

# The CLAS App A mobile training tool to improve handover procedures between hospital interface and family doctors

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# The CLAS App

## *A mobile training tool to improve handover procedures between hospital interface and family doctors*

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### **ABSTRACT**

There is a high potential for mobile learning and support applications in the health domain. In this paper we introduce the CLAS App, a mobile application to support handover procedures based on the improvement of writing skills. Handover of patient care is a time of particular risk and it is important that accurate, reliable and relevant information is clearly communicated between one caregiver to another. Improperly conducted handovers lead to wrong treatment, delays in medical diagnosis, life threatening adverse events, patient complaints, medical litigation, increased health care expenditure, increased hospital length of stay and a range of other effects that impact on the health system. The CLAS App helps standardise and improve handover communication between hospital and community healthcare.

### **Author Keywords**

Mobile learning, health, patient safety, handover, standardization, human error, quality assurance, communication skills, writing skills.

### **INTRODUCTION**

Handover of patient care is a time of particular risk and it is important that accurate, reliable and relevant information is clearly communicated between one caregiver to another. Improperly conducted handovers lead to wrong treatment, delays in medical diagnosis, life threatening adverse events, patient complaints, medical litigation, increased health care expenditure, increased hospital length of stay and a range of other effects that impact on the health system. The World Health Organization (WHO) lists accurate handovers as one of its High 5 Patient Safety initiatives (Joint Commission on Accreditation of Healthcare Organizations, 2011). Training of handover skills would appear to be a promising approach to improve the quality of patient handover. However, the lack of handover training in undergraduate medical education and the need to address this deficiency has been succinctly elucidated (Gordon & Findley, 2011). Research has identified dissatisfaction amongst junior medical staff with current practices as a result of a lack of policies and appropriate training (Gordon, 2010). Moreover, in Europe, training in handover and patient safety is disjointed, lacks focus and there has been a failure to carry out sufficient research assessing appropriate educational strategies (Gordon & Findley, 2011; Reisenberg, Jaeger, Padmore, 2009; Johnson & Barach, 2009; Jeffcott et al., 2009).

Written communication is an intrinsic part of handover. Patients rely on the hospital discharge letter to communicate their 'story' as an in-patient to their family doctor. Their doctor relies on this letter to provide him with the information that he needs to take over the care of the patient. Yet, there is a lack of educational tools to help doctors improve written communications with their colleagues and their patients. To address this problem, the School of Medicine at University College Cork developed a 50-item rating scale (Cork Letter-Writing Assessment Scale - CLAS) to help medical students and doctors improve the quality of hospital discharge letters and thus improve information transfer at handover. Students can use the scale as an assessment tool to evaluate the quality of hospital discharge letters and as a reference checklist when writing discharge letters. The CLAS scale has been developed as a mobile application to support medical professionals at point of practice during the handover procedure.

In this article, we describe the CLAS handover mobile application (CLAS App) designed to standardise and improve handover communication between hospital and the community. The mobile application is designed as a digital checklist. In the next section (section 2), we introduce the added value of mobile applications for the health domain in general. In section 3, we present the rationale behind the Cork Letter-Writing Assessment Scale (CLAS) and present the conceptual checklist. In section, 4 we show the implementation of the CLAS checklist as a mobile application. Finally, we conclude with a summary of the main findings of our prototype study and future research opportunities and plans.

## **ADDED VALUE OF MOBILE APPLICATIONS FOR THE HEALTH DOMAIN**

Recent technological advances in a rapidly changing world have led to a seachange in how we communicate and interact. Social networking and mobile devices are powerful new platforms for 21st century communication. 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. Technology has made possible the rapid storage, retrieval and synthesis of information. Medical students and doctors increasingly use mobile devices to access everything from drug formularies to medical applications. Pocket textbooks and drug formularies have been replaced by mobile devices. The days of white coats bulging with textbooks and scraps of paper are a thing of the past. In a recent study at the University of Maastricht, selections of apps have been defined and evaluated in the practical worklife of medical advanced students (Donkers et al., 2011). The sets of applications evaluated have been defined based on a list of criteria and functionality that has been elicited from a context analysis. The functions identified include: a) doing specific calculations b) reference books for dedicated information c) evidence based medical information access d) case related information e) in-situ practices, e) personal learning environments.

In general, mobile applications can be powerful vehicle for the provision of information, checklists, formularies, clinical tools and assessment. They are, in effect, the doctor's little helper, always on hand, always constant, flexible, supportive, accessible and instant. They provide the information when it's wanted and where it's wanted, with speed and ease of access. Medical students have embraced mobile phones as a learning platform and they welcome mobile applications in medical education with enthusiasm. We do not have to persuade or convert medical students to this form of Technology-Enhanced Learning but rather, the students themselves are leading how medical education needs to be delivered, especially point of practice resources. In addition, mobile applications have the facility of being enabled to talk to each other, and can transfer information quickly and seamlessly. Besides the seamless access to information and computational assistance, mobile devices also can be seen as always present notification systems. New approaches in the area of context-aware computing also take specific context changes or triggers to notify relevant stakeholders and users of these changes and trigger consequent action. A comparable technique is also applied when using mobile devices to collect data in the field with methods as experience sampling which often plays an important role in field studies (Larson, 1983).

Beside the classical function of learning support, information access, and notification, mobile applications have particular promise at handover, when information transfer needs to be accurate, fast, and complete. The combination of mobile information for understanding and following defined procedures, the delivery of training and reflection tasks on site, and also the triggering of contextualized notification gives a unique opportunity to increase training and quality of handover procedures.

### **Related projects**

The development of the CLAS App benefits from two related projects that also address communication issues within medicine, the FP7 HANDBOVER and the EMuRgency projects. In the following sections, we will introduce the two projects and outline their main contributions to the CLAS App.

#### *The Handover project*

The first research project on handovers, the FP7 HANDBOVER (FP7-HEALTH-F2-2008-223409) project, acknowledges that training and learning are important means to encourage the implementation of accurate handover models and tools. It describes the training needs and therefore offers new and innovative learning and teaching tools such as the HANDBOVER Toolbox and its content, to change that situation (Johnson & Barach, 2009).

The HANDBOVER Toolbox is a learning network (Drachler, 2009) that acts like an online community of practice (Wenger, McDermott, Snyder, 2002) for medical professionals and especially young doctors and their trainers (see: [www.handovertoolbox.eu](http://www.handovertoolbox.eu)). This environment takes into account the diversity of solutions available and contains (a) information on standardized tools and ready to use tools to improve handover, (b) information on what needs to be taught and how to train handovers including ready to use training material, and (c) guidelines on how to take into account cultural and organizational issues when improving handovers. The Handover toolbox is available for all stakeholders who want to improve handover practices in their organization. It provides practical guidelines in the form of quality indicators that can be applied for decisions on the content of training, for selecting the most appropriate training design and for establishing favourable learning environments and tools that increase the effectiveness of the training.

However, this is only the first step in the design and delivery of training in handover. The final implementation phase in Europe's medical systems has only partly been achieved within the project. Further efforts and support is needed to implement the developed solutions into the medical education systems. We believe that the CLAS App can be a facilitator that can be used in handover training, connect to the provided contents and the community available in the handover toolbox. It therefore provides a supportive contribution to the current state-of-the-art training in handovers.

#### *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. The project combines several technological and educational innovations to reach this goal. Besides a notification system for first responders, the project develops educational support and training apps to help volunteers and medical staff in the memorization of facts,

activities and procedures to follow when conducting CPR. In this way, the project is also focused on improving citizen/patient safety through the use of mobile devices. Studies have shown the retention times of CPR training decrease after approximately 6 months. Through a combination of preparatory E-Learning, traditional courses in schools and mobile apps, we aim to offer flexible educational opportunities for people in the region and to increase retention times without formal training. In this sense, the EMuRgency project aims to both support performance and to assist preparatory learning, information transfer, and retention of learning knowledge and skills.

#### *The contribution of the CLAS project*

The CLAS project combines research aspects from both projects on a new topic. CLAS also tries to improve handover procedures through educational tools and standards like the FP7 Handover project. More specifically, CLAS aims to improve writing skills for discharge letters that are an important means for handover communication between hospital and community doctors. In contrast to the handover projects, it does not try to teach medical standards in any group settings but provides the target user with a mobile application to memorize and check the required aspects of a discharge letter with a mobile device. This approach is in line with the objectives of the EMuRgency project that follows a comparable approach using mobile learning opportunities to develop and sustain procedural knowledge for CPR training.

### **RATIONALE FOR THE CORK LETTER-WRITING ASSESSMENT SCALE - CLAS**

Communication, in particular written communication, is integral to handover and the hospital discharge letter is probably the most important of written communications between hospital and family doctors. 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). Medication, problem list, management plan and follow-up are particularly important. Incomplete or inaccurate information at handover can contribute to faulty medical decision-making or lack of adequate patient monitoring during follow-up (van Walraven et al., 2004).

#### **Quality of hospital discharge letters for handovers**

The quality of hospital discharge letters is variable (Kripalani et al., 2007). Most discharge letters are written by junior doctors as part of their many daily duties. Often a handwritten summary is given to the patient on the day of discharge and a typed full report follows at a later date. Computer-generated letters are increasingly available but may lack flexibility and may not include all important items. 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 GP 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 is difficult. Moore et al. (2003) found that handover errors occurred in around 50% of patients and were associated with a significantly higher risk of readmission. A recent review (Kripalani et al., 2007) found that primary care physicians generally rated the following information as most important for adequate follow-up care: main diagnosis, pertinent physical findings, results of procedures and laboratory tests, discharge medications with reasons for any changes to the previous medication regimen, details of follow-up arrangements made, information given to the patient and family, test results pending at discharge, and specific follow-up needs. However, audits of hospital discharge letters show that these details, along with other administrative and medical information, are frequently missing (Kripalani et al., 2007). Discharge summaries often did not identify the responsible hospital doctor (missing from 25%), the main diagnosis (17.5%), physical findings (10.5%), diagnostic test results (38%), discharge medications (21%), treatment or hospital course (7%-22%), and follow-up plans (14%) (Kripalani et al., 2007). The highest rates of missing information related to tests pending at discharge (65%) and counselling (information) provided to patients or families (91%) (Kripalani et al., 2007). Physicians 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).

#### **The importance of medical checklists and the CLAS approach**

Use of standardized formats has been shown to improve the quality of procedures within health and especially for interface procedures such as hospital discharge letters. Van Walraven et al. (1998) found that a standardized format with clear subheadings was better than narrative summaries (shorter, easier to access most relevant information) Rao et al. (2005) found that a standardized template for discharge dictations improved the quality and efficiency of dictations. 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.'*

*'In many cases of avoidable maternal death identified in the UK Confidential Enquiry, care was hampered by a lack of cross-disciplinary or cross-agency cooperation and communication problems, including poor or nonexistent cooperation between team members, inappropriate or inadequate telephone consultations, **failure to share relevant information between health professionals, including between GPs and the maternity team, and poor interpersonal skills.**' (WHO Patient Safety Curriculum Guide, 2011)*

Within the CLAS project, we developed the CLAS scale that aims to support students/junior doctors to reflect on their writing and the handover procedure. CLAS is an itemised checklist developed to help write accurate and clear patient discharge letters for handover procedures. This checklist includes key elements of the GP discharge letter as detailed in Table 1. The items are arranged in specific sections listed in the order in which they should ideally appear in the letter.

Table 1. Cork Letter-Writing Assessment Scale (CLAS)

<b>General</b>	<ul style="list-style-type: none"> <li>Personal patient data / GP's name</li> <li>MRN</li> <li>Hospital</li> <li>Ward</li> <li>Consultant</li> <li>Speciality</li> <li>Date of admission / discharge</li> </ul>	General details include basic demographic details such as name, address, date of birth, Medical Record Number (MRN), date of admission and date of discharge of patient. Other items include name of hospital, name of ward, name of consultant and speciality. A specific rating exists for identifying the name of the GP (General Practitioner of Family Doctor) i.e. 'Dear Dr Casey' rather than 'Dear Dr'.
<b>Problem List</b>	<ul style="list-style-type: none"> <li>Is there a problem list?</li> </ul>	A bulleted list of the patient's problems provides an immediate soundbyte of the patient's overall status. Ideally, the problem list should be at the beginning of the letter and highlighted in bold typeface.
<b>History</b>	<ul style="list-style-type: none"> <li>Reason for admission (presenting complaint)</li> <li>History of presenting complaint (details) and other relevant history</li> <li>Past history</li> </ul>	This section includes reason for admission (presenting complaint), history of presenting complaint (details) and other relevant history. Past medical history is included here. Current medication at time of admission can be listed here.
<b>Physical examination</b>	<ul style="list-style-type: none"> <li>Pertinent clinical findings appropriate to the case</li> </ul>	Only pertinent clinical findings appropriate to the case need mention.
<b>Investigations</b>	<ul style="list-style-type: none"> <li>Investigations done</li> <li>Results of abnormal investigations</li> <li>Test results pending</li> </ul>	List of investigations and abnormal results. It is important to mention test results that weren't available at time of discharge.
<b>Diagnosis/diagnoses</b>	<ul style="list-style-type: none"> <li>List of diagnoses</li> <li>Identification and highlighting of new diagnosis</li> </ul>	List of diagnoses and highlighting of new diagnosis.
<b>Treatment</b>	<ul style="list-style-type: none"> <li>Treatment/hospital course/ complications</li> </ul>	A brief summary of treatment given to patient, course of illness while in hospital, and details of any complications that occurred.
<b>Current status</b>	<ul style="list-style-type: none"> <li>Current status documented?</li> </ul>	The patient's family doctor needs to know the patient's current state of health and mobility. Is the patient well and ambulant on discharge or does he need help?
<b>Management Plan</b>	<ul style="list-style-type: none"> <li>Management plan listed? (score 2)</li> </ul>	The management plan is a key section and should clearly outline what further investigations/treatment are planned for the patient.
<b>Medication</b>	<ul style="list-style-type: none"> <li>List discharge medication? (score 4)</li> <li>Dose written correctly? (score 2)</li> <li>Any medication stopped and why? (score 2)</li> <li>Any new medication commenced and why? (score 2)</li> </ul>	Medication error is a major source of potential medical error and has been given higher scoring on the CLAS scale to reflect this. All medications should be listed clearly and written in formal units. In addition, special mention should be made of medication that has been discontinued in hospital and the reasons for this. New drugs commenced should be highlighted and whether they are to be continued as a regular medication or to be prescribed for a limited period only.
<b>Follow-up</b>	<ul style="list-style-type: none"> <li>Follow-up (Outpatients Department (OPD) appointments listed)?</li> <li>Details of other appointments and referrals e.g., chiropody and who has to make the appointment (hospital or GP)</li> <li>Need for specific blood tests - when and who (GP or hospital)?</li> </ul>	This section informs the GP if the patient is returning to the hospital Outpatients Department for review and when. Often a patient may have multiple follow-up appointments in different departments i.e., ophthalmic review, pulmonary function tests appointment, diabetic clinic appointment etc. Details of these appointments should be given and it should be made clear who has to make the appointment (hospital or family doctor). If a patient needs regular blood tests (e.g., for regulation of warfarin therapy), details of how often these need to be done and where (family practice or hospital) should be clarified.
<b>Communication of information to patient</b>	<ul style="list-style-type: none"> <li>Information shared</li> <li>What was explained and to whom? (patient or relatives).</li> </ul>	It is important that the patient's family doctor knows how much information was given to the patient (or the patient's family) about diagnosis, treatment and prognosis (especially in the case of terminally ill patients).
<b>Sign-Off</b>	<ul style="list-style-type: none"> <li>Name of letter-writer</li> <li>Title of letter-writer</li> <li>Bleep no. or phone no.</li> </ul>	Letters should end with the name, title (intern, registrar etc.), bleep number and contact details of the letter-writer.
<b>Clarity and writing style</b>	<ul style="list-style-type: none"> <li>Letter appropriate length for the diagnosis?</li> <li>Structure - did the letter flow logically?</li> <li>Will reader understand all the abbreviations?</li> <li>Is the writing legible?</li> <li>Is there good use of headings?</li> <li>Readability - easy to read, good syntax, grammar, spelling</li> </ul>	Finally, the CLAS scale has a 7-point checklist to help improve overall writing style, clarity and 'readability'.

## THE CLAS APP

Within the CLAS scale checklist, items are grouped in the various sections e.g., History, Physical examination. Touching the section check-box signifies completion of that group of items; touching an individual item signifies completion of that particular item. Items not ‘ticked’ appear at the end as a separate list of ‘unchecked items’. The CLAS App therefore functions as a quick checklist to be used at point of practice. The CLAS application also generates a total score before inviting the user to view his unchecked items.

All items score 1 point except for the five more important criteria for accurate handover procedures: 1. Management plan (2 points), 2. List of discharge medication (4 points), 3. Drug doses written in formal units and clearly written (2 points), 4. Names of any medication stopped and why (2 points), and 5. Names of any new medication commenced and why (2 points). These criteria reflect the particular importance of accurate transfer of medication information for the handover process. The point of the scoring system is to promote the quest for the ‘perfect score’ of 50. A letter scoring 40 may still be good discharge letter, but the objective is to attempt to write the ‘best possible’ discharge letter. Students also appreciate being able to increase their score as they become more familiar with the scale and positive feedback encourages good practice.

Another important use of the scoring system is that the CLAS App can be used to grade the quality of discharge letters in research projects. In addition, the integration of a scoring system into the app allows quantification of improvement in letter-writing when the CLAS scale is taught to medical students (CLAS intervention study).

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.

By using the CLAS scale 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 and optimizing handover practices. By increasing 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 application can be used to improve the quality of all referral letters (i.e. letters to other consultants, letters to physiotherapy etc) and can serve as a model of good written communication between care-givers.

The CLAS App display screen was designed to be simple, intuitive, and user-friendly. Figs 1 - 4 demonstrate the interaction flow within the app. The information icon is displayed on the top left of the screen, to avoid accidentally checking it while checking the section tick-box. The information page explains how to use the App and can be accessed at any stage in the process. The colours of the items fade when an item is checked, rather than changing in colour, as we found this design more visually acceptable to our pilot test users and more aesthetic as a screen display.

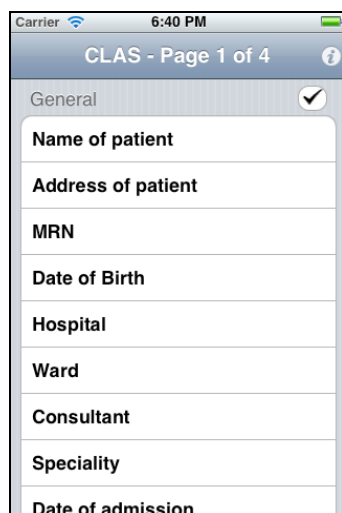


Figure 1: Screenshot of the CLAS App opening page.

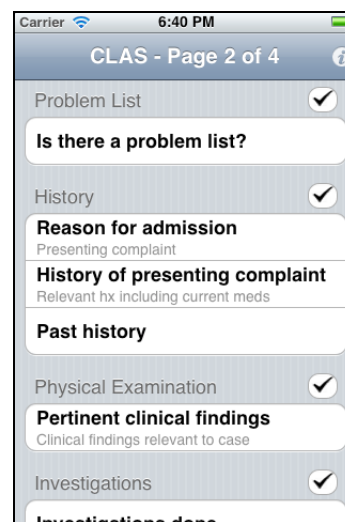
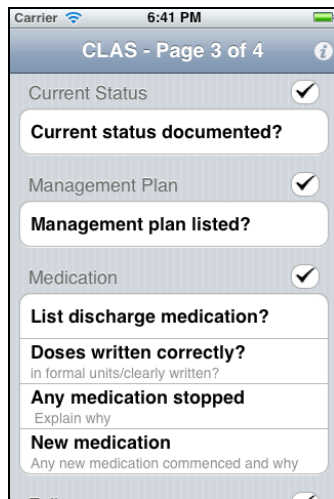
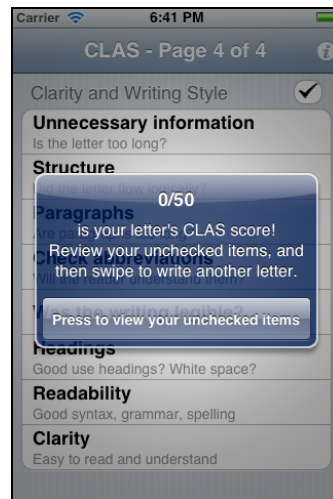


Figure 2: Screenshot of important content in a discharge letter.

During the development process of the CLAS App, we recognized the following issues. There is always a danger of overcrowding the screen and particular care has to be taken when transferring information from existing websites in order to condense the information as much as possible. Like good writing style, every word must earn its place on a mobile application. Even spaces are limited for each line, so wording has to be very succinct while remaining clear. Constantly re-writing and ‘tweaking’ of text according to user feedback on ease of use and clarity, is essential. Of course, mobile applications have the important advantage of being able to be modified and improved. New features can be added and problems fixed. Thus, mobile applications offer a dynamic, versatile and responsive component to 21<sup>st</sup> century learning.



**Figure 3: Screenshot of important medication details required for a discharge letter.**



**Figure 4: Final screenshot of the CLAS App providing overall CLAS score and prompting review of unchecked items.**

## **FUTURE RESEARCH AND DEVELOPMENT**

The CLAS mobile application is currently the basic of two research projects.

1. Assessment of the quality of 200 hospital discharge letters using the CLAS scale.
2. Assessment of the effect of the CLAS intervention on the letter-writing skills of 80 fourth year medical students.

### **CLAS Intervention Study**

In this study, 40<sup>th</sup> year medical students wrote a hospital discharge letter (based on fictional casenotes made available to the students prior to the teaching session). These students were then given instruction on using the CLAS scale to write a hospital discharge letter. Another group (40 students) received the CLAS instruction first, and then wrote the hospital discharge letter. The discharge letters were then graded using the CLAS scale and the results of the two groups compared.

### **Results**

Overall CLAS score in the control group was 26/50 and 42.5/50 in the intervention group. Instruction on the CLAS scale improved the overall CLAS score ( $p < 0.001$  -Mann Whitney U Test for non-parametric data).

Many individual items showed a statistically significant increased score in the intervention group. These items included all items in the medication group and management plan ( $p < 0.001$  using Mann Whitney U test).

The Chi-squared test was used for the remaining items; Address ( $p < 0.001$ ), MRN ( $p = 0.001$ ), DOB ( $p = 0.007$ ), Ward ( $p < 0.001$ ), Admission date ( $p < 0.001$ ), Problem list ( $p < 0.001$ ), Presenting complaint ( $p = 0.002$ ), Details of presenting complaint ( $p < 0.001$ ), Past history ( $p < 0.001$ ), Clinical Findings ( $p < 0.001$ ), List Investigations ( $p < 0.001$ ), Abnormal results ( $p < 0.001$ ), List Diagnoses ( $p < 0.001$ ), New diagnosis ( $p = 0.005$ ), Clinical Course ( $p = 0.002$ ), Current status ( $p < 0.001$ ), Follow-up ( $p < 0.001$ ), Other appointments ( $p < 0.001$ ), Sign off name ( $p < 0.001$ ), Title ( $p < 0.001$ ), Contact no./bleep ( $p < 0.001$ ).

In addition to actual content, structure ( $p = 0.014$ ) and clarity ( $p = 0.005$ ) of the letters improved after CLAS instruction and the students used headings more ( $p < 0.001$ ).

These results suggest evidence for the benefits of the CLAS scale as an educational tool to help medical students write hospital discharge letters.

The CLAS mobile application is relevant to handover in all healthcare transitions i.e nursing, mental health, physiotherapy. The principles of patient presentation - what the problem was and what was done about it, remain the same.

The CLAS application could be applied to health information technology systems to develop or revise patient discharge letter templates. Computer-assisted programmes have the potential to quickly extract information about diagnoses, medications, and test results into a structured discharge document. However, computer-generated reports always need clinician review and the addition of other information such as specific instructions regarding pending test results or the reasons why a particular medication was stopped. Ideally, information should be sent to the patient's family doctor in more than one way i.e. discharge letter given to patient and letter also emailed/faxed to doctor.

The CLAS scale 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. In addition to intern training, it can be used to teach medical students and also as part of induction and orientation training for junior doctors beginning new rotations. Key elements of good communication skills underlie the content of CLAS, thus it can also be used in communication skills training. The format of the CLAS mobile application is also being used to develop other point-of-practice healthcare checklists.

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 minimised and a standard approach can be used for handover communications.

Mobile applications such as CLAS offer exciting opportunities for improving patient safety and minimising medical error at handover and are just the tip of the iceberg with regard to harnessing the vast potential of mobile communications and how we, as medical professionals, interact with each other and more importantly, how we interact with our patients.

In the near future, we aim to further improve the CLAS App with typical mobile application features such as taking into account sensor information from the mobile device such as GPS coordinates and audio recordings. In addition, we want to make the CLAS App more interactive by enabling users to synchronise handover information, thus improving the quality of information transfer at handover.

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#### **REFERENCES**

- Alpers A. (2001). Key legal principles for hospitalists. *Am J Med.* 2001;111:5S-9S.
- Börner, D., Glahn, C., Stoyanov, S., Kalz, M., & Specht, M. (2010). Expert concept mapping study on mobile learning. *Campus-Wide Information Systems*, 27(4), 240-253.
- Drachsler, H. (2009). Navigation Support for Learners in Informal Learning Networks. October, 16, 2009, Heerlen, The Netherlands: Open University of the Netherlands, CELSTEC. SIKS Dissertation Series No. 2009-37. ISBN 9789079447312.
- Donkers, J., Kubben, P., Schols, A., Verstegen, D., Hoogland, H. (2011). Gebruik van Smartphones tijdens de Co-schappen. Conference Proceedings Onderwijs Research Dagen. Maastricht 2011. Downloaded on 31.5.2012 from [http://www.ord2011.nl/data/conference/1/papers/571-ORD2011\\_full\\_JDonkers.pdf](http://www.ord2011.nl/data/conference/1/papers/571-ORD2011_full_JDonkers.pdf)
- Glahn, C. & Specht, M. (2011). Structuring mobile and contextual learning. 10th World Conference on Mobile and Contextual Learning. Beijing, China, 18-21 October 2011.
- Sharples, M. (2006), Big Issues in Mobile Learning, Kaleidoskop Network of Excellence, Mobile Learning Initiative, Nottingham.
- Goldman L, Pantilat SZ, Whitcomb WF. (2001). Passing the clinical baton: 6 principles to guide the hospitalist. *AmJ Med.* 2001;111:36S-39S.
- Poon EG, Gandhi TK, Sequist TD, Murff HJ, Karson AS, Bates DW. (2004). "I wish I had seen this test result earlier!" *Arch Intern Med.* 2004;164:2223-2228.
- Coleman EA, Berenson RA. (2004). Lost in transition: challenges and opportunities for improving the quality of transitional care. *Ann Intern Med.* 2004;141:533-536.



- van Walraven C, Mamdani M, Fang J, Austin P. (2004). Continuity of care and patient outcomes after hospital discharge. *J Gen Intern Med.* 2004;19:624-631.
- Kripalani S, LeFevre F, Phillips C, Williams M, Basaviah P, Baker D. Deficits in Communication and Information Transfer Between Hospital-Based and Primary Care Physicians. Implications for Patient Safety and Continuity of Care. *JAMA.* 2007;297(8) 831-841.
- Moore C, Wisnivesky J, Williams S, McGinn T. (2003). Medical errors related to discontinuity of care from an inpatient to an outpatient setting. *J Gen Intern Med.* 2003;18:646-651.
- Harding J. (1993). Study of discharge communications from hospital doctors to an inner London general practice. *J R Coll Gen Pract.* 1987;37:494-495.
- Roy CL, Poon EG, Karson AS, Ladak-Merchant Z, Johnson RE, Maviglia SM, Gandhi TK. (2005). Patient safety concerns arising from test results that return after hospital discharge. *Ann Intern Med.* 2005;143:121-128.
- van Walraven C, Duke SM, Weinberg AL, Wells PS. (1998). Standardized or narrative discharge summaries: which do family physicians prefer? *Can Fam Physician.* 1998;44:62-69.
- Rao P, Andrei A, Fried A, Gonzalez D, Shine D. (2005). Assessing quality and efficiency of discharge summaries. *Am J Med Qual.* 2005;20:337-343.
- Joint Commission on Accreditation of Healthcare Organizations (2011). Root causes of sentinel events. <http://www.jointcommission.org/SentinelEvents/Statistics/>. [Accessed 17 December 2011.]
- Gordon M, Findley R. (2011). Educational interventions to improve handover in health care: a systematic review. *Medical Education* 2011;45:1081–1089.
- Gordon M. (2010). Handover in paediatrics. Junior perceptions of current practice in the northwest region. *Arch Dis Child* 2010;95(Suppl 1):69.
- Larson, R., & Csikszentmihalyi, M. (1983). The experience sampling method. *New Directions for Methodology of Social and Behavioral Science*, 15, 41-56.
- Reisenberg LA, Jaeger J, Padmore JS. (2009). Residents' and attending physicians' hand-offs: a systematic review of the literature. *Acad Med* 2009;84:1775–87.
- Wenger, E., McDermott, R., Snyder, W., (2002) *Cultivating communities of practice: a guide to managing knowledge*. Harvard Business School Press, 2002.
- WHO Patient Safety Curriculum Guide. Published October 2011. Available at:  
<http://www.who.int/patientsafety/education/curriculum/en/index.html> [Accessed 29 May 2012.]