AN OBJECTIVE FUNCTIONAL ASSESSMENT OF KNEE USING FLEXIBLE ELECTROGONIOMETRY AND THE STRATHCLYDE UNIVERSITY DATA LOGGING SYSTEM (SUDALS) FOR USE IN TOTAL KNEE ARTHROPLASTY (TKA)

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INTRODUCTION
Among the various commercially available data collecting system for use with a flexible electrogoniometer, there is currently a paucity of a user friendly system. What is required is a system where by clicking a single button a user can remotely record and transmit the information pertaining to the flexion/extension of the knee during activities of daily living (ADL) via a Bluetooth wireless connection. Such a device could be used to quantify the knee joint motion outside the gait laboratory, efficiently, by clinical staff at low cost and hence would be suitable for use in multi-centre clinical trials of TKA.

METHODS
A 6 channels, battery operated, remote control, microprocessor based system – SUDALS, which has the potential to collect kinematic joint data such as flexion/extension of the knee and also mark movement events such as foot falls during various ADL has been developed. Flexible electrogoniometers are used to measure the kinematics and force sensing resistors can be used as footswitches or other event markers. The pre-programming feature of the data logger allows the user to attach the instruments, turn on the logger and then initiate data collection by pressing an infra red key fob.

During functional activities, the user-friendly system stores the data from these transducers and transfers the same to a PC at the end of the recording period via a bluetooth connection. The logger can be started and stopped at will using the key fob and hence multiple tests can be recorded and only the data of interest is stored. Software on the PC then displays the angular displacement and allows visual inspection of the entire sequence of recordings or particular events of interest. Prior to releasing the system for general use, it was necessary to validate the newly developed system against a gold standard and test its accuracy, reliability and reproducibility.

RESULTS AND DISCUSSION
The pattern of flexion/ extension of the knee from 10 normal subjects (5 males and 5 females) was collected during a range of activities of daily living (ADL) such as; walking, ascending and descending stairs, in and out of a chair and deep squatting as tabulated in table 1.

The accuracy, reliability and reproducibility of the data from SUDALS were verified by comparing against the data simultaneously collected from the VICON system during walking from 3 normal subjects. The results of these studies indicate that the SUDALS together with flexible electrogoniometers is able to produce stable, precise, accurate and repeatable knee flexion/extension angles with little variation existing between the electrogoniometers [1] and producing data similar to those reported in the literature. [2] A cross correlation coefficient of 0.97 shows that there is a good similarity between the two sets of data obtained from 8 camera motion analysis system and the SUDALS system.
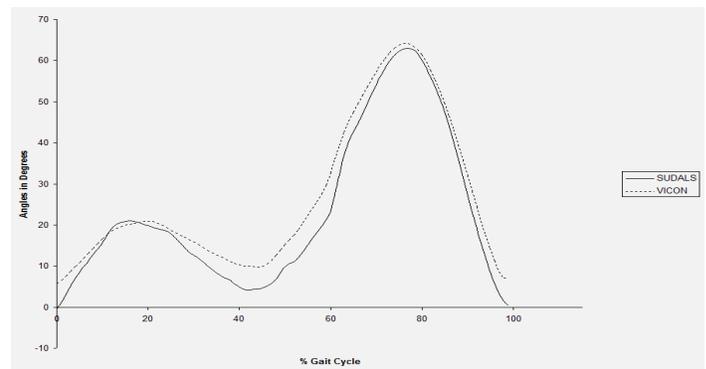

Figure 1: Concurrent validation of SUDALS and Vicon System.

CONCLUSION
Thus, the SUDALS system together with flexible electrogoniometers appear to be a useful clinical tool, capable of recording knee flexion/extension angles accurately during ADL and suitable for use by clinical research staff in multi centre RCTs of TKA.

REFERENCES

1. Rowe P.J et al, *Journal of Orthopedic surgery,* **Vol13**, no: 2, 131-138, 2005
2. Kettlekamp et al, *Journal of bone and joint surgery,* **Vol 52**, 775-790, 1970

Table 1: Maximum knee flexion angles during ADL from SUDALS

Maximum Knee Flexion (degrees)	Activities of Daily living (ADL)					
	Gait	Stair Ascend	Stair Descend	Chair In	Chair Out	Squat
Right Knee	64.9	88.8	80.2	105.6	112.3	115.6
Left Knee	62.6	82.7	79.5	105.8	103.5	121.2