

B. Wallace, L. Ault, J. Larivière-Chartier, R. Goubran, F. Knoefel. Assessment of Time in Bed and Overnight Bed Exits using and Bed Based Sensing. *Gerontechnology* 2020;19(Suppl.):<page>.

Purpose: Most Persons with Dementia (PWD) continue to live at home with family caregivers¹. Previous work has shown the potential for supportive smart home systems to reduce the burden on caregivers^{2,3}. However, a key challenge is accurate assessment of bed occupancy and exit^{4,5}. The goal of this study is to compare alternative technologies.

Methods: 4 different bed sensors were deployed in a residential bed longitudinal study. These commercially available sensors include the Samsung SmartThings sensor (S)^{2,3} and three new sensor devices; Withings Sleep sensor (W), Emfit QS sensor (E) and BestBuy Assured Living bed sensor (B). A 55 year-old male and 50 year-old female tested the devices in the context of a double occupancy bed each having their own sensor E, W and S, while the male also had a sensor B. A log was maintained for all bed entry and exit events to provide a ground truth reference. The sensors were integrated within smart home systems to provide automated reorientation queue lighting^{2,3} allowing the response times to be assessed.

Results: This study has over 100 nights of data from each sensor. The results show the continued challenge in use of S as it did not work within the test bed and a work around using a floor mat deployment was used. W had errors associated with time in bed reporting (35.5%/14.7% error in time of entry/exit), missed out of bed short term exits (15.8%) and also reported 3 false positive exits. E bed entry/exit errors are 13.0%/22.0% with 59.3% short term exit events missed. B had 0%/2.7% bed entry/exit errors. Smart home integration testing showed all systems except E were able to turn on a smart home light within 10 seconds of bed exit while E required 28 seconds. W also failed to turn on the light once in 10 tests.

Discussion: The different bed sensors had variable performance. W automatically determines the overnight period leading it to discard information outside this period resulting in it reporting shorter nights. E appears to confuse bed occupants when there is more than one also leading it to not detect exits by the associated person. Mat B appears to be the best alternative and its errors were associated with the position of the other bed occupant.

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Table 1 Bed entry/Exit detection events

	Actual Nights	Entry Error	Exit Error	Actual Overnight exits	Overnight Exit Error FN	Overnight Exit Error FP
Withings	211	75	31	486	77	3
Emfit	200	26	44	437	259	1
BestBuy	113	0	3	154	0	0
Samsung	178	36	47	451	81	0

Table 2 Sensor Response time

(seconds)	Samsung	BestBuy	Withings	Emfit
mean	3.8	8.5	9.7	28.0
std	0.3	0.3	1.3	8.2

