one or more responses form the subject utilizing a natural language understanding model (and the medical ontologies) to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions.

[0044] The remote patient monitoring system **12** is also configured to receive an entirety of responses from the patient to the personalized patient reported outcome questionnaire and to analyze the entirety of the responses from the subject in the context of both the past medical records of the patient and the obtained clinical guideline. The remote patient monitoring system **12** is configured to generate a personalized patient reported outcome questionnaire report based on this analysis. In particular, the remote patient monitoring system is configured to rank facts within the report in terms of relevancy and novelty and to present the facts in a concise manner. The most relevant and novel facts are presented at the beginning of the report.

[0045] The remote patient monitoring system **12** is further configured to log any edits of the report and/or feedback to the report. The remote patient monitoring system **12** is configured to provide the edits and/or feedback to a fine-tuning layer of a language model utilized by a question generation module in generating questions for subsequently generate personalized patient reported outcome questionnaires.

[0046] FIG. **2** is a schematic diagram of a plurality of modules **40** to be utilizing by a remote patient monitoring system **12** in FIG. **1**. The modules **40** include a verbal-response understanding module **42** (e.g., response understanding module), a response corroboration module **44**, a question generation module **46**, a report generation module **48**, and a usage and feedback logging module **50**. In certain embodiments, other types of modules **40** may be utilized by the remote patient monitoring system **12**.

[0047] The verbal-response understanding module **42** is configured to receive and to interpret (e.g., determine) the responses to questions from the patient. The verbal-response understanding module **42** is configured to receive/obtain the answers. The verbal-response understanding module **42** is also configured to obtain and to utilize one or more natural language understanding models and medical ontologies in interpreting the responses to questions from the patient. The verbal-response understanding module **42** provides the ability to record and follow-up on patient responses outside the scope of the current questionnaire but that may have some significance to future clinical decisions. For example, if a patient gives additional details to their answer (e.g., "I do not have shortness of breath, but have a pain while breathing), then these additional details need to be followed-up with appropriate questions and the responses recorded. The verbal-response understanding module **42** is configured to analyze the one or more responses from the subject utilizing a natural language understanding model to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions. The verbal-response understanding module **42** is configured to communicate with the response corroboration module **44**.

[0048] The response corroboration module **44** is configured to obtain the responses to the questions from the questionnaire from the verbal-response understanding module **42**. The response corroboration module **44** is also configured to obtain/access previous responses to the questionnaire by the patient and the medical records of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, etc.). The response corroboration module **44** is further configured to obtain the feedback from sensors of health or physiological parameters of the patient. The response corroboration module **44** is also configured to corroborate the responses with past responses to questions by the patient, the feedback from the sensors, and the past medical records of the subject. In certain embodiments, the response corroboration module **44** is configured to update the remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the present responses and the past responses, the feedback, and the past medical records of the subject.

[0049] In certain embodiments, the response corroboration module **44** is configured to notify a question generation module when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject. In certain embodiments, the response corroboration module **44** is configured to causes the question generation module **46** to generate one or more follow-up questions to clarify any inconsistency when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject. The response corroboration module **44** is configured to communicate with the question generation module **46**.

[0050] The question generation module **46** is configured to obtain configured to obtain feedback from the one or more sensors (e.g., coupled to the patient). The question generation module **46** is further configured to obtain/receive past medical records of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, past treatment parameters, previous responses to patient reported outcome questionnaires, etc.). The question generation module **46** is further configured to obtain/receive a clinical guideline specific to a condition of the patient. An example of guideline is the National Comprehensive Cancer Network® guidelines in oncology for different cancer types. The question generation module **46** is even further configured to generate a personalized patient reported outcome questionnaire (e.g., compatible with clinical guideline) based at least on the feedback from the sensors, the past medical records of the patient, and the obtained clinical guideline specific to the condition of the patient. The question generation module **46** is also configured to obtain one or more language models and to utilize the one or more language models in generating the questions for the personalized patient reported outcome questionnaire.

[0051] In certain embodiments, the question generation module **46** is configured to obtain patient reported outcome questionnaires of other subjects with a similar medical history or patient profile to the patient. The question generation module **46** may also be configured to generate the personalized patient reported outcome questionnaire utilizing one or more of these other questionnaires in conjunction with the feedback, the past medical records of the subject, and the obtained clinical guideline specific to the condition of the patient.

[0052] In certain embodiments, the question generation module **46** is configured to generate one or more follow-up questions (or clarifying questions) to clarify any inconsistency (e.g., as determined by the response corroboration module **44**) when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject. For example, a patient's answer may not be consistent with the sensor readings (e.g., heart rate or respiratory rate), or previous answers, the inconsistency needs to be resolved then and there via a clarifying question. In certain embodiments, the obtained responses from the patient may be outside a scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions. In this scenario, the question generation module **46** is configured to generate one or more follow-up questions based on these responses outside the scope. For example, if a patient provides additional details in their answer (e.g., "I do not have shortness of breath, but have a pain while breathing"), that information needs to be followed-up with appropriate questions and to be recorded. The question generation module **46** is configured to provide the questions from the personalized patient reported outcome questionnaire to a patient via a user interface on a computing device utilized by the patient. The question generation module **46** is also configured to communicate with the report generation module **48**.

[0053] In generating questions, the question generation module **46** is configured to analyze the feedback from the sensors, the past medical history of the patient, and the

previous responses to questions to access the necessity of each of the subsequent questions. Thus, unnecessary questions, repeated questions, and questions lacking an empathetic tone can be avoided. For example, if a patient has an elevated respiratory rate or heart palpitations (which can be detected via the sensors), the questions on heart palpitations and shortness of breath can be avoided.

[0054] The report generation module **48** is configured to obtain/receive an entirety of responses from the patient to the personalized patient reported outcome questionnaire. The report generation module **48** is also configured to obtain/receive past medical records of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, past treatment parameters, previous responses to patient reported outcome questionnaires, etc.). The report generation module **48** is further configured to obtain/receive a clinical guideline specific to a condition of the patient. The report generation module **48** is to analyze the entirety of the responses from the subject in the context of both the past medical records of the patient and the obtained clinical guideline. The report generation module **48** is configured to generate a personalized patient reported outcome questionnaire report based on this analysis. In particular, the report generation module **48** is configured to rank facts within the report in terms of relevancy and novelty and to present the facts in a concise manner. The most relevant and novel facts are presented at the beginning of the report. For example, when answers are beyond an expected range, or pertains to a new symptom or adverse event, can be highlighted. The report generation module **48** is configured to provide the report to a clinician via a user interface on a computing device utilized by the clinician. The report generation module **48** is also configured to obtain user profile and user preferences for the clinician and to utilize these in generating the report.

[0055] The usage and feedback logging module **50** is configured to receive and to log any edits of the report and/or feedback to the report provided by the clinician. The usage and feedback logging module **50** is configured to provide the edits and/or feedback to a finetuning layer of a language model utilized by the question generation module **46** in generating questions for subsequently generate personalized patient reported outcome questionnaires. This enables accounting for any changes in language specific to a region. In particular, certain terms can be replaced with more regionally understood equivalent terms. The usage and feedback logging module **50** enables automatic learning from a doctor's, hospital's, or region's style of asking questions.

[0056] FIG. **3** is a schematic diagram of an architecture **52** for the system **10** in FIG. **1**. The question generation module **46** obtains feedback from the one or more sensors (e.g., coupled to the patient) via a user interface **54** (e.g., patient-facing user interface) utilized by the patient on a computing device utilized by the patient. The sensor data may be post-processed prior to being provided to the response corroboration module **44** and the question generation module **46** as indicated by reference number **55**. The question generation module **46** is further configured to obtain/receive past medical records **56** of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, past treatment parameters, previous responses to patient reported outcome questionnaires, **57** etc.). The past medical records **56** may include a structured database **58** (e.g., having past complaint parameters, past diagnostic parameters, and past treatment parameters). The question generation module **46** further obtains a clinical guideline **60** specific to a condition of the patient. The question generation module **46** generates a personalized patient reported outcome questionnaire (e.g., compatible with clinical guideline **60**) based at least on the feedback from the sensors, the past medical records **56** of the patient, and the obtained clinical guideline **60** specific to the condition of the patient. The question generation module **46** also obtains one or more language models **62** and utilizes the one or more language models **62** in generating the questions for the personalized patient reported outcome questionnaire. The question generation module **46** communicates with the report generation module **48**.

[0057] In certain embodiments, the question generation module **46** obtains patient reported outcome questionnaires of other subjects with a similar medical history or patient profile to the patient. The question generation module **46** may also generate the personalized patient reported outcome questionnaire utilizing one or more of these other questionnaires in conjunction with the feedback, the past medical records **56** of the subject, and the obtained clinical guideline **60** specific to the condition of the patient.

[0058] In certain embodiments, the questions from the personalized patient reported outcome questionnaire are provide in a textual form to the patient via the user interface **54**. In certain embodiments, the questions from the personalized patient reported outcome questionnaire are converted from text to speech as indicated by reference numeral **64**. Thus, in certain embodiments, the questions from the personalized patient reported outcome questionnaire are verbally provided (e.g., via a speaker) to the patient.

[0059] In certain embodiments, the responses or answers to the questions from the personalized patient reported outcome questionnaire are provided in a textual form via the user interface **54** to the verbal-response understanding module **42**. In certain embodiments, the response or answers to the questions are provided in a verbal form (e.g., via a microphone) via the user interface **54**, converted from speech to text as indicated by reference numeral **66**, and provided to the verbal-response understanding module **42**.

[0060] The verbal-response understanding module **42** receives and interprets the answers or responses to questions from the patient. The verbal-response understanding module **42** obtains and utilizes one or more natural language understanding models **68** and medical ontologies **70** in interpreting the responses to questions from the patient. The verbal-response understanding module **42** may analyze the one or more responses from the patient utilizing a natural language understanding model **68** to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions. The verbal-response understanding module **42** communicate with the response corroboration module **44**.

[0061] The response corroboration module **44** obtains the responses to the questions from the questionnaire from the verbal-response understanding module **42**. The response corroboration module **44** is also obtains/accesses previous responses **57** to the questionnaire by the patient and the medical records **56** of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, etc.). The response corroboration module **44** further obtains the feedback from sensors of health or physiological parameters of the patient. The response corroboration module **44** also corroborates the responses with past responses **57** to ques-

tions by the patient, the feedback from the sensors, and the past medical records **56** of the subject. In certain embodiments, the response corroboration module **44** updates the remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the present responses and the past responses **57**, the feedback, and the past medical records **56** of the patient.

[0062] In certain embodiments, the response corroboration module **44** notifies the question generation module **46** when one or more of the present responses are not consistent with the past responses **57** to the questions, the feedback, and/or the past medical records **56** of the patient. In certain embodiments, the response corroboration module **44** causes the question generation module **46** to generate one or more follow-up questions to clarify any inconsistency when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject. The response corroboration module **44** communicates with the question generation module **46**.

[0063] The report generation module **48** obtains an entirety of responses from the patient to the personalized patient reported outcome questionnaire (which are now part of the previous responses **57**). The report generation module **48** also obtains past medical records **56** the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, past treatment parameters, previous responses to patient reported outcome questionnaires, etc.). The report generation module **48** further obtains the clinical guideline **60** specific to a condition of the patient. The report generation module **48** analyzes the entirety of the responses from the subject in the context of both the past medical records **56** of the patient and the obtained clinical guideline **60**. The report generation module **48** generates a personalized patient reported outcome questionnaire report based on this analysis. In particular, the report generation module **48** is configured to rank facts within the report in terms of relevancy and novelty and to present the facts in a concise manner. The most relevant and novel facts are presented at the beginning of the report. For example, when answers are beyond an expected range, or pertains to a new symptom or adverse event, can be highlighted. The report generation module **48** provides the report to a clinician via a user interface **72** on a computing device utilized by the clinician. The report generation module **48** also obtains user profile and user preferences **74** for the clinician and utilizes these in generating the report.

[0064] The usage and feedback logging module **50** receives and logs any edits of the report and/or feedback to the report provided by the clinician. The usage and feedback logging module **50** edits the logs (indicated by reference numeral **76**) and provides the edits and/or feedback to a finetuning layer of a language model (as indicated by reference numeral **78**) utilized by the question generation module **46** in generating questions for subsequently generate personalized patient reported outcome questionnaires. This enables accounting for any changes in language specific to a region. In particular, certain terms can be replaced with more regionally understood equivalent terms. The usage and feedback logging module **50** enables automatic learning from a doctor's, hospital's, or region's style of asking questions. In certain embodiments, the user profile and preferences **74** may be updated via the usage and feedback logging module **50** based on the received edits and/or feedback.

[0065] FIG. **4** is a flow chart of a method **80** for generating a personalized patient reported outcome (PRO) questionnaire. One or more steps of the method **80** may be performed by one or more components (e.g., processing system **38**) of the remote patient monitoring system **12** in FIG. **1**. One or more steps of the method **80** may be performed simultaneously and/or in a different order from that depicted in FIG. **4**.

[0066] The method **80** includes obtaining feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject (e.g., patient) (block **82**). The method **80** also includes obtaining past medical records of the subject (block **84**). In certain embodiments, the method **80** further includes obtaining a clinical guideline specific to a condition of the subject (block **86**). In certain embodiments, the method **80** includes obtaining patient reported outcome (PRO) questionnaires of other subjects with a similar medical history or patient profile to the subject (block **88**). The method **80** even further includes generating a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline (block **90**). In certain embodiments, the patient reported outcome (PRO) questionnaires of other subjects with a similar medical history or patient profile to the subject are also utilized in generating the personalized patient reported outcome questionnaires. The method **80** also includes obtaining one or more language models (block **92**) and utilizes the one or more language models in generating the questions for the personalized patient reported outcome questionnaire (block **90**).

[0067] FIG. **5** is a flow chart of a method **94** for processing responses to a personalized patient reported outcome questionnaire. One or more steps of the method **94** may be performed by one or more components (e.g., processing system **38**) of the remote patient monitoring system **12** in FIG. **1**. One or more steps of the method **94** may be performed simultaneously and/or in a different order from that depicted in FIG. **5**.

[0068] The method **94** includes receiving the answers or responses to questions (e.g., in a text form) from the subject (e.g., patient) to the personalized patient reported outcome questionnaire (block **96**). The method **94** also includes interpreting the answers or responses to the questions from the subject to the personalized patient reported outcome questionnaire (block **98**). The method **94** further includes obtaining one or more natural language understanding models and medical ontologies (block **100**) and utilizing the natural language understanding (NLU) models and medical ontologies in interpreting the responses to questions from the subject (block **98**). In certain embodiments, interpreting the answer or responses includes analyzing the one or more responses from the subject utilizing the natural language understanding model to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions.

[0069] FIG. **6** is a flow chart of a method **102** for corroborating responses to a personalized patient reported outcome questionnaire. One or more steps of the method **102** may be performed by one or more components (e.g., pro-

cessing system **38**) of the remote patient monitoring system **12** in FIG. **1**. One or more steps of the method **102** may be performed simultaneously and/or in a different order from that depicted in FIG. **6**.

[0070] The method **102** includes obtaining the responses to the questions from the questionnaire (e.g., from the verbal-response understanding module) (block **104**). The method **102** also includes obtaining/accessing previous responses to the questionnaire by the patient and the medical records of the patient (e.g., patient profile, past complaint parameters, past diagnostic parameters, etc.). (block **106**) The method **102** further includes obtaining the feedback from sensors of health or physiological parameters of the subject (e.g., patient) (block **108**). The method **102** even further includes corroborating the responses with past responses to questions by the subject, the feedback from the sensors, and the past medical records of the subject (block **110**). In certain embodiments, the response corroboration module **44** includes causing the updating of the remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the present responses and the past responses, the feedback, and the past medical records of the subject (block **112**).

[0071] In certain embodiments, causing the updating includes notifying a question generation module when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject. In certain embodiments, causing the updating includes causing the question generation module to generate one or more follow-up questions to clarify any inconsistency when one or more of the present responses are not consistent with the past responses to the questions, the feedback, and/or the past medical records of the subject.

[0072] FIG. **7** is a flow chart of a method **114** for generating a personalized patient reported outcome questionnaire report. One or more steps of the method **114** may be performed by one or more components (e.g., processing system **38**) of the remote patient monitoring system **12** in FIG. **1**. One or more steps of the method **114** may be performed simultaneously and/or in a different order from that depicted in FIG. **7**.

[0073] The method **114** obtaining an entirety of responses from the patient to the personalized patient reported outcome questionnaire (block **116**). The method **114** also includes obtaining past medical records of the subject (e.g., patient profile, past complaint parameters, past diagnostic parameters, past treatment parameters, previous responses to patient reported outcome questionnaires, etc.) (block **118**). The method **114** further includes obtaining a clinical guideline specific to a condition of the patient (block **120**). The method **114** even further includes analyzing the entirety of the responses from the subject in the context of both the past medical records of the patient and the obtained clinical guideline (block **122**). The method **114** still further includes generating a personalized patient reported outcome questionnaire report based on this analysis (block **124**). Generating the personalized patient reported outcome questionnaire report includes ranking facts within the report in terms of relevancy and novelty and to present the facts in a concise manner. The most relevant and novel facts are presented at the beginning of the report. For example, when answers are beyond an expected range, or pertains to a new symptom or adverse event, can be highlighted. The method **114** includes obtaining user profile and user preferences for the clinician (block **126**) and to utilize these in generating the report (block **124**).

[0074] FIG. **8** is a schematic diagram of a personalized patient reported outcome questionnaire report **128**. As noted above, the personalized patient reported outcome questionnaire report **128** includes the facts ranked within the report in terms of relevancy and novelty and presented in a concise manner. As depicted in FIG. **8**, the report **128** includes the most relevant and novel facts presented at a beginning portion **130** of the report **128**. The rest of fats are presented in a subsequent portion **132** of the report **128**.

[0075] FIG. **9** is a flow chart of a method **134** for utilizing clinician edits and feedbacks. One or more steps of the method **134** may be performed by one or more components (e.g., processing system **38**) of the remote patient monitoring system **12** in FIG. **1**. One or more steps of the method **134** may be performed simultaneously and/or in a different order from that depicted in FIG. **9**.

[0076] The method **134** includes receiving and logging any edits of the report and/or feedback to the report provided by the clinician (block **136**). The method **134** also includes providing the edits and/or feedback to a finetuning layer of a language model utilized by the question generation module in generating questions for subsequently generate personalized patient reported outcome questionnaires (block **138**). The method **134** further includes updating user profile and user preferences based on the edits and/or feedback (block **140**).

[0077] FIG. **10** is a block diagram of an example processor platform **160** for a portable computing device to be utilized with the disclosed techniques. The processor platform **160** of the illustrated example includes a processor **162**. The processor **162** of the illustrated example is hardware. For example, the processor **162** can be implemented by integrated circuits, logic circuits, microprocessors or controllers from any desired family or manufacturer.

[0078] The processor **162** of the illustrated example includes a local memory **164** (e.g., a cache). The example processor **162** of FIG. **10** executes the instructions of at least FIGS. **4** and **5** to implement the systems, infrastructure, displays, and associated methods of FIGS. **4** and **5**. The processor **162** of the illustrated example is in communication with a main memory including a volatile memory **166** and a non-volatile memory **168** via a bus **170**. The volatile memory **166** may be implemented by Synchronous Dynamic Random Access Memory (SDRAM), Dynamic Random Access Memory (DRAM), RAMBUS Dynamic Random Access Memory (RDRAM) and/or any other type of random access memory device. The non-volatile memory **168** may be implemented by flash memory and/or any other desired type of memory device. Access to the main memory **166**, **168** is controlled by a clock controller.

[0079] The processor platform **160** of the illustrated example also includes an interface circuit **172**. The interface circuit **172** may be implemented by any type of interface standard, such as an Ethernet interface, a universal serial bus (USB), and/or a PCI express interface.

[0080] In the illustrated example, one or more input devices **174** are connected to the interface circuit **172**. The input device(s) **174** permit(s) a user to enter data and commands into the processor **162**. The input device(s) **174** can be implemented by, for example, a sensor, a microphone, a camera (still or video, RGB or depth, etc.), a

keyboard, a button, a mouse, a touchscreen, a track-pad, a trackball, isopoint and/or a voice recognition system.

[0081] One or more output devices **176** are also connected to the interface circuit **172** of the illustrated example. The output devices **176** can be implemented, for example, by display devices (e.g., a light emitting diode (LED), an organic light emitting diode (OLED), a liquid crystal display, a cathode ray tube display (CRT), a touchscreen, a tactile output device, and/or speakers). The interface circuit **172** of the illustrated example, thus, typically includes a graphics driver card, a graphics driver chip or a graphics driver processor.

[0082] The interface circuit **172** of the illustrated example also includes a communication device such as a transmitter, a receiver, a transceiver, a modem and/or network interface card to facilitate exchange of data with external machines (e.g., computing devices of any kind) via a network **178** (e.g., an Ethernet connection, a digital subscriber line (DSL), a telephone line, coaxial cable, a cellular telephone system, Wi-Fi, etc.).

[0083] The processor platform **160** of the illustrated example also includes one or more mass storage devices **180** for storing software and/or data. Examples of such mass storage devices **180** include floppy disk drives, hard drive disks, compact disk drives, Blu-ray disk drives, RAID systems, and digital versatile disk (DVD) drives.

[0084] Coded instructions **182** may be stored in the mass storage device **180**, in the volatile memory **166**, in the non-volatile memory **168**, and/or on a removable tangible computer readable storage medium (e.g., mass storage device **180**).

[0085] Technical effects of the disclosed embodiments include providing for the digitization of guidelines (e.g., graphically) to enable the following of patient over time with respect to a condition. Technical effects of the disclosed embodiments also enable the digitized guidelines to adapt to any changes in the structure which enables the clinician (e.g. oncologist) keep up with the latest updates in the guidelines without any effort from their end. Technical effects of the disclosed embodiments include further helping find similar patients and questionnaires using patient histories and enable generating similar questionnaires for the patient of interest. Technical effects of the disclosed embodiments include enabling all elements of a patient's journey (and similar patient journeys) to be considered. Technical effects of the disclosed embodiments also include enabling more accurate questionnaires to be sent to remote patients using an algorithm that takes into account the rich patient data and history. Technical effects of the disclosed embodiments include enabling the improvement in access and speed and delivery of care to the patient. Technical effects of the disclosed embodiments include improving the efficiency and accuracy of remote patient monitoring and, thus, the quality of life of the patient. Technical effects of the disclosed embodiments also include reducing the burden on healthcare facilities and clinicians in generating the questionnaires. Technical effects of the disclosed embodiments further include reducing cost saving across healthcare.

[0086] The techniques presented and claimed herein are referenced and applied to material objects and concrete examples of a practical nature that demonstrably improve the present technical field and, as such, are not abstract, intangible or purely theoretical. Further, if any claims appended to the end of this specification contain one or more elements designated as "means for [perform]ing [a function] . . . " or "step for [perform]ing [a function] . . . ", it is intended that such elements are to be interpreted under 35 U.S.C. 112(f). However, for any claims containing elements designated in any other manner, it is intended that such elements are not to be interpreted under 35 U.S.C. 112(f).

[0087] This written description uses examples to disclose the present subject matter, including the best mode, and also to enable any person skilled in the art to practice the subject matter, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the subject matter is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

1. A remote patient monitoring system, comprising:

a memory encoding processor-executable routines; and

a processing system configured to access the memory and to execute the processor-executable routines, wherein the processor-executable routines, when executed by the processing system, cause the processing system to:

obtain feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject;

obtain past medical records of the subject;

obtain a clinical guideline specific to a condition of the subject; and

generate, via a question generation module, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

2. The remote patient monitoring system of claim **1**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

obtain questionnaires of other subjects with a similar medical history to the subject; and

generate, via the question generation module, the personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, the clinical guideline, and the questionnaires of the other subjects.

3. The remote patient monitoring system of claim **1**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

obtain, at a response understanding module, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire;

corroborate, via a response corroboration module, the one or more responses with past responses to questions by the subject, the feedback, and the past medical records of the subject; and

update, via the question generation module, a remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the one or more responses with the past

responses to questions by the subject, the feedback, and the past medical records of the subject.

4. The remote patient monitoring system of claim **3**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

notify, via the response corroboration module, the question generation module when the one or more responses are not consistent with the past responses to the questions by the subject, the feedback, and/or the past medical records of the subject; and

generate, via the question generation module, one or more follow-up questions to clarify any inconsistency when the one or more responses are not consistent with the past responses to the questions by the subject, the feedback, and/or the past medical records of the subject.

5. The remote patient monitoring system of claim **1**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

obtain, at a response understanding module, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire, wherein the one or more responses are outside a scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions; and

generate, via the question generation module, one or more follow-up questions based on the one or more responses.

6. The remote patient monitoring system of claim **5**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

analyze, via the response understanding module, the one or more responses from the subject utilizing a natural language understanding model to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions.

7. The remote patient monitoring system of claim **1**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

receive, at a report generation module, an entirety of responses from the subject to the personalized patient reported outcome questionnaire;

analyze, via the report generation module, the entirety of the responses from the subject in context of both the past medical records of the subject and the clinical guideline; and

generate, via the report generation module, a personalized patient reported outcome questionnaire report based on the analysis, wherein facts within the personalized patient reported outcome questionnaire report are ranked in terms of relevancy and novelty and presented in a concise manner.

8. The remote patient monitoring system of claim **7**, wherein the processor-executable routines, when executed by the processing system, further cause the processing system to:

log, via a usage and feedback logging module, edits to the personalized patient reported outcome questionnaire report; and

provide, via the usage and feedback logging module, the edits to a finetuning layer of a language model utilized by the question generation module in generating questions for subsequently generated personalized patient reported outcome questionnaires.

9. A computer-implemented method for remote patient monitoring, comprising:

obtaining, via a processing system, feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject;

obtaining, via the processing system, past medical records of the subject;

obtaining, via the processing system, a clinical guideline specific to a condition of the subject; and

generating, via a question generation module of the processing system, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

10. The computer-implemented method of claim **9**, further comprising:

obtaining, at the processing system, questionnaires of other subjects with a similar medical history to the subject; and

generating, via the question generation module of the processing system, the personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, the clinical guideline, and the questionnaires of the other subjects.

11. The computer-implemented method of claim **9**, further comprising:

obtaining, at a response understanding module of the processing system, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire;

corroborating, via a response corroboration module of the processing system, the one or more responses with past responses to questions by the subject, the feedback, and the past medical records of the subject; and

updating, via the question generation module of the processing system, a remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the one or more responses with the past responses to questions by the subject, the feedback, and the past medical records of the subject.

12. The computer-implemented method of claim **11**, further comprising:

notifying, via the response corroboration module of the processing system, the question generation module when the one or more responses are not consistent with the past responses to the questions by the subject, the feedback, and/or the past medical records of the subject; and

generating, via the question generation module of the processing system, one or more follow-up questions to clarify any inconsistency when the one or more responses are not consistent with the past responses to

the questions by the subject, the feedback, and/or the past medical records of the subject.

13. The computer-implemented method of claim **9**, further comprising:

obtaining, at a response understanding module of the processing system, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire, wherein the one or more responses are outside a scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions; and

generating, via the question generation module of the processing system, one or more follow-up questions based on the one or more responses.

14. The computer-implemented method of claim **13**, further comprising:

analyzing, via the response understanding module of the processing system, the one or more responses from the subject utilizing a natural language understanding model to determine any facts outside the scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions.

15. The computer-implemented method of claim **9**, further comprising:

receiving, at a report generation module of a processing system, an entirety of responses from the subject to the personalized patient reported outcome questionnaire;

analyzing, via the report generation module of a processing system, the entirety of the responses from the subject in context of both the past medical records of the subject and the clinical guideline; and

generating, via the report generation module of the processing system, a personalized patient reported outcome questionnaire report based on the analysis, wherein facts within the personalized patient reported outcome questionnaire report are ranked in terms of relevancy and novelty and presented in a concise manner.

16. The computer-implemented method of claim **15**, further comprising:

logging, via a usage and feedback logging module of the processing system, edits to the personalized patient reported outcome questionnaire report; and

providing, via the usage and feedback logging module of the processing system, the edits to a finetuning layer of a language model utilized by the question generation module in generating questions for subsequently generated personalized patient reported outcome questionnaires.

17. A non-transitory computer-readable medium, the computer-readable medium comprising processor-executable code that when executed by a processing system, causes the processing system to:

obtain feedback from one or more sensors, wherein the feedback relates to one or more health parameters of a subject;

obtain past medical records of the subject;

obtain a clinical guideline specific to a condition of the subject; and

generate, via a question generation module, a personalized patient reported outcome questionnaire based at least on the feedback, the past medical records of the subject, and the clinical guideline, wherein the personalized patient reported outcome questionnaire is compatible with the clinical guideline.

18. The non-transitory computer-readable medium of claim **17**, wherein the processor-executable code, when executed by the processing system, further causes the processing system to:

obtain, at a response understanding module, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire;

corroborate, via a response corroboration module, the one or more responses with past responses to questions by the subject, the feedback, and the past medical records of the subject; and

update, via the question generation module, a remaining portion of the personalized patient reported outcome questionnaire based on a level of corroboration between the one or more responses with the past responses to questions by the subject, the feedback, and the past medical records of the subject.

19. The non-transitory computer-readable medium of claim **17**, wherein the processor-executable code, when executed by the processor, further causes the processing system to:

obtain, at a response understanding module, one or more responses from the subject to one or more questions from the personalized patient reported outcome questionnaire, wherein the one or more responses are outside a scope of the personalized patient reported outcome questionnaire but relevant to subsequent clinical decisions; and

generate, via the question generation module, one or more follow-up questions based on the one or more responses.

20. The non-transitory computer-readable medium of claim **17**, wherein the processor-executable code, when executed by the processor, further causes the processing system to:

receive, at a report generation module, an entirety of responses from the subject to the personalized patient reported outcome questionnaire;

analyze, via the report generation module, the entirety of the responses from the subject in context of both the past medical records of the subject and the clinical guideline; and

generate, via the report generation module, a personalized patient reported outcome questionnaire report based on the analysis, wherein facts within the personalized patient reported outcome questionnaire report are ranked in terms of relevancy and novelty and presented in a concise manner.

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