## Session 3B Concurrent Counting falls and predicting fallers

**Professor Peter Herbison** has been a key member of the statistical consulting service for health researchers at the University of Otago for over 30 years. He has a special interest in randomized controlled trials, systematic reviews and meta-analysis. Peter has made a significant contribution to falls prevention research. He was a reviewer for the recent Cochrane review and has been the statistical adviser our research team. Peter will graduate soon with a Doctor of Science degree.

**Anne-Marie Hill** is a PhD scholar at The University of Queensland and holds The Menzies Foundation allied health sciences scholarship; 2009-2010. She is an APA Gerontological physiotherapist with 20 years clinical experience working with older people and a senior lecturer at the School of Physiotherapy, University of Notre Dame Australia.

**Paul Simpson** is a research fellow with the Ambulance Research Institute in Sydney, Australia. He is an intensive care paramedic and clinical educator with the Ambulance Service of New South Wales and has over 14 years experience in prehospital and emergency care.

**Dr Meghan Donaldson's** PhD at the Centre for Hip Health at the University of British Columbia included reviewing and developing falls prevention methodology analysis. She is currently completing a postdoctoral fellowship at the San Francisco Coordinating Centre with Dr Steve Cummings.

**Professor Pamela Duncan**, Professor and Bette Busch Maniscalco Research Fellow, Doctor of Physical Therapy Division, Department of Community and Family Medicine, Duke University, and Senior Fellow, Duke Center for Clinical Health Policy Research, USA. Her clinical practice includes stroke clinical trials, stroke rehabilitation, and improving the physical function of elderly people. Her research incorporates rehabilitation, health outcomes, evidence based models of practice, measurement development, clinical trials, and health services.

**Dr Cathie Sherrington** is an NHMRC Senior Research Fellow at The George Institute for Global Health, The University of Sydney, Australia. Prior to completing her PhD, Cathie was a clinical physiotherapist in aged care and rehabilitation. Her research focuses on prevention and prediction of falls and disability in older people.

**Sarah Davenport** is a grade 1 physiotherapist at Northern Health, Melbourne. Sarah completed her Bachelor of Physiotherapy at Monash University with first class Honours in 2009. Her Honours thesis focused on validating the DEMMI in a healthy community dwelling population and is the research that she is presenting today.

**Cath Kirkham** is a physiotherapist working as a research assistant on several falls prevention and physical ability improvement studies in stroke, post lower limb fracture and post hospital admission populations.

## ANALYSING COUNT DATA FROM FALLS PREVENTION STUDIES: IMPLICATIONS FOR META-ANALYSIS

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**Aim:**
There are many plausible ways to analyse the number of falls recorded in the different groups in randomised controlled trials. It is not clear what the differences are between these methods, and whether results from different analyses are comparable. In the past we have advocated using negative binomial regression.[1] We report a simulation study that looked at the differences found when data were analysed by different methods and whether this had implications for combining studies in a meta-analysis.

**Methods:**
Simulations were done with a low rate, a medium rate and a high rate of falls (about 15% falling, 2 falls/year and 7 falls/year respectively). Three different levels of overdispersion were built in. Each of the nine simulations was run 1000 times with each data set analysed in seven different ways (rates, dichotomised, poisson regression, negative binomial regression, time to first event, ratio of means, and ratio of medians). Differences between the results of the seven different analyses were analysed.

**Results:**
With a low rate of falls all of the methods gave similar answers apart from the ratio of medians. As the rate increased dichotomising the data into fall/no fall or using the time to first fall increasingly underestimated the true treatment effect until they lost any ability to differentiate the treatment groups. At higher rates the ratio of medians produced similar results to the others but was more inefficient. Increasing overdispersion had only small effects.

**Conclusion:**
For low rates of falls it may be possible to combine results in a meta-analysis regardless of the analysis. For higher means dichotomising the data or using time to first fall would not be able to be combined with other methods of analysis.

**References:**
1. Robertson MC, Campbell AJ, Herbison P. Statistical analysis of efficacy in falls prevention trials. J Gerontol A Biol Sci Med Sci 2005;60(4):530-4.

## A COMPARISON OF THREE REPORTING METHODS TO MEASURE FALLS IN HOSPITALS

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**Aim:**
Falls events are under-reported in hospital reporting systems.[1,2] This study aimed to compare three different methods of falls reporting and examine the characteristics of the missing data from the hospital incident reporting system.

**Methods:**
A 14 month prospective observational study, nested within a randomised controlled trial was conducted on rehabilitation, stroke, medical, surgical and orthopaedic wards in Perth and Brisbane, Australia. Participants were fallers (n = 153) who were part of the larger trial (n = 1206 participants, mean age 75.1 ± 11.0 years). Falls events were measured using three reporting measures: participants' self report of falls events, falls events reported in participants' case notes and falls events reported through the hospital reporting systems.

**Results:**
There were 245 falls events identified in total by the three reporting systems. Participants' case notes captured 226 (92.2%) falls events, hospital incident reporting systems captured 185 (75.5%) falls events and participants' self report captured 147 (60.2%) falls events. Falls events were significantly less likely to be recorded in hospital reporting systems when a participant sustained a subsequent fall, ($p = 0.01$) or when the fall occurred in the morning shift ($p = 0.01$) or afternoon shift ($p = 0.01$).

**Conclusion:**
Falls data that are missing from hospital incident report systems are not missing completely at random and therefore will introduce bias in some analyses where the factor investigated is related to whether the data are missing. Researchers investigating falls in hospitals should be cautious about developing and evaluating falls prevention programmes based on falls event data obtained only through incident reporting systems and should collect data through additional reporting methods such as prospective case note review.

Future investigations should continue to determine the gold standard approach to measuring falls events in hospitals.

**References:**

1. Haines T, Cornwell P, Fleming J et al. Documentation of in-hospital falls on incident reports: qualitative investigation of an imperfect process. BMC Health Serv Res 2008;8:254.
2. Shorr RI, Mion LC, Chandler AM et al. Improving the capture of fall events in hospitals: combining a service for evaluating inpatient falls with an incident report system. J Am Geriatr Soc 2008;56(4):701-4.

## EPIDEMIOLOGY AND GEOSPATIAL PROFILE OF OLDER FALLERS ATTENDED TO BY PARAMEDICS IN NSW

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**Aim:**
To describe the epidemiology and geospatial profile of older fallers who call triple zero in New South Wales, Australia.

**Methods:**
A retrospective analysis was conducted of computer aided dispatch (CAD) and patient health care record (PHCR) databases for all calls assigned a medical priority dispatch system (MPDS) category of 'Falls' in the period 1 July 2008 to 30 June 2009 for patients aged 65 years or older. Descriptive statistics were used to describe epidemiology with 95% confidence intervals and inferential statistics as appropriate with $p < 0.05$ considered statistically significant. Routinely recorded geospatial information from ambulance vehicles was analysed using MapInfo Professional 10.0 to obtain counts, rates and proximity to resources. Bayesian smoothing was used to allow for local variations in rates in areas with small populations such as rural and remote locations.

**Results:**
In the study period there were 73,550 calls for 'Falls', of which 45,117 (61%) were to patients aged 65 years or more. The age standardised rate for falls in this cohort of patients was 4311 per 100,000 population (95% CI 4271 to 4352). The majority of falls (82%) occurred between 0600 and 2100. The majority of falls (95%) occurred in the major cities (68%). We estimate that falls resulted in injury in at least 53% of cases, with 'limb injuries and fractures' (59%) and 'head injury' (19%) being the most common trauma protocol recorded by paramedics. The non-transport rate for older fallers in this population was 25%. Geospatial mapping demonstrates the variability in rates of falls across the state.

**Conclusion**:
Falls in older people are common and are one of the commonest reasons for calling triple zero. Non-injurious falls are common and often result in non-transport. Geospatial mapping using ambulance data may be a useful tool for targeting falls prevention initiatives to areas with higher than average fall rates.

## NOVEL METHODS TO EVALUATE FRACTURE RISK MODELS

**Donaldson MG**[1], Cawthon PM[1], Schousboe JT[2,3], Ensrud KE[3], Cauley JA[4], Hillier TA[5], Taylor BC[3], Hochberg MC[6], Bauer DC[7], Cummings SR[1] for the Study of Osteoporotic Fractures (SOF)
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**Aim:**
Fracture prediction models help identify individuals at high risk who may benefit from treatment. Area Under the Curve (AUC) is used to compare prediction models. However, the AUC has limitations and may miss important differences between models. Novel reclassification methods quantify how accurately models classify patients who benefit from treatment and the proportion of patients above/below treatment thresholds. We applied two reclassification methods, using the National Osteoporosis Foundation treatment thresholds, to compare two risk models: femoral neck BMD and age ("simple model") and FRAX ("FRAX model").

**Methods:**
The Pepe method classifies based on case/non-case status and examines the proportion of each above and below thresholds. The Cook method examines fracture rates above and below thresholds. We applied these to the Study of Osteoporotic Fractures, a prospective study of community-dwelling Caucasian women aged ≥ 65 years in the United States.

**Results:**
There were 6036 (1037 fractures) and 6232 (389 fractures) participants with complete data for major osteoporotic and hip fracture respectively.

Both models for major osteoporotic fracture (0.68 vs 0.69) and hip fracture (0.75 vs 0.76) had similar AUCs. In contrast, using reclassification methods, each model classified a substantial number of women differently. Using the Pepe method, the FRAX model (vs simple model), missed treating 70 (7%) cases of major osteoporotic fracture but avoided treating 285 (6%) non-cases. For hip fracture, the FRAX model missed treating 31 (8%) cases but avoided treating 1026 (18%) non-cases. The Cook method (both models, both fracture outcomes) had similar fracture rates above/below the treatment thresholds.

**Conclusion:**
Compared with the AUC, new methods provide more detailed information about how models classify patients.

## INCIDENCE AND RISK FOR FALLS AMONG AMBULATORY PERSONS POST-STROKE

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**Aim:**
Stroke increases falls risk four-fold. This contributes to an already elevated rate of disability and caregiver burden. The purpose of this study was to investigate the incidence and predictive factors of falls among ambulatory individuals post-stroke.

**Methods:**
Participants in the Locomotor Experience Applied Post-Stroke (LEAPS) trial[1] were monitored for falls using monthly diaries and interviews between 2- and 12-months post-stroke. Negative binomial regression and Classification and Regression Tree (CART) analysis were used to assess fall risk factors: walking speed, motor and sensory impairment (Fugl-Meyer Motor and Sensory Scores), balance (Berg Balance Scale, BBS), balance confidence (Activities-Specific Balance Confidence Scale), cognition (Mini Mental State Exam), depression (PHQ-9), and global disability (modified Rankin Scale), at 2-months post-stroke. At baseline, all participants were able to walk more than three meters with assistance.

**Results:**
Four hundred and eight participants, mean age 62 ± 13 years, were included; follow-up was 10.5 ± 2.2 months. A total of 58% (235) of participants fell; 34% reported multiple falls. Twenty-four (6%) experienced an injurious fall (19/24 with fracture). Univariate negative binomial regression (controlling for age, gender, group) showed that higher fall rate was significantly associated ($p < 0.05$) with greater impairment in walking speed, motor and sensory function, balance, balance confidence, and global disability. CART analysis identified BBS as the most important predictor of multiple fallers with a threshold of 42/56 points. Chance of experiencing multiple falls was reduced from 45.2% to 19.7% with BBS score ≥ 42 at 2-months post-stroke. Further exploratory CART analysis revealed a trend of complex interactions between BBS, depression, lower extremity motor function, and walking speed.

**Conclusion:**
The high incidence of falls in this cohort is consistent with previous reports in the first year post-stroke. The BBS threshold of 42 points is consistent with previous work identifying scores below the mid-40s as important for identifying multiple fallers. Multifactorial fall prevention strategies are needed in stroke rehabilitation.

**Reference:**
1. Duncan PW, Sullivan KJ, Behrman AL et al. Protocol for the Locomotor Experience Applied Post-stroke (LEAPS) trial: a randomized controlled trial. BMC Neurol 2007;7:39.

## A SIMPLE TOOL TO PREDICT PROBABILITY OF FALLING AFTER AGED CARE REHABILITATION

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**Aim:**
To develop and internally validate a falls prediction tool for people being discharged from inpatient aged care rehabilitation units.

**Methods:**
In this prospective cohort study possible predictors of falls were collected for 442 aged care rehabilitation unit inpatients at two Sydney hospitals. Medical and sociodemographic data were collected from medical records, discharge summaries and interviews with participants during the hospital admission. A physical assessment was conducted by a physiotherapist in the 48 hours prior to discharge from the ward. The number of falls during the three months after discharge was ascertained from calendars and phone calls.

**Results:**
One hundred and fifty participants fell in the three months after discharge from rehabilitation (34% of 438 with follow up data). Predictors of falls in a multivariate logistic regression model were male gender (odds ratio (OR) 2.32, 95% CI 1.00 to 4.03), Central Nervous System (CNS) medication prescription (OR 2.04, 95% CI 1.00 to 3.30) and increased postural sway (OR 1.93, 95% CI 1.00 to 3.26). This 3-variable model was adapted for clinical use by unit weighting (i.e. giving a score of one for each predictor present). The AUC for this tool was 0.69 (95% CI of 0.64 to 0.74, bootstrap-corrected AUC = 0.69). There was no evidence of poor model fit (Hosmer-Lemeshow p = 0.158).

**Conclusion:**
After external validation, this simple tool could be used to quantify the probability with which an individual will fall in the three months following an aged care rehabilitation stay. It may assist in the discharge process by identifying high risk individuals who may benefit from ongoing assistance or intervention.

## THE CLINIMETRIC PROPERTIES OF THE DEMMI IN HEALTHY COMMUNITY DWELLING OLDER ADULTS

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**Aim:**
To investigate the clinimetric properties of the de Morton Mobility Index (DEMMI) in healthy community dwelling older adults.

**Methods:**
Data for this cohort study were collected from a retirement village and Returned and Services League (RSL) club in Melbourne, Australia. All participants were 65 years or older, healthy and living within the community. The validation study included participants recruited from a retirement village (n = 61) and the inter-rater reliability studies included participants recruited from an RSL club and a subset of participants from the retirement village. Mobility was assessed using the DEMMI. Questionnaires included the Lower Extremity Functional Scale (LEFS), Quality of Life Scale (QOLS) and the Barthel Index. The percentage of participants who scored the highest and lowest possible score on the DEMMI was calculated to determine if a floor or ceiling effect occurred. The minimally clinically important difference (MCID) was estimated using a distribution based method. Reliability was estimated using the minimal detectable change at 90% confidence ($MDC_{90}$).

**Results:**
Evidence of convergent and discriminant validity were obtained for the DEMMI by examining correlations with measures of similar and other constructs, LEFS (r = 0.69) and QOLS scores (r = 0.28), respectively. Participants who ambulated without a gait aid (82.62 ± 10.63) had significantly higher (p < 0.001) DEMMI scores than those who ambulated with a gait aid (64.1 ±12.40), thus providing evidence of known groups validity. No floor or ceiling effect was identified with 0% and 13% scoring the lowest and highest scores respectively. The MCID for the DEMMI was 7 points. The $MDC_{90}$ for the inter-rater reliability study was 13 (95% CI 8.76 to 17.05) points on the 100 point scale.

**Conclusion:**
The DEMMI is a valid and reliable instrument for measuring the mobility of healthy community

dwelling older adults. It is the first mobility instrument that can accurately measure mobility changes for healthy and hospitalised older adults.

## PREDICTING FALLS IN LONG TERM STROKE SURVIVORS

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**Aim:**
To establish predictors of falls in long term stroke survivors.

**Methods:**
This study involved 151 stroke survivors (average time since stroke of 6 years) who participated in a randomised controlled trial (the Stroke Club Trial) which compared a circuit-based group exercise program targeting the lower limb with an upper limb exercise program. There was no difference between groups in fall rates over 12 months (incidence rate ratio (IRR) 0.96, 95% CI 0.59 to 1.57, $p = 0.877$) so data from participants in both groups were used in this analysis. Possible predictors included gender, past falls, fear of falling, comorbidity and measures of physiological function and mobility. The predictors which were associated with faller status on univariate logistic regression ($p < 0.2$) were entered into a multivariate logistic regression model. Variable selection and predictive ability (area under the ROC curve: AUC) were internally validated with bootstrapping.

**Results:**
Eighty-five participants (56%) fell in the 12-month study period.

Predictors of falling in univariate analyses ($p < 0.2$) were self-reported fear of falling, history of falls, reported continence problems, slow 10 metre walking speed, slow reaction time, knee extension weakness of the affected leg, poor single leg stance ability on the affected leg and poor Step Test performance.

Predictors of falling in the multivariate model were fear of falling (odds ratio (OR) 2.08, 95% CI 1.01 to 4.25), history of recurrent falls (OR 2.47, 95% CI 1.02 to 5.99), continence problems (OR 2.36, 95% CI 1.01 to 5.53) and slow reaction time (OR 1.00, 95% CI 1.00 to 1.01). The AUC for this model was 0.71 (95% CI of 0.63 to 0.79, bootstrap-corrected AUC = 0.71). There was no evidence of poor model fit (Hosmer-Lemeshow $p = 0.66$).

**Conclusion:**
In long term stroke survivors, those who fell could be predicted with reasonable accuracy.