ISSN 1753 - 044X

IJOCS

DOCENDO AC DISCENDO

Volume 3 Issue 3
September 2009

INTERNATIONAL JOURNAL OF CLINICAL SKILLS

A Peer Reviewed International Journal for the Advancement of Clinical Skills

- 'docendo ac discendo' - 'by teaching and learning'

In this issue:

Executive Board

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Published by SkillsClinic Ltd.

Acknowledgements

I would like to take this opportunity to show appreciation to all those involved with the production of the International Journal of Clinical Skills (IJOCS). Many thanks to all members of the Editorial and Executive Boards. A special thank you Dr Ronald Woro and Dr Dora Affam for their inspirations.

Our sincere gratitude for the kind support from Sir Liam Donaldson, the Chief Medical Officer for England, United Kingdom.

The International Journal of Clinical Skills looks forward to contributing positively towards the training of all members of the healthcare profession.

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Foreword

A Message from the Chief Medical Officer for England, United Kingdom

The systematic and safe acquisition of high quality clinical skills is an essential part of modern medical training as highlighted in my Annual Report published in March 2009. I wish the International Journal of Clinical Skills every success in highlighting research and knowledge in this important area.

Sir Liam Donaldson
The Chief Medical Officer for England

Video compression and assessment of basic life support skills

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Keywords:
Clinical skills assessment
E-Portfolio
Resuscitation
Video compression
Basic Life Support
Medical education

Abstract

Introduction: a video of students performing clinical skills is very useful for teaching, learning and assessment. Optimal utilisation of videos requires these media files to be transferred between staff and students through the web and to be stored. Video compression is required because access to high-speed broadband is not universal and there are additional factors limiting file transfer.
Methods: videos of students (n=65) performing basic life support (BLS) for approximately 3 minutes on a Resusci® Anne with SkillReporter™ were viewed by 5 assessors. Videos were presented as original data files, approximately 30MB, 10MB, 5MB and 2MB files. Assessors rated the students' performance as acceptable, unacceptable or unable to assess (based on image quality).
Results: the ability to assess performance from the video was compared for the four file sizes and only compression to 2MB was significantly different to the uncompressed video ($p < 0.001$).
Conclusion: current technology allows short video files to be compressed for transfer and storage through the web and still be useable for assessment or inclusion in an e-Portfolio; but there is a limit. This allows healthcare students and postgraduates, even in areas without high speed broadband, to access opportunities for feedback on performance and to track their skills development.

Introduction

All medical students should become competent in Basic Life Support (BLS) and in many elements of Advanced Life Support (ALS) during their course. They should also be confident in their ability to provide this care in an emergency, but know the limits of their knowledge and skills. Unfortunately, there have been several reports that resuscitation teaching is not achieving desired outcomes with many new medical graduates not competent or not confident in their knowledge and skills [1, 2, 3]. It is not immediately clear whether this problem arises through teaching (or lack of), learning or assessment, although where teaching has been studied BLS trainers frequently depart from the curriculum and trainees often pass testing even when performance is poor [4].

Over several years we have made a systematic effort to improve the quality and consistency of resuscitation teaching and assessment and have adopted many of the recommendations of the "Advisory Statement" from the International Liaison Committee on Resuscitation (ILCOR) on Education in Resuscitation [5]. The steps taken have included dividing teaching BLS into four separate sessions, training the trainers, using simulation to present varied and challenging resuscitation scenarios after each skills training session, separating teaching and assessment, documenting explicit performance criteria (competencies) for passing the assessment, using instrumented patient simulators for training and assessment, video-recording the CPR assessment, and offering students expert feedback on performance.

Resuscitation training during undergraduate medical education should be the foundation of life-long and career-wide learning.

Successful engagement with this process requires well-developed skills in self-evaluation in order to identify training need, but there are also reports that medical students [6] and health professional trainees are not able to do this well [7]. When an individual overestimates their abilities they are less likely to seek to improve (and may even be resistant to teaching) and when they underestimate them, they are reluctant to use them on patients.

We are now providing an e-Portfolio (PebblePad) for students to collate evidence of achievement in acquiring acute care skills throughout the course and to reflect on their abilities so that over time they can demonstrate that they can self-regulate (i.e. identify gaps in knowledge and skills and respond appropriately) [8]. This requires students to be able to acquire a video of their performance, store it in a secure space, link it to other items (such as a commentary on their effort or competency profile), share the video with others (such as a tutor or assessor) and be sure they and the others can always access this information. The ILCOR "advisory" [5] included the recommendation that "video should be recognised and more widely adopted as a useful assessment tool for research and quality control purposes, to be used with objective mechanical measurements".

Whilst high-speed broadband has been (or is being rolled out) in many countries, availability is often limited outside cities, cost can still be an issue and actual download and upload speeds are frequently less than those advertised by carriers [9]. This means that there may be difficulties moving video files between computers through the web. A standard definition digital video file is typically around 10 megabytes (10MB) per minute so even a short video clip is too large to be sent as an e-mail attachment. Other limitations on transfer of large files can come from bandwidth of internet connections, upload limits on data, file size limits of software and even download quotas from education institutions. Video files can be compressed but at the cost of reduced image and/or audio quality. We have investigated if a video file could be compressed to a size compatible with the technological limits currently faced by our students and still be used in assessment of resuscitation skills and be a worthwhile asset in an e-Portfolio.

Methods

The study was designed to determine to what level videos could be digitally compressed before the quality became so degraded that the videos could no longer be accurately assessed. We reviewed several video clips of students undertaking BLS and determined that a 3 minute video clip would allow assessment of BLS skills. The videos were recorded when the students were being assessed on BLS. The clinical scenario was coming across a person collapsed in a hospital corridor who was not showing any signs of life. The patient simulator used was a Resusci®Anne with SkillReporter™ (www.laerdal.com) with the actual "SkillReporter" deliberately placed to appear in the frame to facilitate assessment of external cardiac compression and artificial ventilation (Figure 1).

Figure 1: The assessment setting showing position of the 'SkillReporter' in the camera view. Some loss of detail through blurring caused by lossy compression can be seen in this image

We calculated that sixty-five videos viewed by 5 assessors provides 80% power at a two tailed type I error of 0.05 to detect degraded information if 15% of videos are 'not assessable' in a compressed format but assessable in the original (uncompressed) format, assuming that only 1% of videos are not assessable in the uncompressed format but assessable in compressed format.

The Flinders University and Southern Adelaide Health Service Social and Behavioural Ethics Committee approved the study and 65 students from the 2007 cohort of first year medical students at Flinders University gave written consent for the video recording of their BLS assessment to be used. A 3 minute video was around 30MB. We compared this file size with 20 MB, 10MB, 5MB and 2MB. These sizes were determined based on the maximum size of file permitted for upload on the PebblePad e-Portfolio (10MB), the maximum file size allowable as an attachment on the university's e-mail system (5MB), and file size that could be uploaded on a slow internet connection. A 20MB compression was also included to allow for anticipated improvements in software and data transfer rates through greater access to broadband.

Video and audio were captured using camcorders connected via a composite audio/video cable to a Digital Video Recorder (DVR). At the end of each session they were written to DVD as MPEG2 files. For compression, video files were 'ripped' using *Handbrake* (http://handbrake.fr/), an open-source, GPL-licensed, multiplatform, multithreaded DVD to MPEG-4 converter, on a Mac mini. Files were ripped into mp4 (video) and ACC (audio) with the bitrate and frame size manipulated to achieve the required file size. All of the video clips were deinterlaced when ripped. Compression of the files to 2MB from the ripped raw files required the use of another piece of software, *Sorenson Squeeze* (www.sorensonmedia.com/products/?pageID=1&ppc=3

Sorenson Media 2008). File sizes, frame sizes and bitrates for each of the compression levels are summarised in Table 1.

Table 1: Frame size and bitrate used to compress the video in each file size

File Size	Frame Size (pixels)	Bitrate (kbps)
Raw (30 MB)	720 x 576	1000
20 MB	352 x 288	780
10 MB	352 x 288	325
5 MB	352 x 288	100
2 MB	160 x 120	48

The video files were renamed using an alphanumeric code to ensure anonymity of subjects. The codes were then randomised using the random number generator in *Microsoft Excel* (Microsoft Excel Microsoft Corporation 2009) and separated into five groups of sixty five videos, a total of 325 individual files.

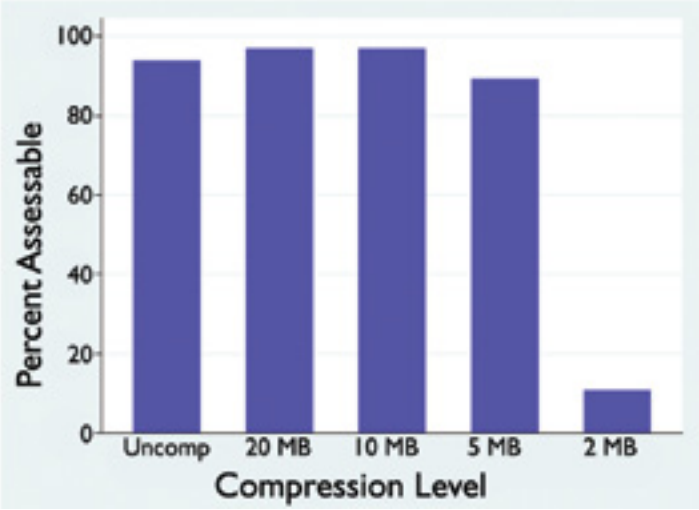
Five assessors involved with teaching BLS were recruited to review the videos. Every effort was taken to ensure that the assessors did not know the identity of the student performing the BLS. None had been involved in teaching or assessing BLS with these students and they had not previously seen the videos. Assessors each received 65 videos in a combination of file sizes. In some cases an assessor would have received multiple versions of the same video but at different compressions. The assessors were instructed to view the videos at a consistent screen size, utilising the 'double view' function on the *Quicktime* viewer (V. 7.5 ©1991-2009 Apple inc). This ensured that each video was viewed on the same size for consistency among assessors. Assessors then scored each video using a BLS Marking Sheet based on that published for ILCOR [5].

Each assessor scored the skills performed on video as "Pass", "Fail" or "Not assessable". The proportions of "Not assessable" videos at each compression level were compared to the proportion in the uncompressed video using McNemar's test.

Results

Each of the five assessors viewed 65 videos with a mixture of file sizes (uncompressed, 20MB, 10MB, 5MB and 2MB). Of the 325 files viewed, assessors rated 73 as 'Not assessable' and most of those (58/65) were 2MB file size. In that group only 10.8% (95% CI 4.4% to 20.9%) were assessable compared with 93.8% (95% CI 85.0% to 98.3%) in the uncompressed files (Figure 2). McNemar's tests showed that only the 2MB compression had significantly lower level of 'assessability' than the uncompressed video ($p < 0.001$).

Figure 2: Comparison of video files that could be assessed in each file size



There was some heterogeneity among assessors but this could only be explored in the 2MB file size where there were an appreciable number of video files that were 'Not assessable'. The differences between the assessors are reported in Table 2. One assessor (Assessor 1) appeared to be less demanding than the others, being able to assess 5 of 11 videos. Differences among assessors were significant (Fisher's exact analysis = 0.003).

Table 2: The numbers of videos judged "assessable" or "not assessable" by each assessor

Assessor	Not Assessable	Assessable	Total
1	6	5	11
2	12	0	12
3	13	0	13
4	10	1	11
5	17	1	18
Total	58	7	65

Discussion

Results of this study show that a 3 minute video can be compressed to 5MB, but not 2MB, without important loss of information. This is useful information for those planning to use digital videos for education, training and assessment. We have to work within technological and financial constraints such as bandwidth and storage available to the organisation and to individual users that restrict the transmission of videos and limit the size and number of files on a server. These results show how far compression can be taken and still allow valid assessment of BLS. While there was some heterogeneity among assessors in determining whether a video was assessable, this would not have introduced bias as videos were randomly assigned to assessors.

Currently, videos need to be compressed for transfer through the web and for web-based storage. When videos can be easily transmitted it allows flexibility in assessment and feedback to fit in with experts' schedules and it facilitates training for students and trainees in rural or remote areas. This decoupling of temporal and geographical proximity from the point of training or care has important implications for medical education and quality assurance in assessment. Subjective judgements about depth of compression and volume of ventilations cannot be relied on and reliable video assessment, like assessment on the spot, requires a patient simulator containing mechanisms to measure ventilations and compressions like the one we used [10].

Compression of digital video and audio is very complicated with many inter-related factors. The Moving Picture Experts Group (MPEG) is an international organisation established to develop standards for video and audio formats. The different standards are designed for particular applications and bit rate, for example, MPEG-2 designed for video compression for transmission and DVDs [11]. Most compression involves some loss of information (lossy compression) and generally more compression leads to greater loss of detail when the file is uncompressed. Some compression is performed 'at source' in the digital camcorder, typically using the DV (digital video standard). It is possible that compression undertaken with different software for compression and settings (e.g. of bit rate) video and audio recordings, would lead to different file sizes and results. However, the hardware and software we used is typical of that widely used in education settings.

We introduced off line/remote assessment to have a single assessor for consistency of assessment and this then revealed how much concentration is required by the assessor on the spot, who also has to supervise the scenario. BLS has many steps and processes and assessing resuscitation technique, timing and progress, even with instrumented manikins, requires sustained mental effort [10]. Assessment from videos also requires the information from the manikin to be available to the assessor. The ability to identify features of the SkillReporter™ influenced the decision on whether the compression had removed too much detail to be "assessable". Poor image quality is seen as blurring, blocking and edge distortion. Low bitrate has an additional adverse impact on "assessability". The subjective opinion of multiple viewers has been widely used in quality assessment of video-codecs [12]. Objective measures of video quality have been developed, but these do not always correlate with perceived quality at the lower bit rates and lower frame rates [12] which is the region of video compression investigated here.

Performance improvement in psychomotor skills requires both deliberate practice and expert feedback [13] and videos allow the learner to see exactly what the teacher is commenting on. Memory is fallible and students and trained health professionals often believe they have done something or done it well, when this is in fact not case. Mackenzie et al observed that emergency care providers viewing videos of themselves identified performance errors they could not recall making [14]. An investigation of unnecessary interruptions of cardiac massage during simulated cardiac arrests revealed many staff did not notice departures from BLS guidelines [15]. This is important because when a student or trainee overestimates their ability, they will be resistant to corrective feedback. Most trained health professionals, like students and trainees, are not very good at self-assessment of resuscitation skills [8, 10, 15 16]. Critical reflection on practice is the basis for developing competence, [17] so self-assessment needs to be included in resuscitation training. Structured procedural skills training can improve self-evaluation [18].

Ultimately, we want our students to own their videos and use them to identify areas for improvement and to document reflection on their videos in their e-Portfolio [8]. Many medical courses are adopting on-line portfolios for students to aggregate information about their studies, other professional activities and to present achievements. Student performance in simulated patient encounters has been identified as a key component of assessment of learning outcomes for the competent and reflective practitioner. Over time we hope the students will be able to demonstrate, through their e-Portfolio, that resuscitation and acute care skills have improved over time in response to tutor feedback and increasingly through self-evaluation [19].

Conclusions

Students can upload video files of clinical skills being performed to an e-Portfolio and use this as evidence of achievement. Video files can be compressed greatly to facilitate transfer through the web and storage. However, there is a limit to the compression that can be undertaken, thereby leaving a file that can still be used for assessment of BLS and as an asset in an e-Portfolio.

Acknowledgements

The authors thank the students who agreed to allow their videoed BLS performances to be used for this research, to the assessors of the videos (Kurt Domuracki, Lesley-Ann Hall, Heather Gray, Maria Perez-Marrero and Maria Cimeljeski) and to Lynn Sanderson for helping with the video compression.

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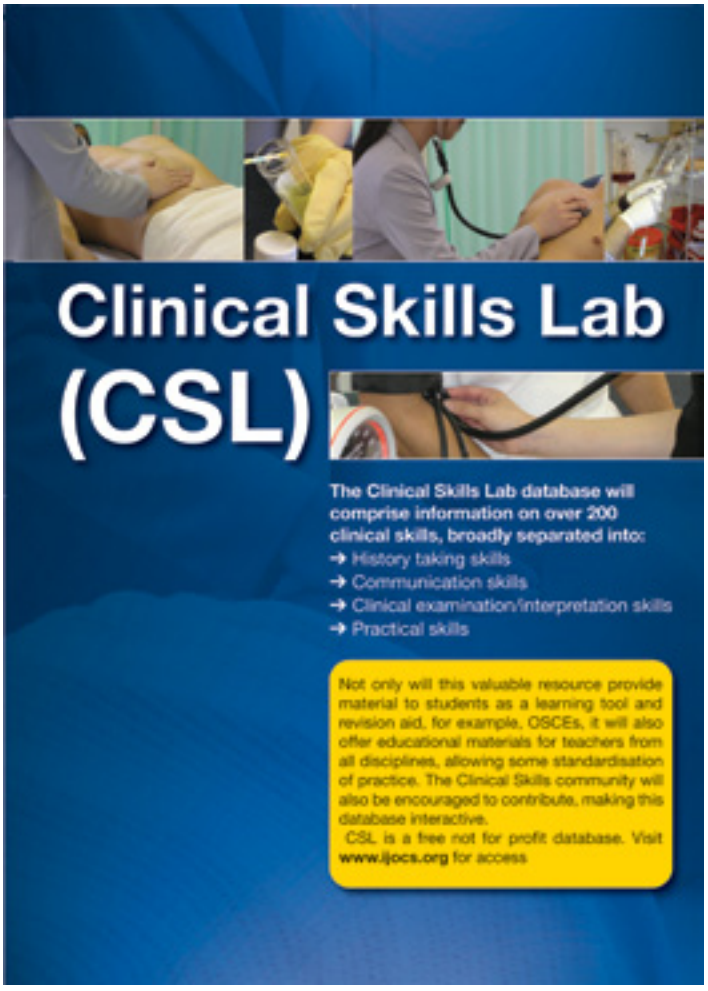

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