Scientific Rationale and Empirical Testing: Expanding PSI 08 to Capture In-Hospital Fall-Associated Fractures

The Agency for Healthcare Research and Quality (AHRQ) pursues the goal of bringing excellence to health care decision making, quality improvement, and research. One of the avenues through which AHRQ achieves this goal is by developing and managing a set of standardized, evidence-based quality indicators (QIs) that can be used with hospital inpatient administrative data to measure and track clinical performance and outcomes and inform quality improvement efforts. These QIs include hospital-level quality indicators, which measure the outcomes of hospital care.

AHRQ continuously evaluates and refines the QIs to incorporate changes in the field of quality measurement, and before implementing a potential refinement, AHRQ evaluates its conceptual rationale and its impact on QI numerators, denominators, and rates. This document presents the rationale and testing supporting AHRQ's decision to update the PSI 08 indicator from "In-Hospital Fall with Hip Fracture Rate" to "In-Hospital Fall-Associated Fracture Rate."

Rationale for Expanding the PSI 08 Indicator

Prior to v2023, the PSI 08 indicator was defined as "In-Hospital Fall with Hip Fracture Rate," and the "hip fracture" (HIPFXID) code list was used in this indicator to define hip fractures that would be included in the numerator. However, this definition was much narrower than accepted definitions of fall-related major injuries. In v2023 QI software, AHRQ is expanding the PSI 08 indicator from "In Hospital Fall with Hip Fracture Rate" to "In-Hospital Fall-Associated Fracture Rate." The revised indicator is a combination of two components: a "hip fracture" component, similar to the previous PSI 08 definition, and an "other fracture" component, capturing selected non-hip fractures that are fall-associated.

The expanded PSI 08 indicator accounts for a wider range of fall-associated fractures, aligning the indicator with clinically accepted definitions of major fall-associated injuries. For example, due to the potential for serious harm associated with patient falls, the National Quality Forum (NQF) considers "patient death or serious injury associated with a fall while being cared for in a health care setting" a Serious Reportable Event. NQF's definition of "serious injury" includes "but is not limited to fractures, head injuries, and intracranial hemorrhage."[1] Similarly, the National Database of Nursing Quality Indicators (NDNQI) developed by the American Nurses Association (maintained by Press Ganey) defines major fall-associated injury as having "resulted in surgery, casting, traction, required consultation for neurological (e.g., basilar skull fracture,

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[1] https://www.qualityforum.org/Publications/2011/12/SRE_2011_Final_Report.aspx, page A-11; accessed February 26, 2023.

small subdural hematoma) or internal injury (e.g., rib fracture, small liver laceration), or patients with any type of fracture regardless of treatment…"[2]

AHRQ has expanded the definition of the PSI 08 indicator to include falls with a potential for major injury to support hospitals' practices for monitoring patients at high risk for falls and, in so doing, to reduce the frequency of patient falls with injury. Certain protocols and prevention measures to reduce patient falls with injury include using fall risk assessment tools to gauge individual patient risk, implementing fall prevention protocols directed at individual patient risk factors, and implementing environmental rounds to assess and correct environmental fall hazards. Recommended clinical guidelines and practices to reduce falls and injuries from falls in hospitals support many prevention activities, including multifactorial interventions and tailoring interventions to patient conditions and needs.[3] The intent and desired outcome of this change to the PSI 08 indicator is to encourage hospitals, hospital systems, and quality improvement entities to track fall-associated in-hospital fractures, and ultimately to reduce the frequency of inpatient falls resulting in major injury.

In 2021, AHRQ conducted a literature review for potential refinements to the PSI 08 definition to expand the numerator, issuing this internal recommendation:

> "The literature revealed multiple approaches to identifying in-hospital falls using claims-based algorithms. Based on two articles (Hoffman et al. 2016; Davis et al. 2020), we recommend comparing two approaches to identify in-hospital falls. The first uses a combination of (1) the presence of ICD-9 e-codes for falls… that are not present on admission (POA) and (2) the presence of codes for fall-related injuries that are not POA, such as fractures, dislocations, sprains, strains, head injuries, and contusions… These codes would need to be updated to ICD-10 before implementing this measure. However, there are concerns about false negatives with this approach. Hospitals may under-report [external cause] codes for such fall events because these codes do not affect payment, are not required for reporting in some states, and could suggest legal liability for hospital-acquired injuries. The second approach would use only the presence of codes for fall-related injuries that are not POA, such as fractures, dislocations, sprains, strains, head injuries, and contusions…. The concern with this approach is that there may be false positives identified. The goal is to expand PSI 08 (In-Hospital Fall with Hip Fracture Rate) to focus on in-hospital falls

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[2] https://members.nursingquality.org/NDNQIPortal/Documents/General/Guidelines - PatientFalls.pdf, page 7; accessed February 26, 2023.

[3] Registered Nurses Association of Ontario. Preventing Falls and Reducing Injury from Falls. 4th edition. Toronto, ON; 2017. https://rnao.ca/bpg/guidelines/prevention-falls-and-fall-injuries; accessed February 26, 2023. National Institute for Health and Care Excellence. Falls in Older People: Assessing Risk and Prevention. Clinical Guideline [CG161]. London, UK; 2013. https://www.nice.org.uk/guidance/cg161; accessed February 26, 2023. ACS National Surgical Quality Improvement Program (NSQIP)/American Geriatrics Society (AGS). Optimal Perioperative Management of the Geriatric Patient: Best Practices Guideline from ACS NSQIP/AGS; 2016. https://www.facs.org/media/y5efmgox/acs-nsqip-geriatric-2016-guidelines.pdf; accessed February 26, 2023.

associated with an injury and identify codes for fractures… Because there is no currently validated ICD-10 algorithm, and because the risks of false negatives versus false positives must be weighed for each approach, we recommend further developing the ICD-10 version of these measure specifications and testing the results in… future iterations of the software."

Of note, a key study not included in that environmental scan (because its scope included fall-related injuries occurring outside hospitals) evaluated multiple ascertainment algorithms based on administrative data and reported that an algorithm based on external cause codes only captured 51% of significant fall-related injuries.[4] By contrast, algorithms based on fracture diagnosis codes had higher sensitivities and positive predictive values for fall-related injury of 80% or greater.

Refinement to Expand the PSI 08 Indicator

Based on this prior feedback from stakeholders and evidence review, AHRQ is implementing a refinement to broaden the PSI 08 indicator in v2023 to capture a wider range of fall-associated fractures. The updated indicator, "In-Hospital Fall-Associated Fracture Rate," aims to capture all such fractures while excluding non-fall-associated fractures, such as teeth and oral cavity fractures typically from anesthesia-related or assaultive injuries. The updated indicator also excludes apophyseal fractures (which were previously included in HIPFXID) because apophyseal fractures are rare injuries typically affecting young athletes whose cartilaginous growth plates have not yet ossified.[5] Therefore, these codes do not apply to adults with closed growth plates.[6]

The previous HIPFXID code list used 195 codes to capture hip fractures. To capture the broader range of fractures, the updated "fracture" code lsit (FXID) is now used. Compared with HIPFXID, FXID adds 2,831 codes and removes 18, for a total of 3,008 codes. The 18 codes that were removed all describe apophyseal fractures. The "HIPFXID to FXID Full Code List" in the linked Excel file under Table 1, below, shows a full comparison of the codes in the HIPFXID and FXID code lists.

Impact Analysis Methods

To test the impact of broadening HIPFXID to the new FXID code list in the PSI 08 numerators and denominators, AHRQ compared results from the v2022 QI software and the v2023 QI

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[4] Min L, Tinetti M, Langa KM, Ha J, Alexander N, Hoffman GJ. Measurement of Fall Injury With Health Care System Data and Assessment of Inclusiveness and Validity of Measurement Models. JAMA Netw Open. 2019 Aug 2;2(8):e199679. doi: 10.1001/jamanetworkopen.2019.9679. PMID: 31433480.

[5] Filippo, C., Alessandro, N., Cristina, G., Margherita, M., Francesco, P., & Francesco, C. (2017). Apophyseal avulsion fractures of the pelvis. A review. Acta Bio Medica : Atenei Parmensis, 89(4), 470-476. doi: 10.23750/abm.v89i4.7632

[6] McKee, J. (2014). Conservative Treatment Effective for Most Apophyseal Fractures in Adolescents. AAOS Now, Clinical4(May 2014). https://www.aaos.org/aaosnow/2014/may/clinical/clinical4/

software with this refinement. Both versions were run on testing data which combined the 2019 AHRQ Healthcare Cost & Utilization (HCUP) State Inpatient Databases (SID) with partial data from the 2020 SID.

Impact Analysis Results

Replacing HIPFXID with FXID caused the PSI 08 numerator to increase by a ratio of 3.64 (from 1,795 to 6,538), the denominator to decrease by 3.1% (from 24,704,753 to 23,945,351), and the observed rate to increase by a ratio of 3.76 (Table 1).

Table 1. Impact of replacing HIPFXID with the expanded FXID on PSI 08

Indicator	Ratio of Numerator, Denominator, and Observed Rate of PSI 08, v2023 to v2022		
	Numerator	Denominator	Observed Rate
PSI 08	3.6423	0.9693	3.7579

Source: Analysis of combined 2019 and partial 2020 reference data. See the "Empirical Test Results of PSI 08 Expansion" document for full results.

The "FXID Fracture Codes Frequency" sheet in the above-linked Excel document shows the fracture diagnosis codes in FXID, sorted by descending frequency and stratified by hip fracture codes (currently in HIPFXID) versus other fracture codes (not currently in HIPFXID). The most common fracture types added to the PSI 08 numerator include (combining left and right):

- Fracture of nasal bones
- Age-related osteoporosis with current pathological fracture, vertebra(e)
- Unspecified fracture of the lower end of radius
- Other specified fracture of pubis
- Other fracture of upper and lower end of fibula
- Unspecified fracture of lumbar vertebra
- Fracture of sacrum
- Unspecified fracture of upper end of humerus
- Other osteoporosis with current pathological fracture, vertebra(e)
- Unspecified fracture of T11-T12 vertebra
- Other fracture of base of skull
- Displaced bimalleolar fracture of lower leg
- Unspecified displaced fracture of surgical neck of humerus
- Maxillary fracture
- Other displaced fracture of upper end of humerus
- Other intraarticular fracture of lower end of radius
- Displaced fracture of lateral malleolus of fibula

- Fracture of orbital floor
- Unspecified fracture of second lumbar vertebra
- Displaced bicondylar fracture of tibia
- Displaced trimalleolar fracture of lower leg
- Wedge compression fracture of first lumbar vertebra
- Unspecified fracture of shaft of humerus
- Displaced fracture of lateral end of clavicle
- Fracture of coccyx
- Fracture of vault of skull
- Displaced fracture of greater tuberosity of humerus
- Unspecified fracture of lower end of femur
- Unspecified fracture of fifth metacarpal bone
- Age-related osteoporosis with current pathological fracture, unspecified site
- Unspecified fracture of shaft of femur
- Displaced supracondylar fracture without intracondylar extension of lower end of femur
- Unspecified fracture of femur
- Fracture of superior rim of pubis
- Displaced fracture of medial malleolus of tibia
- Zygomatic fracture
- Other fracture of first lumbar vertebra

Discussion of Results & Comparison with Published Literature

The large increases in the PSI 08 numerator and observed rate were expected, given the broad expansion from HIPFXID (hip fractures) to FXID (all fall-associated fractures). The small decrease in PSI 08's denominator was also expected, given that HIPFXID/FXID is used both as an inclusion criterion in PSI 08's numerator (including secondary diagnosis) and an exclusion criterion in its denominator (excluding principal diagnosis or secondary diagnosis POA).

To compare findings using HCUP data with the published literature, AHRQ performed a rapid-cycle PubMed search using snowball (forward/backward citation) methods to identify case series of falls involving patients in acute care hospitals since 1990. These studies are summarized below, with all fractures described at the highest level of detail provided in the paper (Table 2). Consistent with AHRQ's empirical findings summarized above, the literature suggests that fractures of the hands, upper and lower arms, clavicle, lower legs (ankle), vertebrae, skull, orbit and sinus, and nose should be regarded as fall-associated fractures in acute care hospitals. Although rib fractures are also identified as fall-associated fractures, we are unable to include them at this time due to confusion (documented in American Hospital Association [AHA] Coding Clinics for ICD-10) in the stakeholder community about coding of rib fractures associated with cardiopulmonary resuscitation (CPR). The literature does not identify dental,

foot, finger, and toe fractures as fall-associated, so we follow Mintz et al. (2022)[7] in omitting them from FXID.

Table 2. Literature on falls involving patients in acute care hospitals

Author	URL	Summary
Church	URL	190 falls; 1 hip fracture
Hata	URL	45 falls; 1 fracture of L1 vertebra, 1 fracture of left 4th metacarpal
Schwendimann	URL	3842 falls; 31 hip fractures, 22 fractures of hands, arms, ribs, 12 skull fractures
Hitcho	URL	183 falls; 1 spinal fracture, 1 orbit/sinus fracture
Bradley	URL	636 falls; 3 hip fractures, 1 humerus fracture, 1 vertebral fracture, 1 nasal fracture, 1 rib fracture
Ackerman	URL	(limited to orthopedic surgery): 70 falls; 1 hip fracture, 1 ankle fracture
Rohde	URL	874 falls; 8 hip fractures, 10 "other fractures"
Kobayashi	URL	(limited to orthopedic surgery): 230 falls; 2 rib fractures, 2 lumbar vertebral fractures, 1 clavicle fracture, 1 radius fracture
Toyabe	URL	47 "severe injuries after falls"; 28 arm/leg fractures, 5 vertebral fractures
Halfon	URL	634 falls; 14 fractures NOS
Mion	URL	784 falls; 25 fractures or intracranial injuries, including 4 deaths, NOS
Fischer	URL	1,235 falls; 22 major injuries, not well characterized
Krauss	URL, URL	7,082 falls; 82 major injuries, not well characterized
Staggs	URL	*See here for details regarding assisted vs. unassisted falls*
Brand and Sundarajaran	URL	*See here for an example using claims-type data*
Ghosh	URL	*See here for an in-depth description of fall mechanisms and locations*

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[7] Mintz J, Duprey MS, Zullo AR, Lee Y, Kiel DP, Daiello LA, Rodriguez KE, Venkatesh AK, Berry SD. Identification of Fall-Related Injuries in Nursing Home Residents Using Administrative Claims Data. J Gerontol A Biol Sci Med Sci. 2022 Jul 5;77(7):1421-1429. doi: 10.1093/gerona/glab274. Erratum in: J Gerontol A Biol Sci Med Sci. 2022 May 09; PMID: 34558615.