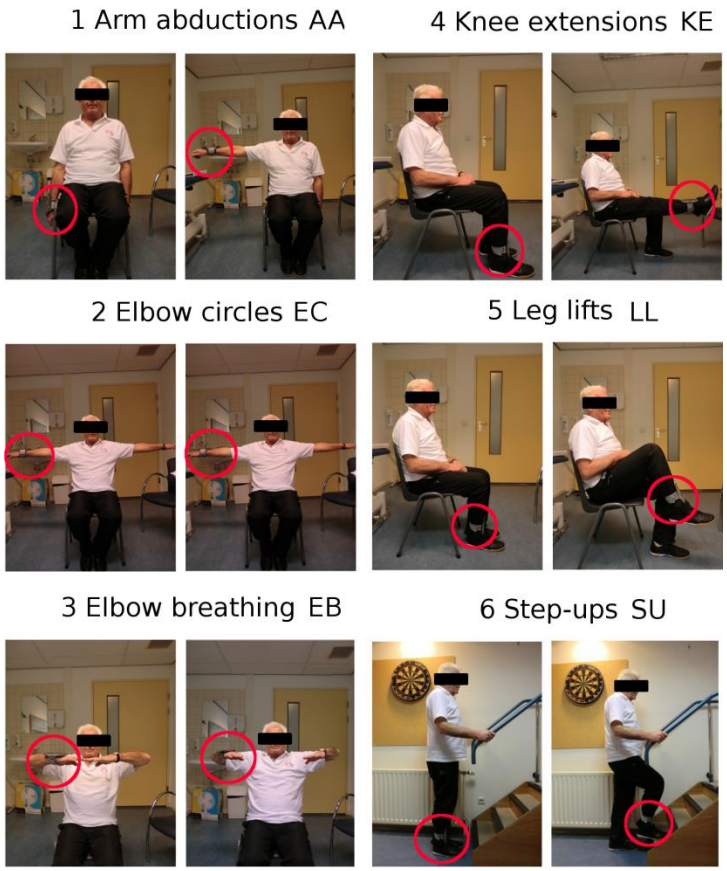

Figure 8 Illustration of the exercises selected for the training system evaluation with COPD patients. The patient is wearing the smartphone (red circle) on limbs that are involved in the different exercises. During the active part of the movements the patients were recommended to breathe in (inhale) and during the return phase to breathe out (exhale).

3.5.2 Data collection and exercise features

Both healthy participants and COPD patients were asked to wear the smartphone in a holster during the exercises. The holster was attached to the right wrist during the upper body exercises and to the right ankle during the leg exercises using Velcro straps. Three acceleration signals (A_x, A_y, A_z) and three Euler orientation angles (Azimuth O_x, Pitch O_y and Roll O_z) were recorded from the 3D accelerometer and magnetometer sensors embedded in a Samsung Galaxy SIII phone. Data was acquired at the sampling frequency of ~50Hz using the Android Software Development Kit (SDK). From the available motion signals, we chose orientation estimates as features to describe the sinusoidal exercise pattern. According to the phone orientation at the body, Azimuth orientation angle (O_x) was used for elbow breathing and Pitch (O_y) for all other exercises. Orientation estimates can be efficiently derived on smartphones, thus the approach can be used even on entry-level phones.