Use of Mobile Applications for Hospital Discharge Letters - Improving Handover at Point of Practice

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ABSTRACT

Handover of patient care is a time of particular risk and it is important that accurate and relevant information is clearly communicated. The hospital discharge letter is an important part of handover. However, the quality of hospital discharge letters is variable and letters frequently omit important information. The Cork Letter-Writing Assessment Scale (CLAS) is a mobile application based on an itemized checklist and scoring system developed to improve the quality of discharge letters. In a recent study, CLAS improved the quality (content, structure and clarity) of discharge letters written by medical students. Retention of these skills into the workplace and effects on patient safety have yet to be demonstrated. The development of standardized electronic discharge letters allow faster and safer transfer of information between healthcare providers and is a welcome advance. Mobile applications using Near Field Communication to seamlessly transfer discharge letters between devices is another important advance.

Keywords
Mobile learning, mobile applications, discharge letters, patient safety, handover, communication skills, hospital discharge, medical error, Near Field Communication.

INTRODUCTION

Handover

Handover is the transfer of patient care from one care-giver to another and is a time of particular risk for medical error. At handover, it is important that accurate, reliable and relevant information is clearly communicated from one caregiver to another. Improperly conducted handovers lead to medical error, delay in diagnosis, life threatening adverse events, patient dissatisfaction, increased health care expenditure and increased length of hospital stay, and other effects that impact on the healthcare system (van Walraven et al., 2004). The World Health Organization (WHO) lists accurate handovers as one of its ‘High 5’ Patient Safety initiatives (WHO, 2011). Training of handover skills is an important step in improving patient safety. However, the lack of handover training in undergraduate medical education and the need to address this deficiency have been succinctly elucidated (Gordon & Findley, 2011). Research has identified dissatisfaction amongst junior medical staff as a result of lack of handover policies and training (Gordon, 2010). In Europe, handover training is unstandardized in medical curricula and undermined by the lack of research assessing appropriate educational strategies for handover (Gordon & Findley, 2011; Reisenberg, Jaeger, Padmore, 2009; Johnson & Barach, 2009; Jeffcott et al., 2009).
Communication errors specifically have been reported to be a contributing factor in up to half of all preventable adverse events in patient care (Forster, 2003). Written communication is an intrinsic part of handover and the quality of handover is enhanced by the availability of printed information (Bhabra, 2007). In order to ensure good continuity of care during a patient’s transition from hospital care to primary care, good communication between healthcare practitioners is of vital importance in the discharge process. The doctor taking over the patient’s care needs timely access to information about a patient’s hospital stay in order to optimize patient care and decrease risk of medical error.

Handover is seen as an increasingly important area in medical education research. The HANDOVER Project (FP7-HEALTH-F2-2008-223409) identified handover training needs and developed and made available to the wider community, innovative handover teaching tools including the HANDOVER Toolbox (Johnson & Barach, 2009, Stoyanov et al., 2012). The HANDOVER Toolbox is a learning network (Drachsler et al, 2012) that acts like an online community of practice (Wenger, McDermott, Snyder, 2002) for medical professionals. The toolbox (www.handovertoolbox.eu) contains standardized ready to use handover tools, training material, and guidelines on training content and course design. Another important handover project, the multi-lateral EU-funded PATIENT project (www.patient-project.eu) aims to standardize handover training in medical schools across Europe by developing an evidence-based handover study module. A pilot training module will initially be implemented and evaluated in participant sites. The module will use simulation-based teaching and technological tools including innovative mobile applications and use of the HANDOVER Toolbox. The project will provide evidence-based research on the effectiveness of various handover interventions.

The Hospital Discharge Letter

Communication, in particular written communication, is integral to handover and the hospital discharge letter is probably the most important of all written communications between hospital and family doctor. All patients who access hospital services need a discharge letter, including brief day-case admissions or patients with prolonged in-patient stays. Family doctors rely on the hospital discharge letter to learn about the patient’s ‘story’ as an in-patient and to deliver the necessary information to take over patient care.

Optimal healthcare and patient safety depend on the availability of information that is accurate, reliable, timely and relevant. This information needs to be structured, clear, legible and complete. A lack of accurate and up-to-date information can lead to the unnecessary duplication of tests and even more importantly, can prevent or delay the commencement of prescribed medication. Medication errors can have serious adverse effects.

Healthcare professionals taking over patient care need to know the patient’s story: what the problem was, how was it diagnosed and what was done about it (Alpers 2001; Goldman, Pantilat, Whitcomb, 2001; Poon et al., 2004; Coleman & Berenson, 2004). The patient’s medication, problem list, management plan and follow-up are particularly important. Incomplete or inaccurate information at handover can cause mistakes in medical decision-making and inadequate patient monitoring and treatment (van Walraven et al., 2004).

Adverse events are likely to occur in the immediate post discharge period if there is poor communication at handover (Forster, 2004). One study demonstrated a higher risk of hospital readmission in patients who were seen in follow up appointments by a physician who was not in receipt of a discharge summary (Van Walraven, 2002).

The importance of writing clear and accurate hospital discharge letters is becoming more apparent as changes occur in how hospital healthcare is provided. The European Working Time Initiative means
that junior doctors are required to do more shift-work and may be required to write discharge letters about patients they are not familiar with. In addition, economic pressures mean that a patient’s hospital stay is now as short as possible, increasing patient vulnerability at time of discharge and also increasing the number of handovers back to primary or community care.

The hospital discharge letter is the basis for communication between healthcare professionals in different healthcare settings. Ideally, a patient’s discharge letter must be a complete, accurate and relevant record of the inpatient stay and must be made available to the patient’s doctor at the time of discharge or as soon as possible after discharge. Ideally the discharge letter should be available to community healthcare professionals on the day of the patient’s discharge. Missing information, especially important items like medication details and follow-up plan, or a delay in sending out the discharge letter, can put the patient’s health at considerable risk and compromise patient safety. The hospital discharge letter may be handwritten or typed. Electronically-generated letters are becoming increasingly available and are a welcome advance in minimizing the potential for error associated with free text or hand-written entries. However, computer-generated letters lack standardization.

A safe and effective patient-centered discharge process depends on the quality of the information provided in the discharge letter. Quality information can be considered as information that is accurate, complete, legible, relevant, reliable, timely and valid (CIHI, 2009; Australian Bureau of Statistics, 2009). The discharge letter should provide a full picture of the patient’s inpatient stay, should be fit for purpose and should not be so detailed as to be confusing or too short as to lack important information. Ideally, information should be communicated in more than one way i.e. the discharge letter given to patient and also emailed to the patient’s GP.

Currently, there is no general agreement or consensus on the information that should be included in a discharge letter. Some hospitals have developed their own templates and datasets for patient discharge summaries. However, there is a lack of standardization as to the exact content of the discharge letter, how much detail is required, and the most important elements of the letter. Medical professional bodies have given advice in this area (AMA, 2012). Scotland has developed a minimum dataset for clinical discharge summaries known as the ‘SIGN 128 Discharge Document’ (SIGN, 2012). Northern Ireland has also developed a minimum dataset for clinical discharge summaries (GAIN, 2011). In Ireland, the Health Information and Quality Authority (HIQA, 2012) recently invited submissions relating to the development of a standardized discharge letter dataset. In Australia, the National E-Health Transition Authority published a detailed specification for content of electronic discharge summaries (NEHTA, 2012). In England, the Royal College of Physicians has published a list of headings for inclusion in a clinical discharge summary (RCPI, 2012). The Joint Commission on the Accreditation of Healthcare Organizations, (Joint Commission, 2012) an international healthcare standards organisation, has also developed specifications for a discharge summary including mandatory components (Amy, 2012).

Quality of Hospital Discharge Letters - Cause for Concern

Traditionally, discharge letters have been paper-based and handwritten based on narratives and free text descriptions of diagnoses and diseases. Often a handwritten summary is given to the patient on the day of discharge and a typed full report follows at a later period. This frequently results in doctors trying to decipher illegible handwriting from carbon copies or indeed the letter itself (Bolton, 2001). Most discharge letters are written by junior doctors and writing discharge letters can take time away from a junior doctor’s other clinical duties. Importantly, discharge letters are frequently not received by the family doctor for days or even weeks after the patient has been discharged from hospital. Studies show that the quality of hospital discharge letters is very variable (Kripalani et al.,
Datasets are unstandardized and vary between different hospitals, leading to considerable differences in content and quality of discharge letters. Discharge letters frequently omit, or fail to emphasize, important information. Letter format may lack structure, clarity, and ‘readability’. Legibility is a big concern in hand-written letters. Often the family doctor receives the discharge letter at night-time or on weekends, times when the full hospital team is not on duty and clarification of confusing content may not be possible. Moore et al. (2003) found that handover errors occurred in around 50% of patients at discharge and were associated with a significantly higher risk of readmission.

Were et al., (2009) found that only 16% of discharge letters contained information on tests with pending results. Grimes et al (2008) prospectively investigated the quality and consistency of medication details in the discharge documents of 139 patients. There was a discrepancy in medication documentation in 10.8% of medication orders affecting 65.5% of patients. The most frequent discrepancy was drug omission. Many of the inconsistencies identified had the potential to cause moderate patient harm.

Audits of hospital discharge letters show that important information is frequently missing (Kripalani et al., 2007). Discharge summaries often did not identify the responsible hospital doctor (missing from 25%), the main diagnosis (missing from 17.5%), physical findings (missing from 10.5%), diagnostic test results (missing from 38%), discharge medications (missing from 21%), treatment or hospital course (missing from 7% - 22%), and follow-up plans (missing from 14%) (Kripalani et al., 2007). The highest rates of missing information related to tests pending at discharge (65%) and information or advice given to patients or families before discharge (91%) (Kripalani et al., 2007). Doctors estimated that patient care was affected adversely in about 24% of cases by delayed or incomplete discharge communications (Harding, 1987). One study found that 41% of patients had test results pending on the day of discharge, and nearly 10% of these results were rated as potentially actionable, some requiring urgent attention (Roy et al., 2005).

Results of a recent study on quality of discharge letters (Maher et al., 2012) carried out in our own institution support previous findings (Kripalani et al., 2007). Analysis of 200 patient discharge letters from four different medical practices found that 99% of letters did not have a problem list, 73% did not have details of the patient’s presenting complaint (main complaint), 65% did not have details of the patient’s past medical history, 87.5% did not include clinical findings, 38.5% did not have any information on investigations, 52% did not have information on abnormal results and 93% did not mention results that were still pending at time of discharge. Whilst 86% of letters contained a list of diagnoses, only 1.5% actually highlighted a new diagnosis. Eighty-one percent of letters did not give any information on the patient’s clinical course in hospital and 74% made no comment on the patient’s clinical status at discharge. Only 10% of letters contained a patient management plan. Sixty-nine percent of letters included a list of medications but doses were written incorrectly in 41%. Only 3% of letters drew attention to medications that were stopped and only 3.5% highlighted new medications. Only 3% of letters had details of information shared or discussed with the patient or family and only 22% of letters contained the title of the letter-writer (i.e. intern, Registrar, Senior House Officer etc.). Twenty-one percent of letters had poor legibility.

Of importance is the fact that medical students lack standardized training in handover including instruction on how to write a hospital discharge letter (Gordon & Findley, 2011). Skills such as this are often perceived to be acquired ‘on the job’ or are presumed to be taught elsewhere on the medical curriculum. Moreover, there is a lack of educational tools and resources to help doctors improve their skills in writing discharge letters.
Development of the Cork Letter-Writing Assessment Scale (CLAS)

The use of standardized formats has been shown to improve the quality of procedures within healthcare including hospital discharge letters (Van Walraven et al., 1998; Rao et al., 2005). Van Walraven et al. (1998) found that a standardized discharge letter format with clear subheadings was better than narrative summaries (shorter and easier to access the most relevant information). Rao et al. (2005) found that a standardized template improved the quality and efficiency of discharge letter dictations.

In an attempt to address the lack of educational tools in this area, The School of Medicine at University College Cork (UCC) developed an itemized check-list (Cork Letter-Writing Assessment Scale or CLAS) to help medical students and doctors improve the quality of hospital discharge letters and to standardize information transfer at handover (Table 1).

Checklists are increasingly used in medical education and patient safety protocols. The recently published WHO Patient Safety Curriculum Guide advocates the use of checklists in medical training (WHO Patient Safety Curriculum Guide October, 2011): ‘Checklists, protocols and care plans designed for particular categories of patients are effective ways of communicating patient-care orders.’ The development of a standardised dataset for discharge letters as a checklist would therefore appear to be an important step towards improving patient safety at handover.

The CLAS checklist was developed after analysis of several discharge letter datasets developed in other jurisdictions and after an extensive literature review. Kripalani et al., (2007) found that family doctors rated inclusion of the following information as most important in the discharge letter: main diagnosis, pertinent physical findings, results of procedures and laboratory tests, discharge medications/ reasons for any changes, details of follow-up arrangements, information given to the patient and family, test results pending at discharge and specific follow-up needs.

Similarly, Van Walreven and Rokosh (1999) suggests inclusion of the following items: admission diagnosis, pertinent physical findings, laboratory results, procedures and complications in hospital, discharge medications and follow up. An observational study performed by Lloyd and Barnett (1993) found that 94% of doctors wanted a problem list included in the discharge letter.

Family doctors and medical education professionals were also consulted regarding discharge letter content and structure. The development of the CLAS checklist was informed by professional recommendations and other datasets currently in use. The checklist includes all items that are deemed important in a discharge summary. Items are grouped in specific sections in the order in which they should ideally appear in the letter. CLAS includes (a) demographic details: patient, doctor, and hospital identification details, (b) details regarding the inpatient stay: diagnosis list, details of the clinical course in hospital and the treatments or procedures undertaken, investigation results, (c) discharge details: medications on discharge, follow up plans and details of communication that took place with the patient, (d) writing style: legibility, use of headings, structure, readability and appropriate length.

The CLAS checklist can be used as a reference when writing discharge letters or can be used as an assessment tool to evaluate the quality of hospital discharge letters. CLAS is suitable for all discharge locations (home, step-down care, nursing home or other institutions).

The next step after the dataset had been agreed upon was to develop the checklist as a mobile application in the form of a digital checklist with a scoring system. The aim was to support medical professionals and students in handover communications in the clinical environment.
Recent and rapidly progressive technological advances have changed how we communicate and interact in all aspects of our lives. Technology has made possible the rapid storage, retrieval and synthesis of information. Social networking and mobile devices are powerful new platforms for 21st century communication and learning (Glahn, 2011, Sharples, 2006). Generation Y has embraced this technological age with enthusiasm. The medical profession has been quick to become part of this process. Doctors constantly strive to stay informed about new research and developments. Medical students and doctors increasingly use mobile devices to access a wide range of resources - drug formularies, clinical calculators, check-lists, online libraries, on-line medical quizzes, exam papers, medical image banks, and accredited learning tools and resources from professional bodies.

Pocket textbooks and manuals have been replaced by mobile devices. Traditional textbooks are cumbersome, pose an infection risk, may be outdated, and may not always be suitable for use at the bedside. Medical students are increasingly using mobile devices to take notes and for audio-recording. Hand-written notes are difficult to write and read in a clinical setting and pose a risk to patient confidentiality and data protection. Medical students have embraced mobile phones as a learning platform and are leading the way in how future medical education needs to be delivered, especially ‘point of practice’ educational resources.

Mobile applications offer flexible, accessible and instant support, providing information when it’s wanted and where it’s wanted, with speed and ease of access (Börner, 2010). In addition, mobile applications have the facility of being able to communicate with each other, either by bluetooth or Near Field Communication (NFC). In this way, information can be transferred quickly, safely and seamlessly. Besides seamless access to information and computational assistance, mobile devices can be seen as ‘always present’ notification systems. New approaches in the area of context-aware computing also use specific context changes or triggers to notify relevant stakeholders and users of these changes. A comparable technique is also applied when using mobile devices to collect data in the field using methods such as experience sampling, which often plays an important role in field studies (Larson, 1983).

In addition to the recognized functions of learning support, information access, and notification, mobile applications have particular promise at handover, a time when information transfer needs to be accurate, fast, and complete. The combination of mobile information for understanding and following defined procedures, delivery of training and reflecting on tasks on site, and also triggering of contextualized notification, provides a unique opportunity for healthcare training innovations such as the EMuRgency project. The EMuRgency project (EMR INT4 1.2.-2011-04/070) is a socio-technological innovation project to increase the rate of first-responder Cardio-Pulmonary Resuscitation (CPR) in the Euregio Meuse-Rhine region. The project combines several technological and educational innovations to provide performance support and preparatory learning, transfer, and retention of CPR knowledge and skills (Kalz et al., 2012). In addition to a notification system for first responders, the project provides educational support and training applications to help volunteers and medical staff to memorize facts, activities and procedures to follow when conducting CPR (studies have shown that the retention times of CPR training decrease after approximately 6 months). Through a combination of preparatory e-learning, traditional taught courses, and mobile applications, EMuRgency offers flexible educational opportunities and aims to increase information retention times without formal training.
Development of CLAS as a mobile application

The CLAS mobile application uses the 50-item CLAS checklist. Items are grouped into the various sections e.g., History, Physical Examination, Diagnosis, Medications etc. Figures 1 - 4 demonstrates the interaction flow with the application. The first page relates to the patient’s demographic details. The second page covers problem list, presenting complaint, history of presenting complaint, past medical history and investigations. The third page relates to current status, management plan and medications. The final page concerns items relating to writing clarity and letter structure. Ticking the section check-box signifies completion of all that particular group of items; ticking an individual item signifies completion of one particular item. At the end of the process, items not ‘ticked’ appear as a list of ‘unchecked items’, prompting the user to write a ‘corrected’ discharge letter which includes the omitted items. The CLAS mobile application therefore functions as a quick checklist to be used at point of practice as an aide-memoire checklist while writing a discharge letter. CLAS also generates a total score at the end, allowing the user to evaluate their discharge letters. The objective of the scoring system is to promote the quest for the ‘perfect score’ of 50. A letter scoring 40 may still be a good discharge letter, but the objective is to attempt to write the ‘best possible’ discharge letter. No patient data are entered at any point, thus there are no ethical or medico-legal issues regarding the storage of personal or clinical data.

All items score one point except for areas which are of particular importance in handover and patient safety (medications and management plan).

1. Management plan (two points).
2. List of discharge medications (four points).
3. Drug doses written in formal units and clearly written (two points).
4. Names of any medication stopped and why (2 points).
5. Names of any new medication commenced and why (2 points).

An important advantage of the integration of a scoring system into the CLAS application is that CLAS can be used to grade the quality of discharge letters. In addition, the scoring system allows quantification of improvement in letter-writing following instruction and use of CLAS. By using CLAS frequently, and by being prompted that certain items have been omitted, students and doctors can increase their recall of important items, thus improving the quality of hospital discharge letters at handover. In addition, by increasing overall awareness of the importance of discharge letter content and quality, doctors and medical students may pay more attention to this important area of handover.

In addition to letters to family doctors, the CLAS mobile application can also be used to improve the quality of other referral letters (i.e. letters to other consultants, letters to physiotherapy etc.) and can provide a template for good written communication between care-givers. The CLAS display screen was designed to be simple, intuitive, and user-friendly. The information icon is displayed on the top left of the screen, to avoid accidental checking. The information page explains how to use the app and can be accessed at any stage in the process. The colors of the items fade when an item is checked, as this design was deemed more visually aesthetic by the pilot test users.

Figures 1 and 2 here

The development of mobile applications has inherent design challenges. Like good writing style, every word must earn its place on the screen of a mobile application. Character spaces are limited, so wording has to be succinct while remaining clear. Repeated modification based on user feedback is
important. One advantage of mobile applications, of course, is that they can be modified, improved and re-issued. New features can be added and existent problems fixed. Thus, mobile applications offer a dynamic, versatile and responsive component to 21st century learning.

Figures 3 and 4

METHODS

Evaluation of CLAS mobile application

Objective
The objective of the study was to assess the effect of the CLAS mobile application on medical students’ ability to write a hospital discharge letter.

Study design
The study was an experimental study involving 80 fourth-year medical students attending UCC. The students comprised school-leaver students (students enrolled on the Direct-Entry medical programme) and Graduate-Entry medical students.

Selection of participants
The study was carried out as part of a Letter-Writing Work-shop for Fourth-Year medical students. None of the students had received any formal instruction on how to write a hospital discharge letter. The class (80 students) was randomly divided into two groups in advance of the work-shop. Each group contained 40 students and had a similar number of males and females. Both groups had similar numbers of non-EU students the majority of whom were North American. Students in both groups were similar ages and the average age of participants was 22. At the commencement of the workshop, the study was explained to the students and they were invited to participate. Participation was voluntary and anonymous.

Study procedure
In advance of the workshop, a hand-written fictional set of patient case-notes containing a variety of complex entries was developed by medical faculty in the medical school. The casenotes were made available on the University’s Learning Management System one week before the workshop and students were emailed asking them to print and read the case-notes and to bring the case-notes with them to the work-shop. Students were not informed at that stage that they would be asked to write a discharge letter based on these fictional case-notes.
The two groups were placed in different lecture theatres. At the beginning of their work-shop, Group A students were given a presentation on the importance of the hospital discharge letter and instruction on how to write a discharge letter based on the CLAS checklist and a demonstration of the CLAS app. The students wrote notes during the presentation. The QR code of the CLAS app on itunes was also provided for students who wished to download the application (the CLAS app is available free of charge on i-tunes). The presentation and subsequent discussion lasted approximately 40 minutes.

After the presentation had been delivered, the students were asked to read the fictional case-notes again and to write a discharge letter based on these case-notes (referring to their notes or the CLAS app). Copies of the case-notes were given to the students who had forgotten to bring the case-notes with them to the work-shop. The students were allowed 25 minutes to write the letter.

*Control Group*

Group B students were allocated to a different lecture theatre. These students were informed about the study and invited to participate. In contrast to Group A, Group B were asked to read the fictional case-notes and write a discharge letter at the beginning of the work-shop (prior to being given the presentation on how to write a discharge letter and instruction on the CLAS mobile app). These students were given the same time allocation to write the discharge letter (25 minutes). The discharge letters were collected and the students were given the presentation on how to write a discharge letter and use of the CLAS app. This instruction took 40 minutes (similar to Group A). The discharge letters did not contain any student identification as participation was anonymous.

*Analysis*

All of the discharge letters were read and analysed for content and writing style using the CLAS checklist mobile application. Data was inputted into an excel spreadsheet and a score was allocated for each check-list item (most items had a score of 1 apart from medications and management plan which scored 2). Total score was calculated for each student (maximum score was 50).

*Statistical analysis*

Data was initially recorded in an Excel spreadsheet and was subsequently exported to SPSS version 19 for statistical analysis. Initial analyses were undertaken to assess normality. Descriptive statistics, frequencies and graphs were produced. Individual items which were scored 0 or 1 were compared across intervention and control group using Chi squared analysis. Mann Whitney U tests were used for items which were scored on a scale of 0-2 and 0-4 (medications). Mann Whitney U test was also used to compare mean total scores of the two groups. A p value of 0.05 or less was considered statistically significant.

*Ethical approval*

Ethical approval was obtained from the Clinical Research Ethics Committee of the Cork Teaching Hospitals and study approval was obtained from UCC School of Medicine Research Ethics Committee.
RESULTS

Mean CLAS score
All students present at the work-shop participated in the study (n=80). Total mean score (out of 50) was 42.23 in the intervention group (received CLAS app instruction prior to writing the letter) compared to 25.68 in the control group who wrote the discharge letter without having had any prior instruction on the CLAS application. The difference between the mean scores of the CLAS intervention group compared with the control group was statistically significant (p<0.001) using Mann Whitney U Test for non-parametric data. Overall, the CLAS intervention group had higher scores for the majority of the individual items.

Inclusion of Patients’ Demographic information
Student scores for patient address (p<0.001), Medical Record Number (MRN) (p<0.001), date of birth (DOB) (p=0.007), name of hospital ward (p<0.001) and date patient admitted to hospital (p<0.001) all showed a statistically significant difference between the group who had received CLAS instruction and controls. Only seven students in the control group (compared with 39 in the CLAS intervention group) included the patient’s admission date in their discharge letter (Table 2).

Table 2

History, Clinical Findings, Investigations
Only two students in the control group (out of a total number of 40) began the discharge letter with a bulleted problem list (Table 3) compared to 38 students in the intervention group (p<0.001). While most students (31 in the control group and 40 in the CLAS intervention group) included the presenting complaint, only 22 of the control group included details of the presenting complaint (p<0.001). Only 13 of the control group included a past medical history compared with 38 in the intervention group (p<0.001). Only 9 control students (vs. 35 in the CLAS intervention group) listed pertinent (relevant) clinical findings and only 13 control students vs. 32 in the CLAS intervention group (p<0.001) included a list of investigations. Twenty students in the control group compared with 36 in the intervention group (p<0.001) listed abnormal results.

Table 3

Diagnosis and Clinical Course
None of the students in the control group included a list of diagnoses (compared with 33 in the CLAS intervention group; p < 0.001) and only 18 students in the control group (vs. 33 in the CLAS intervention group) highlighted a new diagnosis (p = 0.005) (Table 4). Only half of the control group mentioned the patient’s clinical course in hospital compared with 34 in the CLAS intervention group (p< 0.001).
Medications

While most students (33 in the control group and all students in the CLAS intervention group) included a list of medications, only 27 students in the control group wrote these medications correctly in formal units (vs. all the students in the CLAS intervention group). Only 11 students in the control group listed medications that were stopped in hospital (vs. 22 in the CLAS intervention group). All of these items showed significant differences between control group and intervention group (p< 0.001) (i.e. between those who had received CLAS app instruction and those who hadn’t).

Current Status, Follow-up, Sign-off

Only two students (compared with 17 in the CLAS intervention group) mentioned the patient’s clinical status at time of discharge (p < 0.001) (Table 5). There was also a significant difference between both groups in patient follow-up and sign-off details (p< 0.001). Only 16 students in the control group included their contact details as writer of the discharge letter.

Structure, Style and Clarity

Letter structure was scored more highly in the letters written by students who had received CLAS instruction (36 versus 26 in the control group (p< 0.001). Letter clarity also received more scores in the CLAS intervention group compared to the control group (32 vs 19; p = 0.005). Students who received CLAS instruction prior to letter-writing also used headings more frequently: 29 students used headings in the CLAS intervention group compared with two students in the control group (p<0.001).

DISCUSSION

Instruction and use of the CLAS mobile application improved the majority of items considered important in discharge letters. Items that showed no difference in score between the CLAS intervention group and controls related to obvious information such as the patient’s name. Overall CLAS score was greater in the students who had received CLAS instruction and individual item and section scores were also higher. Letter structure, use of headings, and clarity were also better in the CLAS intervention group compared with controls. Thus, use of the CLAS check-list may improve the quality of discharge letters written by medical students.

Our findings are similar to results from other studies that have reported increased quality of discharge letters using a discharge letter template (Van Walraven et al. (1998); Rao et al. (2005); Braun et al (2003); Ferran et al. (2008). Both Van Walraven et al. and Rao et al. found that using a
discharge letter template shortened the length of the letters, but length of letter was not specifically assessed in our study.

We found that the CLAS mobile application was well-received by medical students. Students are motivated by attempting to increase their score (positive feedback encourages good practice) and are interested in using mobile applications such as CLAS for knowledge acquisition.

Use of checklists in patient safety is advocated by the World Health Organization (WHO, 2012) and medical professional bodies have given advice in this area (AMA, 2012; RCPI, 2012). Scotland has developed a minimum dataset for clinical discharge summaries known as the ‘SIGN 128 Discharge Document’ (SIGN, 2012). The Joint Commission on the Accreditation of Healthcare Organizations, (Joint Commission, 2012) has also developed specifications for a discharge summary including mandatory components (Amy, 2012). Thus the checklist approach is a convenient and acceptable way of developing a discharge letter template.

Mobile applications are an ideal vehicle for educational ‘point-of-practice’ checklists, offering flexible, accessible and instant support and providing information when it’s wanted and where it’s wanted, with speed and ease of access (Börner, 2010). Experiences of the EMuRgency project strengthen the use of mobile applications for performance support, and transfer and retention of knowledge and skills (Kalz et al., 2012).

There is no doubt that handover is an important area in patient safety and that written communications such as the discharge letter are vital to the safe continuum of patient care. There is a need for interventions and tools such as the CLAS mobile application. The lack of handover training in undergraduate medical education and the need to address this deficiency has been widely acknowledged (Gordon & Findley, 2011). There is also a deficit of research assessing appropriate educational strategies for handover (Gordon & Findley, 2011; Reisenberg, Jaeger, Padmore, 2009; Johnson & Barach, 2009; Jeffcott et al., 2009). In particular, there has been no evaluation of educational mobile applications in improving medical letter-writing skills. Results of this study suggest that use of a letter-writing checklist available as a mobile application can improve the quality of hospital discharge letters, a vital component in the transfer of handover communications between hospital and family doctors/community healthcare workers. In contrast to other handover projects, ho CLAS does not try to teach medical standards in any group settings but provides the target user with a mobile application to help memorize and check the important items of a discharge letter. This approach is in line with the objectives of the EMuRgency project which follows a similar approach using mobile learning opportunities to develop and sustain procedural knowledge for CPR training.

The PATIENT project provides an ideal environment to role out the CLAS mobile application to a wider medical audience in participant medical schools. The CLAS app can also be used to grade discharge letters for research or individual purposes.

### Study Strengths

This is the first study to evaluate this type of educational intervention (mobile application based on a checklist or dataset), as this is the first letter-writing checklist available as a mobile application. The use of a detailed fictional set of case-notes in this study is a good simulation exercise in handover.

### Study Limitations

This study has a number of limitations. In this study, the assessment took place immediately after CLAS instruction. Total score and overall results are likely to be lower if the assessment occurred at a later date. However, whilst retention of benefits may indeed decline with time, the fact that the CLAS mobile application is a permanently available ubiquitous tool available in any setting, means
that students can refresh their knowledge at any time and as needed (mobile applications are particularly suited to point of practice checklist use).

The CLAS tool has not yet been validated and there is a lack of validated tools for this purpose. However, the CLAS checklist is based on international professional best practice guidelines and the checklist items are very similar to the items proposed for the new standardised summary from HIQA which is currently under development (HIQA, 2012). Future work could include parallel scoring of discharge letters by hospital physicians and general practitioners. A global rating could be allocated (not based on CLAS scale) based on the perceived quality of the discharge letters as evaluated by General Practitioners. The global ratings could then be compared with the CLAS scores – consistent agreement between the global score and CLAS score would help validate the CLAS scale. Differences between the global ratings and total CLAS scores could also lead to revisions and modifications of the CLAS checklist.

Another limitation is the amount of time allowed to write the discharge letter (25 minutes). Even though this amount of time is more than that likely to be available to a junior doctor to write a discharge letter, we judged that hospital doctors would be more familiar with the patient’s history and that the fictional case-notes were particularly complex (including a drug allergy, pending test results, multiple appointments to be made, use of warfarin and need for follow-up blood tests). Thus, considering that this was also the medical students’ first attempt at writing a discharge letter, we considered 25 minutes a reasonable amount of time for writing the discharge letter.

Another limitation is that the study was confined to one medical school only and may not be representative of other medical schools. Finally, letters were scored by one evaluator only. Ideally evaluation should have been by two assessors and inter-rater variability assessed. Assessor bias is another possibility.

**Future Developments**

While this study has shown immediate benefits of an educational mobile application in improving the quality of discharge letters written by medical students, we do not know if these benefits will be retained into the workplace. Even more importantly, we do not know if these benefits will lead to improvement in patient safety as to date, there is very little evidence showing the benefit of educational interventions on patient safety outcomes (Gordon & Findley, 2011). As CLAS instruction is now part of the 4th year medical curriculum for all medical students, we plan to assess the quality of discharge letters written by next year’s hospital interns and compare them with discharge letters written before 2013 (prior to the introduction of CLAS and discharge letter teaching).

**Electronic discharge letters**

Information and communications technology have a critical role to play in ensuring that information is available when and where it is required, supporting faster, reliable and safer communications between hospitals and community. As paper-based healthcare data is progressively moving to electronic storage, there is a trend (and obvious need) to move from paper-based discharge letters to electronic discharge letters (e-DL). The development of e-discharge letters, based on standardized templates, has many important advantages (Box 1). Electronic letters allow a faster and more efficient transfer of patient information, ensuring that doctors have access to important clinical information at time of patient discharge. Importantly, use of standardized datasets allow patient information to be standardised across organizations, services and even geographical locations and facilitate a faster, more effective, and safer transfer of patient care. Lissauer et al (1998) prospectively compared computer generated and dictated discharge summaries for 133 neonates admitted for intensive care during a six month period. They found that computer generated
summaries provided more completeness of data and that usage of additional comments in the free text area improved readability.

A study assessing GP’s preference for computer generated or manually formed discharge summaries showed that 68.5% of GPs preferred the computerized summary and particularly liked its comprehensiveness, conciseness, ease of access to relevant information, clarity and ease of reading (Archbold, 1998). Chen et al (2011) found that transmission of computer-generated discharge summaries by fax or email was the most effective method of communicating with primary care physicians, as long as accurate contact information was available. Although fax was still the most preferred method, email had many advantages that could potentially allow it to replace fax as a standard mode for delivery of discharge communication. O’Leary et al (2009) found that use of an electronic discharge summary significantly improved the quality and timeliness of discharge summaries (mean quality rating 3.04 versus 3.64; \( P < 0.001 \), mean timeliness rating 2.59 versus 3.34; \( P < 0.001 \)). Several elements of the discharge summary were present more often with the electronic discharge summary, including discussion of follow-up issues (52.0% versus 75.8%; \( P = 0.001 \)), pending test results (13.9% versus 46.3%; \( P < 0.001 \)), and information provided to the patient and/or family (85.1% versus 95.8%; \( P = 0.01 \)).

Sdrinis et al. (2004) noted that e-DLs were faster to prepare and deliver and Cannaby et al. (2004) commented that implementing e-discharge systems reduced costs and operations associated with hospital discharge. As a result of easier preparation, e-DLs were shown to result in improved work practices of both doctors and nurses in primary and secondary care settings (Laerum, Karlsen and Faxvaag, 2004). In addition, handover using e-DLs supports the use of structured data, controlled vocabularies, clinical terminology bindings, improved legibility and European Health Record (EHR) standards. These are all essential prerequisites to enable semantic interoperability and improved patient safety and continuity of care (Stroetmann, 2009). Bludau et al. (2003) described the implementation of an e-DL system that supports some of these features.

### Box 1. Benefits of e-Discharge Letters

- Terminology bindings/ semantic description of data.
- Structured data.
- Controlled vocabularies.
- European Health Record (HER) standards.
- Seamless integration in EHR systems.
- Legibility.
- Faster generation – improved work practices and efficiency.
- Provide support across heterogeneous systems (e.g. between countries).
- Greater data protection security than paper discharge letters (electronic signature).
- Greater privacy than paper discharge letters.
- Can be used to monitor adverse events and medical error.
- Useful audit of in-patient information i.e. length hospital stay etc.
- Disease classification registry audits allow generation of valuable epidemiological data.

However, electronic discharge letters also pose certain challenges. Because of the lack of standardized international datasets for discharge letter content or standardized procedures, e-DL development has tended to be a localized process, limiting the interoperability of e-DLs to local or
national boundaries. Agreement on the use of available clinical terminologies e.g. ICD (International Classification of Diseases) (ICD, 2012), SNOMED-CT (Systematized Nomenclature of Medicine-Clinical Terms) (SNOMED, 2012) is yet to be reached, along with agreement on the area of European Health Record (HER) standards where openEHR archetypes, CEN (European Committee for Standardization) 13606 and HL7 (Health Level 7) are available (Lezcano et al., 2011; Schloeffel et al., 2011).

Electronic discharge letters do not necessarily imply higher quality letters. Callen et al. (2008) concluded that “electronic summaries may contain many more deficiencies than handwritten summaries”. Some health care providers decline electronic transmission of discharge letters because of the highly sensitive nature of the data (Schabetsberger et al., 2006). Some countries may even have privacy legislation that prohibits the electronic transfer of discharge summaries. Signature functionality must be integrated into the workflow surrounding document creation, ideally by using PKI (Public Key Infrastructure) (Brandner et al., 2002). Another disadvantage of electronic discharge letters is that the traditional handover process where the patient is the carrier of the discharge letter is generally not supported by electronic discharge systems.

Pillai et al (2004) found that 70% General Practitioners complained of inadequacies in content relating to medication and follow-up information in electronic discharge letters. Eighty percent agreed that they were faster and 68% felt significant cost savings could be made. Discharge content was considered more important than delivery method. Thus emphasis should be placed on ensuring standards are met on the quality and quantity of e-discharge documents.

A recent review on handover reviewed interventions to improve patient discharge from hospital to primary care (Hesselink et al., 2012). Identified interventions included electronic tools to facilitate quick, clear, and structured summary generation, use of electronic discharge notifications and web-based access to discharge information for general practitioners. Statistically significant effects were mostly found in reducing hospital use (for example, rehospitalizations), improvement of continuity of care (for example, accurate discharge information), and improvement of patient status after discharge (for example, satisfaction).

**The Electronic Discharge Letter (e-DL) Mobile Application**

An innovative electronic Discharge Letter (e-DL) mobile application was developed as part of the PATIENT project using international best practice guidelines on discharge letter content and knowledge gained from the CLAS project. The app uses Near Field Communication (NFC) to transfer an e-discharge letter from one phone to another (from hospital doctor’s phone to patient’s phone and subsequently from patient’s phone to family doctor’s phone). Mobile devices supporting Near Field Communication (NFC) technology are growing in popularity (e.g. Google Wallet) and the adoption of NFC standards will be a key feature of future e-DL mobile applications. The doctor extracts information from the patient’s electronic in-patient record and inputs it into the e-DL app. The digitally signed e-DL is sent to the patient’s mobile device through a simple NFC-based transfer that does not involve any kind of previous data exchange between peers. The patient’s app version is not able to modify the e-DL but can organize the letters and also provide multilingual and medical terminology support services.

Use of NFC in the e-DL app has a number of advantages:

- In contrast to bluetooth or internet-based messaging applications such as email, NFC doesn’t require pairing of devices before transfer of information, or sender/receiver addresses to be defined; the only requirement is a maximum distance of 4cm between devices.
- No internet connection is required and no setting up is required for transfer.
- NFC provides the same level of security and privacy protection as paper based discharge
letters, but in a digital context. In addition, the recommendations of Brandner et al. (2002) are followed by integrating Public Key Infrastructure (PKI) signature functionality into the e-DL app workflow.

• The eDL app can automatically give reminders about appointments and medications based on information digitally contained in the e-DL. Dalal et al. (2012) found that automated email notification was a useful strategy for managing results of tests pending at discharge.

• In contrast with centralized solutions, the patient is the carrier of the information. Patient empowerment is an increasingly important feature of 21st century healthcare.

CONCLUSIONS

The patient discharge letter is a very important element in the transfer of patient care at handover. The quality of discharge letters, however, is a cause for concern and discharge letters vary greatly in content and structure. Use of a letter-writing checklist mobile application (CLAS) can improve the overall quality, content, structure and clarity of hospital discharge letters written by medical students. Use of the CLAS application at point of practice may improve the quality of hospital discharge letters and has the potential to improve patient safety, though to date there is a lack of evidence to support this.

Mobile application offer exciting opportunities in medicine. The CLAS mobile application is a useful addition to the Handover toolbox and makes a valuable contribution to handover training. The CLAS mobile application is the first step in a suite of point of practice services for junior doctors to improve patient safety and minimise risk of medical error at handover. These applications focus on improving information transfer, the provision of clinical tools and the organization of knowledge resources so that patient care can be optimised, medical error reduced and a standard approach applied to handover communications.

Future studies need to address the benefits of the CLAS app in clinical practice. The challenge will be to demonstrate that an educational intervention such as CLAS improves patient safety. Studies linking the quality of discharge letters with hospital re-admission rates is one possible research option.

The future lies in electronic discharge letters using standardized datasets. Electronic discharge letters have the potential to quickly extract information about diagnoses, medications, and test results into a structured discharge document and offer many important advantages over current paper discharge letters, including reliability, speed of information transfer, data protection, and standardization of content. The added value of the NFC e-DL mobile application includes speed of information transfer, the ability to transfer the discharge letter to a variety of care-givers and patient empowerment as patients control the transfer of information. Standardization of datasets allow for improved quality of discharge letters and faster transfer of information across countries and continents. These developments are just the tip of the iceberg in the exciting quest to harness the vast potential of mobile communications and how we, as medical professionals, use technology to interact with each other and with our patients, and how patients use technology to manage their healthcare.
Acknowledgements

The work presented in this article has been carried out with European Commission funding support. More specifically, the work of Bridget Maher, Hendrik Drachsler, and Leonarod Lezcano was funded by the LLP PATIENT project (FP7- EAC/27/11 (2011/C 233/06) while the work of Marco Kalz and Marcus Specht was partly funded by the INTERREG IVa project EMuRgency (EMR INT4 1.2.-2011-04/070).

Word count = 7650


<table>
<thead>
<tr>
<th>Heading</th>
<th>Items included</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>• Personal patient data</td>
<td>A specific rating exists for identifying the name of the GP i.e. ‘Dear Dr Casey’ rather than ‘Dear Dr’.</td>
</tr>
<tr>
<td></td>
<td>• MRN (Medical Record Number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hospital</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ward</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Consultant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Speciality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Date of admission/speciality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• GP’s name</td>
<td></td>
</tr>
<tr>
<td>Problem List</td>
<td>Is there a problem list?</td>
<td>Ideally, problem list should be at beginning of letter.</td>
</tr>
<tr>
<td>History</td>
<td>• Reason for admission (presenting complaint)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• History presenting complaint (details)/other relevant history</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Past history</td>
<td></td>
</tr>
<tr>
<td>Clinical Findings</td>
<td>Pertinent clinical findings</td>
<td></td>
</tr>
<tr>
<td>Investigations</td>
<td>• Investigations done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Results of abnormal investigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Test results pending</td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td>• List of diagnoses</td>
<td>List of diagnoses and highlighting of new diagnosis.</td>
</tr>
<tr>
<td></td>
<td>• Identification and highlighting of new diagnosis</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Treatment/hospital/course/ complications</td>
<td>A brief summary of treatment and procedures, course of illness, and details of any complications.</td>
</tr>
<tr>
<td>Current status</td>
<td>Current status documented?</td>
<td>Is the patient well and ambulant or does he need help?</td>
</tr>
<tr>
<td>Medication</td>
<td>• List discharge medication? (score 4)</td>
<td>Medication mistakes are a major source of medical error and has been given higher scoring. All medications should be listed clearly and in formal units. Special mention should be made of medication that has been discontinued and why. New drugs commenced should be highlighted including duration of use.</td>
</tr>
<tr>
<td></td>
<td>• Dose written correctly? (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Any medication stopped and why? (score 2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• New medication commenced and why? (score 2)</td>
<td></td>
</tr>
<tr>
<td>Follow-Up</td>
<td>• Follow-up (Outpatient appointments)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Details of other appointment e.g., chiropody and who has to make the appointment (hospital or family doctor)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Need for specific blood tests (family doctor or hospital)?</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>• Information shared</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• What was explained and to whom?</td>
<td></td>
</tr>
<tr>
<td>Sign-Off</td>
<td>• Name, Title, Bleep no/phone no.</td>
<td></td>
</tr>
<tr>
<td>Clarity/writing style</td>
<td>• Unnecessary information (letter appropriate length for diagnosis?)</td>
<td>The CLAS scale has a 7-point checklist to help improve overall writing style, structure, clarity and ‘readability’.</td>
</tr>
<tr>
<td></td>
<td>• Structure -did the letter flow logically?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Will the reader understand all the abbreviations?</td>
<td></td>
</tr>
</tbody>
</table>
• Is the writing legible?
• Is there good use of headings?
• Readability - easy to read, good syntax, grammar.
• Clarity (easy to understand)

Figure 1: CLAS opening page

Figure 2: CLAS page 2.
Figure 3: Medication details

Figure 4: Final screenshot giving overall score
Table 2. Differences between CLAS scores - Demographic information

<table>
<thead>
<tr>
<th>Item</th>
<th>Address</th>
<th>MRN</th>
<th>DOB</th>
<th>Ward</th>
<th>Speciality</th>
<th>Date admitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>26</td>
<td>28</td>
<td>7</td>
<td>29</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>Post-CLAS instruction</td>
<td>40</td>
<td>39</td>
<td>32</td>
<td>36</td>
<td>36</td>
<td>39</td>
</tr>
<tr>
<td>P value</td>
<td>p&lt;0.001</td>
<td>P=0.001</td>
<td>p=0.007</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

Table 3. History, Clinical Findings, Investigations

<table>
<thead>
<tr>
<th>Problem List</th>
<th>Presenting Complaint (P/C)</th>
<th>History of Presenting Complaint</th>
<th>Past Medical History</th>
<th>Clinical Findings</th>
<th>List Investigations</th>
<th>Abnormal results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>2</td>
<td>31</td>
<td>22</td>
<td>13</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>CLAS</td>
<td>instruction</td>
<td>38</td>
<td>40</td>
<td>39</td>
<td>38</td>
<td>35</td>
</tr>
<tr>
<td>p value</td>
<td>p&lt;0.001</td>
<td>p=0.002</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>
Table 4. Diagnosis and Clinical Course

<table>
<thead>
<tr>
<th></th>
<th>List diagnoses</th>
<th>New diagnosis</th>
<th>Clinical course in hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>0</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Post-CLAS instruction</td>
<td>33</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>p value</td>
<td>p &lt; 0.001</td>
<td>p = 0.005</td>
<td>p = 0.002</td>
</tr>
</tbody>
</table>

Table 5. Current status, Follow-up and Sign-off

<table>
<thead>
<tr>
<th></th>
<th>Current status</th>
<th>Follow-up (OPD) appointments</th>
<th>Other appointments</th>
<th>Name of letter-writer</th>
<th>Title letter-writer</th>
<th>Contact details letter-writer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>2</td>
<td>23</td>
<td>21</td>
<td>27</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Post CLAS instruction</td>
<td>17</td>
<td>39</td>
<td>36</td>
<td>40</td>
<td>38</td>
<td>36</td>
</tr>
<tr>
<td>p value</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>