



Revisit three “I” model: a novel five “I” model of fracture liaison service

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Fracture liaison services (FLSs) are effective models for prevention of osteoporotic fractures. The three “I” model classifies FLS types at different hospitals based on the intensity of identification, investigation, and initiation of the appropriate treatment [1]. However, one important setback in osteoporotic fracture care is poor medication adherence (34.1%) [2], reportedly having a significant influence on re-fracture rate [3]. Although FLSs are cost-effective [4], their manpower demands and implementation costs are considered as caveats of FLS implementation.

To improve these caveats, we propose a novel five “I” model for identification, investigation, initiation of the appropriate treatment, improvement of adherence, and intelligence. The original three “I” model emphasizes treatment initiation, but a lacking adherence exists. Therefore, the fourth “I” focusing on long-term treatment adherence implies adherence improvement. In the era of artificial intelligence (AI), FLS models established by smart healthcare systems can assist clinicians and case managers

to identify, investigate, and initiate treatments and improve adherence efficiently. The role of AI will become increasingly important and comprise a fifth “I” (intelligence).

The E-Da hospital serving approximately 1,000,000 (outpatients)/40,000 (inpatients) person-times/year is a tertiary referral hospital in southern Taiwan. Its FLS program was successfully implemented using the five “I” model in 2016 and accredited as a 100% golden program by the IOF in 2017 [5]. The smart healthcare case management system in this hospital completely satisfies the five “I” model as follows [6]:

1. Identification: All patients with vertebral and hip fractures are automatically identified by the AI system. Patients with osteoporosis or low bone mass defined by dual-energy X-ray absorptiometry (DXA) can also be detected.
2. Investigation: The system performs a comprehensive assessment wherein a large amount of information, e.g., basic information, history, laboratory data, and X-ray and DXA results, can be automatically integrated.
3. Initiation of appropriate treatment: The AI system can help professionals to provide adequate pharmaceutical (reimbursed by National Health Insurance or self-paid) and non-pharmaceutical treatment to patients.
4. Improving adherence: The AI warning system can remind physicians and case managers about non-adherent patients. The system also reminds about fragility fractures or at-risk patients regarding the revisit date for regular treatment.
5. Intelligence: The implementation of the abovementioned four “Is” can be assisted by the working intelligent healthcare information system efficiently.

On an average, the AI system has automatically analyzed 20,480 and 479 reports of X-ray and DXA examinations, respectively, and has identified 967, 803, 87, and 206 patients with hip fractures, vertebral compression

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fractures, osteoporosis, and low bone mass, respectively, each month at the E-Da hospital. Moreover, the system's data analysis cannot only save manpower and reduce the rate of omitted patients, but can also reach a 93.6% rate of 1-year medication adherence. The smart healthcare case management system demonstrates that the novel five "I" model based on the original three "I" model but with the two "I," i.e., "Improvement of adherence" and "Intelligence," can be a novel model to achieve better outcomes in the fragility fracture prevention program of FLSs, especially in a sizable hospital.

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Compliance with ethical standards

Competing interests The authors declare that they have no conflict of interest.

References

1. Ganda K, Puech M, Chen JS, Speerin R, Bleasel J, Center JR, Eisman JA, March L, Seibel MJ (2013) Models of care for the secondary prevention of osteoporotic fractures: a systematic review and meta-analysis. *Osteoporos Int* 24:393–406
2. Huybrechts KF, Ishak KJ, Caro JJ (2006) Assessment of compliance with osteoporosis treatment and its consequences in a managed care population. *Bone* 38:922–928
3. Wu CH, Tu ST, Chang YF, Chan DC, Chien JT, Lin CH, Singh S, Dasari M, Chen JF, Tsai KS (2018) Fracture liaison services improve outcomes of patients with osteoporosis-related fractures: a systematic literature review and meta-analysis. *Bone* 111:92–100
4. Wu CH, Kao IJ, Hung WC, Lin SC, Liu HC, Hsieh MH, Bagga S, Achra M, Cheng TT, Yang RS (2018) Economic impact and cost-effectiveness of fracture liaison services: a systematic review of the literature. *Osteoporos Int* 29:1227–1242
5. International Osteoporosis Foundation: Capture The Fracture. <https://www.capturethefracture.org/e-da-hospital>. Accessed 5 Jan 2019
6. Yang RS, Wu CH, Chen CH, Chan DC, Hung WC, Chang LY (2018) Fracture liaison services effectiveness and experience worldwide and in Taiwan. *Fracture Liaison Service in Taiwan*. 1st edn. Scholars' Press, Moldova, pp 67–88

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