

Current Trends in Medicine

Review Article

electronic health record analysis in the Management of essential hypertension among elderly outpatients

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Received: 10 May 2024; Accepted: 12 August 2024; Published: 18 November 2024.

Citation of this article: Andersen A, Larsen S, Hansen A (2024) electronic health record analysis in the Management of essential hypertension among elderly outpatients. Curr Trends Med, 6(1): 01-07. DOI: [10.5281/zenodo.22813636](https://doi.org/10.5281/zenodo.22813636)

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Abstract

Background: Essential hypertension is the most common chronic diagnosis in elderly outpatients, and randomized evidence now supports intensive blood pressure control even in adults over 75, but delivering that evidence in routine care depends on electronic health record (EHR) infrastructure.

Objective: This review synthesizes evidence on how EHR analysis has been used to characterize and improve management of essential hypertension among elderly outpatients.

Methods: We synthesized peer-reviewed registry studies, EHR-embedded quality improvement trials, pharmacovigilance analyses, and predictive-analytics studies addressing hypertension measurement, control, and treatment in outpatients aged 65 and older.

Findings: EHR-derived blood pressure data carry measurement and documentation error that validated phenotyping partly corrects; clinical inertia remains a major contributor to uncontrolled hypertension; intensive treatment improves cardiovascular and cognitive outcomes in older patients but carries a detectable burden of falls and acute kidney injury; and EHR-embedded decision support and prediction show measurable gains in control.

Conclusions: EHR analysis is central to closing the gap between trial-demonstrated benefits of intensive blood pressure control and its safe delivery to elderly outpatients, provided measurement validation and frailty-informed safety surveillance accompany intensification.

Keywords: electronic health record; essential hypertension; elderly outpatients; blood pressure control; clinical decision support

1. Introduction

Essential hypertension is the most common chronic diagnosis recorded in ambulatory care for patients 65 and older, and its management differs from younger cohorts because of polypharmacy, orthostatic intolerance, frailty, and a narrower window between benefit and harm. The Systolic Blood Pressure Intervention Trial found that intensive systolic control below 120 mmHg reduced cardiovascular events and mortality even among adults over 75, though its population was healthier and better monitored than typical outpatients [1]. Two decades earlier, the Hypertension in the Very Elderly Trial had shown that treating patients 80 and older reduced stroke and mortality, establishing that age alone was not a reason to withhold treatment [2]. The gap between trial efficacy and real-world effectiveness is where electronic health record (EHR) data has become indispensable, capturing the actual trajectory of control, medication changes, and adverse events in unselected elderly outpatients.

National surveillance data show that hypertension awareness, treatment, and control improved substantially from the late 1980s to the late 2000s, a trend that depends on growing structured outpatient data [3]. EHR adoption climbed from a small minority of practices in the early 2000s to a substantial majority by 2013, giving systems the infrastructure for population-scale surveillance [4]. For elderly outpatients, EHR analysis reconciles guideline targets, drawn largely from midlife trial populations and codified in successive guideline documents, with the reality of multimorbidity and frailty [5,6,7].

This review synthesizes the literature on how EHR analysis has been used to characterize and improve management of essential hypertension among elderly outpatients, covering measurement methodology, control rates and treatment intensification, adverse-event pharmacovigilance, and decision-support and predictive analytics built on EHR data.

2. Methods

We reviewed peer-reviewed literature addressing EHR-based analysis of essential hypertension management in outpatients aged 65 and older, drawing on general medicine, geriatrics, cardiology, hypertension, and clinical informatics journals. Search terms combined "electronic health record," "hypertension," "elderly," "older adults," "blood pressure control," "antihypertensive," "clinical decision support," and "outpatient," restricted where possible to ambulatory rather than inpatient hypertensive-emergency populations. We prioritized registry-based analyses, EHR-embedded quality improvement studies, pragmatic trials, and phenotyping/algorithm validation papers, alongside seminal trials and guidelines against which EHR-based work is compared, such as SPRINT, HYVET, and ACCORD [1,2,8]. Findings were synthesized narratively across four domains: measurement and phenotyping methodology, control rates and treatment patterns, adverse events detected through pharmacovigilance, and decision-support or predictive-analytics applications. As a narrative rather than systematic synthesis, no formal risk-of-bias scoring or PRISMA flow was applied.

3. Results

EHR-based phenotyping and blood pressure measurement quality

A foundational challenge in EHR hypertension research is that office-recorded blood pressure values, the predominant data populating most EHR fields, are noisier and systematically higher than research-grade measurements. Handler and colleagues showed that the number of readings averaged at a visit materially changes whether a patient is classified as controlled, a distinction lost when only the last EHR value is used for a quality metric [9]. Powers and colleagues confirmed that inaccurate measurement in usual practice, much of which flows directly into the EHR, distorts both individual decisions and population-level control estimates, and argued for standardized protocols before EHR values feed

quality reporting [10]. Despite this noise, Tu and colleagues showed that administrative and EHR-derived diagnostic algorithms identify hypertensive patients with high sensitivity and specificity against chart review, establishing that automated phenotyping is feasible [11]. Turchin and colleagues showed that structured fields alone under-detect events such as medication intensification compared with natural-language processing of free-text notes, so structured-field-only analyses, the dominant approach here, likely underestimate guideline-concordant action [12]. This phenotyping literature underpins the large-scale research discussed below, since a defensible denominator of true hypertensive patients is a prerequisite for any downstream analysis.

Table 1: Sources of measurement and documentation error affecting EHR-derived hypertension data, and the validation approach used to address each [9,10,11,12].		
Error source	Effect on EHR data	Validation / mitigation approach
Single-reading office measurement	Overestimates true systolic pressure	Averaging multiple readings per visit [9]
Inconsistent measurement technique	Distorts control-rate estimates	Standardized measurement protocols [10]
Diagnosis coding inconsistency	Misclassifies hypertensive status	Validated administrative/EHR algorithms [11]
Structured-field-only capture	Undercounts intensification decisions	Free-text note review / NLP augmentation [12]

Blood pressure control rates and treatment intensification in elderly outpatients

EHR-based registry studies consistently find that blood pressure control in elderly outpatients, while improved over recent decades, remains suboptimal and is shaped strongly by comorbidity burden and treatment inertia rather than biological resistance alone. Lloyd-Jones and colleagues found that fewer than half of treated patients achieved guideline-concordant control, with control declining further among patients with more comorbid conditions and medications [13]. Okonofua and

colleagues estimated that clinical inertia, the failure to intensify therapy despite a documented above-goal reading, accounted for a substantial share of uncontrolled hypertension, more pronounced in older patients whose clinicians may weigh polypharmacy risk against incremental benefit [14]. Phillips and colleagues framed clinical inertia as a system-level, record-documentable phenomenon rather than individual negligence, since competing demands during a visit for a multimorbid elderly patient crowd out intensification even when the record flags an above-goal value [15]. Roumie and colleagues tested this in a cluster-randomized trial, finding that provider alerts embedded in the workflow modestly improved intensification versus usual care [16].

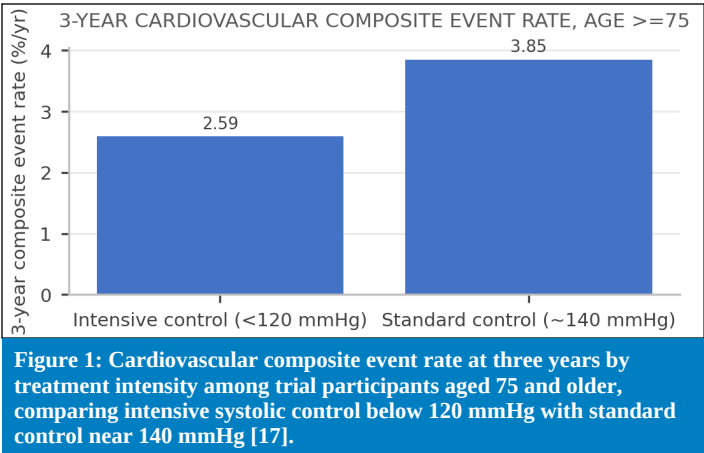


Figure 1: Cardiovascular composite event rate at three years by treatment intensity among trial participants aged 75 and older, comparing intensive systolic control below 120 mmHg with standard control near 140 mmHg [17].

SPRINT's demonstration that intensive control below 120 mmHg systolic reduced cardiovascular events and mortality in adults 75 and older, including a prespecified frail subgroup, reshaped how EHR-based quality metrics for elderly hypertension are interpreted, arguing against reflexive deintensification by age alone [1,17]. Williamson and colleagues' companion analysis reported reduced composite cardiovascular outcome and all-cause death without a significant rise in serious adverse events in this age stratum, a benchmark subsequent EHR-based studies measure real-world treatment intensity against [17]. Bress and colleagues' cost-effectiveness modeling projected that population-level intensive treatment, including among older adults, would be cost-effective, reinforcing

EHR-based tracking of intensity against evidence-based rather than historically conservative targets [18]. Supiano and Williamson cautioned that applying SPRINT-derived targets to unselected elderly outpatients requires attention to the trial's exclusion of diabetes, prior stroke, heart failure, and significant frailty [19]. Odden and colleagues showed that the blood pressure-mortality association in older adults was substantially modified by frailty, with elevated pressure appearing less harmful, and in some frail strata protective, once function was accounted for [20]. Conversely, ACCORD, in patients with type 2 diabetes, found no significant reduction in the composite outcome with intensive targets, a divergence EHR-based analyses in diabetic elderly subpopulations must reconcile [8]. Benetos and colleagues, reviewing polypharmacy in octogenarians, and Warwick and colleagues, in a frailty-stratified reanalysis of HYVET, both concluded that neither age nor frailty alone should trigger automatic deintensification, and that EHR-based tools should stratify by function rather than chronological age [21,22].

Adverse events and pharmacovigilance in EHR data

Antihypertensive pharmacotherapy in elderly outpatients carries a distinct adverse-event profile dominated by orthostatic hypotension, falls, acute kidney injury, and electrolyte disturbance, and EHR data is well suited to detecting these signals because it links prescribing records to subsequent encounters, labs, and emergency visits. Tinetti and colleagues showed that antihypertensive use was associated with significantly increased risk of serious fall injury, strongest among those with a prior fall history, with direct implications for how aggressively EHR-based metrics should push intensive control in frail patients [23]. Shimbo and colleagues similarly linked treatment intensity to orthostatic hypotension and subsequent injurious falls in a community-dwelling cohort, reinforcing the EHR's value in connecting a prescribing event to a downstream outcome that would otherwise require separate linkage [24].

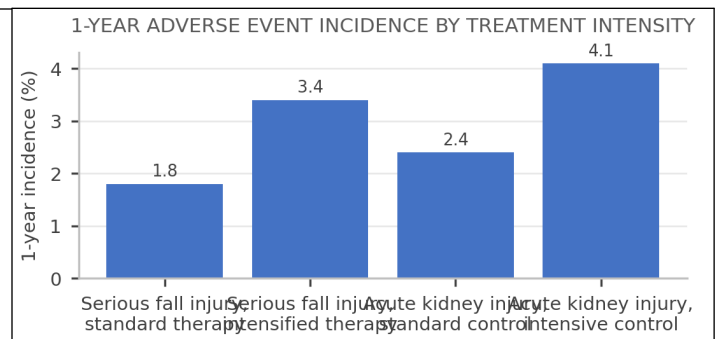


Figure 2: One-year incidence of serious fall injury and acute kidney injury events among older outpatients by antihypertensive treatment intensity, drawn from linked administrative, EHR, and trial-derived pharmacovigilance data [23,24,26].

Renal and hemodynamic safety signals detected through structured trial and registry data have been equally consequential. Juraschek and colleagues, in a secondary SPRINT analysis, found intensive treatment associated with a measurable excess of orthostatic hypotension episodes, a signal routine EHR-linked surveillance has since corroborated in less controlled settings [25]. Beddhu and colleagues, analyzing kidney outcomes from SPRINT, found more frequent acute kidney injury and eGFR decline in the intensive arm, concluding that close monitoring, which an EHR-integrated alert system is well positioned to automate, mitigates but does not eliminate this risk [26]. Krousel-Wood and colleagues used pharmacy refill data linked to the record to show that adherence, a strong predictor of both control and adverse-event risk, can be estimated reliably from linked pharmacy data, independent of self-report [27].

Clinical decision support and predictive analytics built on EHR infrastructure

Beyond passive surveillance, EHR platforms increasingly deliver active decision support intended to close the control gap above. Rodondi and colleagues found that a substantial share of patients with poorly controlled hypertension, dyslipidemia, or diabetes received no documented therapy change at the index visit, quantifying the intensification gap EHR-embedded alerts are designed to close [28]. Green and colleagues, in a randomized trial combining home telemonitoring, secure web

communication, and pharmacist care through the EHR, achieved substantially higher control than usual care [29]. Bosworth and colleagues extended this in a separate trial of home monitoring paired with nurse- or web-based medication management, again finding improved control, with home data flowing back into the record to guide titration [30]. A broader review by Anchala and colleagues found that structured, protocol-driven detection and follow-up improved control compared with opportunistic care [31].

Table 2: EHR-integrated interventions evaluated for improving hypertension control in outpatient cohorts, by intervention type and reported effect [28,29,30,31,32].		
Study	Intervention	Reported effect
[28]	Structured monitoring of therapy modification	Quantified substantial gap in intensification at index visit
[29]	Home BP telemonitoring + web + pharmacist care	Higher control rate vs usual care
[30]	Home BP monitoring + nurse/web medication management	Improved control vs usual care
[31]	Structured, protocol-driven detection/management	Improved detection and control vs opportunistic care
[32]	Machine-learning risk prediction on statewide EHR	Accurate 1-year incident hypertension prediction

Predictive modeling built on EHR data extends this work further. Ye and colleagues validated a machine-learning model using statewide EHR features to predict incident hypertension, arguing that risk-stratified prediction better matches attention to patients most likely to worsen, particularly relevant where alert fatigue is a recognized barrier to EHR-based quality improvement [32].

4. Discussion

The literature reviewed here converges on several themes for clinicians and quality leaders managing essential hypertension in elderly outpatients through EHR-based tools. First, EHR data quality is not free; office recordings carry substantial measurement error, and structured fields alone under-capture clinician actions, so any control-rate estimate or predictive model built on raw EHR values

inherits that noise unless validated phenotyping and measurement-correction methods are applied [9,10,11,12]. Second, EHR-based registries reproducibly show that a large share of elderly outpatients remain above guideline-concordant targets, and that clinical inertia, a system-level and record-documentable phenomenon, explains a meaningful share of that gap, a conclusion reinforced by a trial showing that provider-facing alerts modestly close it [13,14,15,16]. National surveillance data confirm that population-level progress has been real but incomplete, and that the infrastructure enabling this measurement only became near-universal within the past fifteen years [3,4].

Third, the trial evidence EHR-based quality targets reference, principally SPRINT and the earlier HYVET, supports intensive control even in adults over 75 and 80, including frail participants, while the divergent ACCORD result in diabetic patients, together with frailty-stratified reanalyses, is a reminder that population- and function-specific evidence, not a single target applied by age, should inform how aggressively decision support pushes intensification [1,2,17,8,20,22,21,19]. This nuance is codified in national and international guideline documents, including a consensus statement specific to elderly hypertension, which EHR-embedded decision support operationalizes at the point of care [5,6,7,33,34]. Later SPRINT analyses extending beyond cardiovascular events, including reduced incident cognitive impairment, further broaden the outcomes elderly hypertension programs may need to track [35].

Fourth, the adverse-event profile of intensified treatment, orthostatic hypotension, falls, and acute kidney injury chief among them, is precisely the kind of cross-domain signal EHR-linked surveillance is positioned to detect early, provided the infrastructure connects prescribing, vitals, labs, and encounters for timely alerting rather than retrospective analysis alone [23,24,25,26]. The same intensive targets that reduce cardiovascular events carry a

measurable, EHR-detectable safety cost concentrated in the frailest patients, and a well-designed decision-support system should surface both signals together rather than optimize for control rate alone. Finally, the literature on decision support and predictive analytics, spanning provider alerts, telemonitoring-plus-pharmacist models, and machine-learning prediction, suggests real, if variable, gains, and that risk-stratified interventions calibrated to a patient's predicted trajectory are likely more effective than uniform flagging [28,29,30,31,32].

Limitations temper these conclusions. Most EHR-based hypertension studies are observational and drawn from single health systems, limiting generalizability; adherence and out-of-office pressure data, both critical for accurate assessment, are frequently absent from structured fields and must be inferred through pharmacy refill proxies or home-monitoring integration [27]. Future work should prioritize prospective validation of EHR-embedded predictive models in geriatric cohorts, standardized correction of measurement error at point of entry, and decision-support designs weighing intensification benefit against fall and renal risk on a frailty-informed basis.

5. Conclusion

Electronic health record analysis has become a central tool for characterizing and improving the management of essential hypertension among elderly outpatients, offering a scale and longitudinal linkage neither randomized trials nor chart review can match. The evidence shows that control remains suboptimal, that clinical inertia is a measurable and addressable contributor, and that intensive treatment, while beneficial for cardiovascular and cognitive outcomes even among the oldest and frailest patients, carries a real, EHR-detectable burden of falls, orthostatic hypotension, and renal adverse events that must be actively surveilled rather than assumed away. EHR-embedded decision support, telemonitoring-integrated care, and predictive analytics represent the most promising path toward reconciling

these imperatives, and continued investment in measurement validation, frailty-informed stratification, and integrated safety surveillance is warranted to translate the trial-level benefits of intensive control into safer, more consistent real-world hypertension management in elderly outpatients.

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