Aspects of Home blood pressure: Data collection, analysis, understanding complexity in making and happening, and shift responsibility in clinical practice

In 2020, 33.3 % of the death in the U.S, was directly or indirectly related to cardio-metabolic diseases. (1) Hypertension (HTN) is the leading risk factor for cardiovascular deaths. (2,3,4) The average time delay in initiating treatment of high blood pressure (BP) (> 140/90 mm Hg) from the time of diagnosis seems to be 5 years or more (5). Not being treated even after diagnosis of hypertension (>140/90) is common in up to 80% the population. The proportion of patients not being treated could be higher in younger and other vulnerable subgroups according to new ACC/AHA threshold for HTN (6,7,8,9,10 &11). The net benefit from maintenance of BP systolic and diastolic below 120/ 80 mm Hg seems to keep cardiovascular and renal risks at low level in adult population (12,13,14) The fluctuation in BP is normal hence, guidelines recommend numerous methods to process multiple BP values to ensure accuracy taking time factor in to consideration. Guidelines recommend home blood pressure measurement (HBPM) to help management(22,27,29,30,31,32). The process of gathering BP data directly from patients periodically or continuously adds additional element in profiling BP pattern.

These concerns in general reinforce the need for physicians to consider substitute tools to address valid out-off office data collection and processing to add additional element of making in natural setting and complement with component analysis to more accurately detect clear shift in BP trend in conjunction with other risk factors to influence clinical management of patient. Here we argue gaps in hypertension practice guidelines, practice circumstances, some parallels between ambulatory blood pressure measurement (ABPM) and home blood pressure measurement (HBPM), barriers to adopt recommended standards and patient factors to justify home blood pressure as a basic start up process to exchange information between clinic and patient.

We attempt here to describe required technical platform to facilitate practice to exchange unlimited data on patient's BP, P, blood sugar (BS), weight (WT), Pulse oxygen (PO), temperature (T) and also process additional relevant clinical and supporting activities at frequent intervals to exchange patient's and clinician's need.

Method to improve data collection across home and health care setting;

Here we concentrate on a practical clinical tool to collect validated BP and P data for analysis and explore opportunity to gain deeper insight and improve blood pressure management.

We discuss three-way operation to collect uploaded data, data analytical platform and report interface action in the EMR. The justification in our method aligns with shifting responsibility to end customer with key role to self-monitor principal and routine physiological parameters, introduce critical steps to identify aspects, prioritize challenges and opportunities to rationalize activities to support health needs.

The processing platform assists analyses of components on incoming physiological parameters and designing the weekly report in a customer friendly format for meaningful use. The communication platform helps synchronize interaction and dispatch health or other desired clips.In this report we limit range activity on BP and P and additional components with potential practice implication.

Blood pressure variability

Variability of BP is an intrinsic behavior with fluctuating BP dynamics, and this phenomenon is complex and is affected large number of variables. Hence, detection of magnitude of variability or average real variability (ARV), understanding mean arterial pressure (MAP) around this variability and stiffness index (SI), peak to trough ratio (SI) can be valuable parameters. Thus, a new and operationally easy method may allow better understanding on its added value to routine clinic BP to guide clinicians in risk assessment. Kalman filter process uses linear quadratic equalizer from the past data sets to provides the best estimate on the present state. In time series BP analysis this may aid one to gain insight in to inter current events.

Inference drawn in hypertension is often takes the from aggregation statistics. Distinguishable clinical events and best temporal aggregates on blood pressure is used to infer association in cross sectional and longitudinal data. In this process latent clinical events and time series data on blood pressure may have the potential to help analysis and improve risk allocation than risk attribution. In hypertension, the process of approximation may potentially strengthen significance attached in its temporal changes. Kalman filter data on BP may assist in this process to understand latent clinical factors and change in time series or intercurrent changes in BP.

Discussion

In the clinics BP, T, P, WT, readings are taken routinely during patient's visits by trained medical assistant. The diagnosis of HTN and ongoing treatment is usually made in the office. The value in happening is relevant and to situation it represents. What extent this is accurate reflection to future health risk remains hypothetical. The momentary changes in the blood pressure have demanded clarification of factors in the making. The operational making of this observation could be suboptimal in following the standard guidelines. The details on reporting the estimate/s are limited.

HBPM offers unlimited number of blood pressure readings to support analysis and deeper insight to BP hemodynamics. However, the direction on evidence documentation on HBP is limited. There is no protocol for valuable analysis or characterization of data, running outline on trends, summaries across report groups, sensible, purposive reporting, interfacing in the electronic medical record (EMR), designing the report that appeals for more effective clinical decision and meaningful use to diverse stakeholder's need. Numerous articles on HBP have focused on its potential to detect blood pressure phenotypes, medication titration during management of low and high blood pressure, higher level of achievement of treatment goals in patients and patient empowerment.

BP is a dynamic variable but, assessment in the clinic is a pragmatic to circumstances and reporting in the EMR is random. In the clinics and automated oscillometric blood pressure (AOBPM) is the

most common device used for measurement of BP (CBP) for diagnosis and ongoing management of hypertension. The clinical team often, take additional BP readings for validation using aneroid device. In general, it is assumed observations are standardized.

Electronic medical record (EMR) and barriers

The EMR is a used to improve physician's pursuit to improve patient care with quality and quantity of stored information in a crude digital form. Here the required standard underscores validity of patient's presence at the clinical setting to match accuracy of observation and association. The longitudinal biometric parameters (BP and pulse) are assembled in atomic are form. The number of estimates on vital signs allowed during official clinic visit are limited without any additional resolution (order of determination, site consistency, time lapse before and between repeat estimates, remark on taking BP in isolation or quiet setting or with attendant/s presence, diurnal time and concurrent health issues) and informal components are separated. Epidemiological studies across the globe (15,16,17,18) supports small increments in BP from 110 mmHg systolic BP with similar predictive increase in adverse cardiovascular events in adults above 18 years of age. The existing method of collection of vital signs in the EMR do not support clinicians to detect changes with high resolution and clarity. This requires tools to facilitate processing data for predictive report easy to grasp and visualize for meaningful use.

Guidelines for data extraction and generalizability paradox

Guidelines in hypertension in general are supposed to improve quality of information to support clinical decision. These ideals are very difficult to implement in clinical practice or in real life setting. There are differences between guidelines (19,20,21,22, 23, 24,25,26,27 28) on clinic measurement protocol and conflicting message on BP threshold for intervention. In general home blood pressure (HBP) is accepted as a better measure to guide clinicians and patients during clinical care (29, 30, 31, 32, 33)

The guidelines focus on factor standardization in the clinics to overcome scattered BP measurements and produce better BP size effects. In clinical research studies with objective evaluating clinical outcome, consistency and avoiding error in making and happening across and within setting becomes a key part of evidence synthesis from various studies and supposed impact they make in developing guidelines. These stipulations are critical for comparison in research (evidence-based guidelines) but, not a realistic to routinely practice. This approach to standardize measurement is in conflict with recommendation that also advances out of office setting "Check points" for BP data collection where implementing standard protocol consistently is not practical. These study programs would require additional tools to collect free data for handling and integration in the EMR. Besides, encouraging out-of-office BP monitoring in diverse settings as a routine can pose fidelity issue in a real-world setting.

Ambulatory blood pressure monitoring

Major societies espouse ambulatory blood pressure monitoring (ABPM) in this method frequent collection of additional residuals from outside of clinic adds additional weight and in principle, is comparable to HBPM that is realistic to practice setting and more liberal data collection from those

with limited resources. Ambulatory blood pressure measurement (ABPM) is automated easy-going method of taking blood pressure at predefined intervals. The diversity in this method is integral part of both making and happening including blood pressure measured during sleep. The collection 40 – 60 BP readings, is extended over 24 hours in patients natural setting. The only stipulation here is "stay still" during BP estimation. The standards applied to clinic or home BP measurements (CBPM &HBPM) are not part of this process (meal, watching TV, driving, listening to music, screening e-mail, ambient temperature, break-time, noise factor, back support, bladder factor, status of internal organs or anatomical position). Integration these data sets in the EMR is more complicated with associated cost.

BP has rhythmic and non-rhythmic physiological components. This is included in ABPM thus, inclusion of residuals from diverse making in the aggregate makes it superior to CBP estimate in detection and management of hypertension. CBP realistically, is another singular BP estimate with degree of similarity to random component of ABMP and the idea is also the same in frequent and free HBPM estimates. The question of accuracy and reliability of CBPM is not unique, variation and misclassification are also detected in studies comparing different protocols and in repeated ABPM in research setting. (33,34,35 ,36,37)

Thus, BP assessment protocols are not comparable and variability is intrinsic biological property of BP (37). In addition, in clinical research simultaneous cuff brachial BPM and intrabrachial artery BPM the most sensitive method, is associated with misclassification of BP phenotype in up to 27% in elderly patients (38). Besides, measured BP at any anatomical location represents site specific segmental physiological behavior of the artery (39). Despite all of the above concerns cuff BP measurement will remain the standard method in clinics for routine use. However, the requirement in clinical practice is a tool to collect constantly and reliably patient-centered making of unlimited number of readings to facilitate pattern detection and more synchronized management.

Practice consideration

After the SPRINT trial (40) the major guidelines consider120 – 129 systolic and 75 – 80 mmHg BP optimal and above 130 mm Hg systolic and 80 mm Hg diastolic is abnormal for age group 18 years of age. It also recognizes doubling of cardiovascular risk associated with a 20-mmHg change in systolic BP from 110 – 130 mm Hg in the middle age population (15) There is also graded association of coronary artery calcification with increase in systolic blood pressure above 90 mmHg (42) and change in integrity of the kidney podocyte (43). Increase in systolic BP above 90-100 mmHg seems to be associated with pathological changes in target organ including left ventricular hypertrophy and brain volume and white matter defects. (44,45) These evolving evidences in the background of epidemiological studies with absent cardiovascular issues and acculturation associated BP change and increase in vascular problem in special population raises the question what is ideal and threshold blood pressure level that is safe and not associated with significant health risk, qualify for aggressive monitoring and scale intervention with sound scientific support. (46,47,48, 52)

HTN is asymptomatic, many determinants impact acceptance of intervention benefits. In addition, conflict in level of concern (clinical team) and estimate between settings, fear of wrong categorization on marginal BP values, distrust in estimate and its potential reflection on demands in one's personal life such as employability, social stigma, impact on insurance coverage and life policy etc… affect acceptance of diagnosis. Clinical care givers are also equally sensitive to these concerns (49,50,51).

In the clinics evidence for diagnosis of hypertension could be subjective (self-report) or objective measures based on random estimates or association logic such as age, weight, medication often admixed with manifestation of risk factors or report created in other settings with similar unclear definition. The process of extraction of evidence from past medication history with integrity is complicated when there is therapeutic overlap. Acceptance of diagnosis of hypertension and treatment is also affected by patient's age and health literacy.

In clinical practice anchoring to HBPM as is more practical and dependable when collection protocol is more flexible and informal for patients to exercise. Adopting elaborate formalities is less sustainable in routine clinical practice. We believe these observations will make HBPM similar to random ABP estimates.

Acceptance of continuous or intermittent HBP monitoring is an empowerment strategy to detect many underrepresented happening in the natural making. The process of synchronized interaction with robust incoming data is sustainable only through provider interaction beyond problem solving care. Facilitating sustainable involvement in asymptomatic conditions where, checking BP is not a priority as in the majority type ii diabetes patients, integrating active role play by allied health personal is critical to make this sustainable.

Guidance is needed to improve diagnostic method to detect optimum to mild or early elevation or rate of change of BP trajectory. This is only possible with high frequency BP data collection directly or indirectly from patients using capacity building resources. The major challenge is collection and creation of reliable calibrated report on patient's repeated blood pressure holding state, grades and characterize risk adjusted trajectories with other components. The process of analysis and scale blood pressure in to various categories and monitor changing trend is helpful to determine level of risk and qualify for graded clinical intervention.

Summary

The directive for action in the clinic in general provides graded BP risk burden and outline sample template for data collection and reporting. However, operational complexity and limited time during clinic visit are significant barriers to implementation. The details of these operations are not practical for patients with high risk and limited resources. The larger issue to contend is guidance to implement practice change in the clinics. The method and framework require community alliance that has potential to build data capacity. Platform to facilitate incoming data verification, collaboration to synchronize interaction, system behavior for data processing and linear integration in the EMR. What is now considered ideal may not be really ideal (52,53,) in the future. Besides the vast majority of cardiovascular events are in patients with blood pressure below 140/90 mmHg (54).

The concern about assignment of equivalent BP scale for ages 18 – 75 is a concern in the context our new understanding on cardiovascular risk in young adults (55,56) Hence, approach to detection and management need consideration to adopt substitute methods.

Therefore, information that supports clinicians and patients with the changes in blood pressure requires reliable running estimate on age adjusted upper limit of systolic and diastolic pressure and combine this with attendant risks to equation during shared decision making.

There is no clinical pathway in extant clinical setting to process and detect fine set of BP grades transitioning early from 90 mm Hg and above and track changes. This requires practical and cost-effective patient participatory activity to collect HBP and device enabled platform to collect and structure report to support clinical team The collection of high frequency HBP and other digital data permits estimation of running average, antecedent trend and makings to characterize the information better for clinical decision.

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