


Online training improves medical students' ability to recognise when a person is dying: The ORaCIES randomised controlled trial

Palliative Medicine
2020, Vol. 34(1) 134–144
© The Author(s) 2019



Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/0269216319880767
journals.sagepub.com/home/pmj



Nicola White^{1*}, Linda JM Oostendorp^{1*}, Christopher Tomlinson², Sarah Yardley^{1,3}, Federico Ricciardi^{1,4}, Hülya Gökalp^{5,6}, Ollie Minton⁷, Jason W Boland⁸, Ben Clark⁹, Priscilla Harries^{6,10**} and Patrick Stone^{1**}

Abstract

Background: Recognising dying is a key clinical skill for doctors, yet there is little training.

Aim: To assess the effectiveness of an online training resource designed to enhance medical students' ability to recognise dying.

Design: Online multicentre double-blind randomised controlled trial (NCT03360812). The training resource for the intervention group was developed from a group of expert palliative care doctors' weightings of various signs/symptoms to recognise dying. The control group received no training.

Setting/participants: Participants were senior UK medical students. They reviewed 92 patient summaries and provided a probability of death within 72 hours (0% certain survival – 100% certain death) pre, post, and 2 weeks after the training. *Primary outcome:* (1) Mean Absolute Difference (MAD) score between participants' and the experts' scores, immediately post intervention. *Secondary outcomes:* (2) weight attributed to each factor, (3) learning effect and (4) level of expertise (Cochran–Weiss–Shanteau (CWS)).

Results: Out of 168 participants, 135 completed the trial (80%); 66 received the intervention (49%). After using the training resource, the intervention group had better agreement with the experts in their survival estimates ($\delta_{MAD} = -3.43$, 95% CI -0.11 to -0.34 , $p < 0.001$) and weighting of clinical factors. There was no learning effect of the MAD scores at the 2-week time point ($\delta_{MAD} = 1.50$, 95% CI -0.87 to 3.86 , $p = 0.21$). At the 2-week time point, the intervention group was statistically more expert in their decision-making versus controls (intervention CWS = 146.04 (SD 140.21), control CWS = 110.75 (SD 104.05); $p = 0.01$).

Conclusion: The online training resource proved effective in altering the decision-making of medical students to agree more with expert decision-making.

Keywords

Medical education, palliative care, dying, prognosis, decision-making

What is already known about the topic?

- Recognising dying is a core clinical skill.
- There is inconsistent training in the United Kingdom and both medical students and doctors report feeling unsure and ill prepared when working with a dying patient and their family.

¹Marie Curie Palliative Care Research Department, Division of Psychiatry, University College London (UCL), London, UK

²Bioinformatics Data Science Group, Imperial College London, London, UK

³Central and North West London NHS Foundation Trust, London, UK

⁴Department of Statistical Science, University College London (UCL), London, UK

⁵Department of Electrical and Electronics Engineering, Ondokuz Mayıs University, Samsun, Turkey

⁶Department of Clinical Sciences, Brunel University London, London, UK

⁷Brighton and Sussex University Hospitals NHS Trust, Brighton, UK

⁸Hull York Medical School, Hull, UK

⁹Imperial College Healthcare NHS Trust, London, UK

¹⁰Centre for Applied Health and Social Care Research, Faculty of Health, Social Care and Education, Kingston University and St George's, University of London, London, UK

*Nicola White and Linda JM Oostendorp are joint first authors.

**Priscilla Harries and Patrick Stone are joint last authors.

Corresponding author:

Nicola White, Marie Curie Palliative Care Research Department, Division of Psychiatry, University College London (UCL), 6th Floor, Wing B, Maple House, 149 Tottenham Court Road, London W1T 7NF, UK.
Email: n.g.white@ucl.ac.uk

What this paper adds?

- Our study suggests that the online training resource can alter what information medical students review, to make decisions more like that of the experts.

Implications for practice, theory or policy

- This online training resource could be used to facilitate learning in this complex area, and provide a complementary education approach to clinical training.

Introduction

Predicting survival is a key clinical skill for doctors.^{1,2} Accurate recognition of dying in acute hospitals can enable timely discharge to a preferred place of death, reduce unnecessary interventions and enable the dying person to spend time with their loved ones.³

The General Medical Council (GMC)⁴ oversees medical training in the United Kingdom. It recommends that all medical schools teach students about palliative care and caring for patients who are dying as part of their curriculum. There is little to no specific training in the clinical skill of prognostication embedded in medical school curricula.^{5–7} Undergraduate palliative care training has been implemented inconsistently across the United Kingdom^{1,8–11} with newly qualified doctors still reporting feeling unsure and ill prepared when caring for a dying person.¹² A key recommendation from the ‘More Care, less pathway’⁵ report was for NHS England and Health Education England to collaborate and to promote ‘*evidence-based education and competency training for professionals working with people at the end of their lives . . . to ensure competency [in the diagnosis of dying]*’.⁵

In a previous study, we identified a group of expert palliative care doctors and asked them to review a set of hypothetical patient summaries, or ‘vignettes’. From these experts’ responses, we developed an online training resource to provide education in the skill of recognising dying.¹³ This resource was very simple, non-interactive, containing mainly text and diagrams. Similar online training resources have been shown to improve clinical skills of health care professionals in other subject areas.^{14–16} The aim of this trial was to determine whether this newly developed training resource can help to improve the way that medical students recognise dying patients by bringing their decision-making process into closer alignment with palliative care experts.

Primary objective

- To measure whether probabilities of death estimated by medical students who receive training in identifying dying patients are nearer to expert estimates than those who have not received training.

Secondary objectives

- To determine if the medical students become more consistent and discriminatory in their prognostic decision-making.
- To examine if, after receiving training, medical students weight the information presented in the vignettes more similarly to the experts.
- To determine if the training effect is maintained after 2 weeks, when the training resource has been withdrawn.

Methods

This trial follows the CONSORT 2010 guidance.¹⁷ The checklist can be found in Supplementary File 1. The study protocol¹⁸ was registered prospectively on the ClinicalTrials.gov registry (identifier: NCT03360812) on 4 December 2017. This trial received ethical approval from the UCL Research Ethics Committee (8675/002) on 19 January 2018.

Trial design

An online multicentre double-blind randomised controlled trial using a 1:1 allocation ratio.

Patient and public involvement

Two medical students in their fourth year of medical school reviewed all study documents and piloted the website. Their comments on both the content and usability of the website were incorporated into the final study documents.

Participants

Penultimate or final year medical students from five UK medical schools were contacted. Students were approached either as part of a palliative care lecture, workshop or by email.

Intervention

The intervention group received the online training resource (see Supplementary File 2). The content of the

Practice Patient Summary : 1 of 1

The patient you are assessing is a 64 year old woman who was admitted to the hospice 4 days ago. She has a diagnosis of metastatic incurable cancer. The senior hospice doctor has confirmed there are no reversible causes for her condition and that she is likely to die within the next two weeks. As the junior doctor at the hospice, you have been asked to see her and assess whether or not you think she will die within the next 72 hours.

The results of your assessment are shown below. You can read a description of the symptom by using your mouse to hover over the type of symptom.

On assessment:	
Secretions	There are no audible respiratory secretions.
Rate of decline	Her global condition has rapidly declined over the last 24 hours.
Peripheral Cyanosis	There is no evidence of peripheral cyanosis.
Breathing	You can see that the patient is experiencing Cheyne-Stokes breathing.
Urine Output	You notice that the urinary output hasn't reduced in the last 24 hours.
Richmond-Agitation Sedation Scale (RASS)	Her RASS score is +1.
Palliative Performance Scale (PPS)	Her palliative performance score is 40%.

What do you think the probability is that this patient will die in the next 72 hours?

Submit →

Your estimate in %

Figure 1. Sample patient summary.

resource described how a group of expert specialist palliative care doctors prioritised the various pieces of prognostic information.¹³ Participants randomised to the control group received no training materials and were encouraged to continue on to the second set of vignettes.

Procedure

The participant timeline can be seen in Supplementary File 3. After providing electronic consent, participants were asked to provide demographic information about themselves and any experience with palliative care at baseline ($t=0$). They were asked to provide their university email address so the study team could validate their attendance at the medical school and send out invitations for the follow-up assessment, gift vouchers and reminders if necessary. Students could also use their email address to log out and return to the trial website.

Participants were asked to complete the pre intervention ($t=1$) and post intervention ($t=2$) assessments. Both assessments could be completed immediately after baseline ($t=0$). Pre intervention ($t=1$), participants reviewed 40 patient vignettes, and provided a probability of death within 72 hours (0% certain survival – 100% certain death). Within these 40 vignettes, 10 were repeats, included in

order to assess the participants' level of expertise (see 'Secondary outcomes' for more detail). Post intervention ($t=2$), participants reviewed 26 further vignettes (including six repeats). The participants in the intervention arm were able to re-access the training resource while providing a probability of death during ($t=2$). At the 2-week follow-up ($t=3$) participants repeated the ($t=2$) task but without access to the training tool. Each participant had 4 weeks to complete this final ($t=3$) assessment.

Participants were offered £30 online gift vouchers (£10 at $t=2$, £20 at $t=3$). At the end of the trial, they were able to download a certificate of completion.

Vignette development

The vignettes were generated using IBM SPSS.¹⁹ An example vignette is shown in Figure 1. Items reported in the vignette are displayed in Table 1.

Outcomes

Primary outcome. The continuous percentage estimate (0%–100%) provided in response to, 'What do you think the probability is that this patient will die in the next 72 hours?' for each vignette in the second set ($t=2$).

Table 1. Data presented in the vignettes.

Variable	Measure
Palliative Performance Score (PPS)	10% (bed bound and requires all care) to 100% (fully independent)
Presence of Cheyne–Stokes breathing	Yes/no
Richmond Agitation–Sedation Scale (RASS)	–5 (unarousable to voice or touch), 0 (alert and calm) up to +4 (combative)
A rapid decline in condition over the last 24 h	Yes/no
Noisy respiratory secretions	Yes/no
If peripheral cyanosis was evident	Yes/no
A reduction in urinary output	Yes/no

Secondary outcomes. The percentage estimates from ($t=3$) were used to determine if there was any maintenance effect of the training intervention.

Individual cue (the pieces of information presented in the vignettes) weightings were compared against the experts' cue use. This was measured at all three time points.

Participants' level of expertise was assessed with the Cochran–Weiss–Shanteau (CWS) index²⁰ of expertise using the repeat vignettes ($t=1$, $t=2$ and $t=3$).

Sample size

Assuming a common standard deviation, 80% power and using a two sample t -test at the 5% significance level, a sample size of 128 (64 per arm) was needed to detect a medium effect size (Cohen's $d=0.5$) between the intervention and the control group. We anticipated a dropout rate of approximately 30% based on previous work¹³ so we estimated that a sample size of 183 participants would be required to obtain 128 complete cases.

Randomisation

A computer-generated blocked randomisation list (with a block size of 10) was created by a member of the team not involved in recruitment or analysis (CT). Participants were able to self-enrol on to the trial at any convenient time and the website database automatically allocated the participant to one of the groups using the randomisation sequence.

Blinding

The participants and most of the researchers (L.O., N.W., F.R., H.G., P.S., P.H. and S.Y.) were blind to allocation.

During recruitment, only three researchers (C.T., L.O. and N.W.) had access to the online database and were able to see which group each participant had been assigned to; coded as either 1 or 0 (the allocation of these codes were unknown to L.O. and N.W.). This access allowed the researchers to assess if the randomisation process was successfully balancing participants between

groups and to end recruitment when the required sample size was achieved. Only once recruitment had ended, the database had been checked and locked, and the analysis had been completed and discussed, was the allocation revealed. Participants were blind to allocation. The information sheets for the trial informed participants that they would receive training in one of two formats. Those randomised to the control group were not informed that this was not the intervention group. This low level of deception was deemed necessary in order to reduce the risk of attrition in the control group. This deception and the use of gift vouchers were approved by the ethics committee.

Adverse event recording

This was a very low-risk online educational intervention. No adverse effects were recorded.

Statistical methods

A detailed statistical analysis plan is available to view on ClinicalTrials.org (NCT03360812). To prevent ordering effects, the vignettes were presented in a random order for each participant. The order in which the cues were presented was also randomised, but held consistent for each participant to reduce the burden of participation. The analysis was performed by the trial statistician (F.R.) and the analysis of the primary outcome was repeated by an independent statistician. A per-protocol analysis was conducted for this proof of principle study.

Primary outcome analysis

For each participant, to estimate the degree of agreement between the participants' predictions about the probability of dying and the experts' reference values at each time point, the Mean Absolute Difference²¹ (MAD) was calculated as

$$MAD_i^{(t)} = \frac{\sum_{j=1}^{j^{(t)}} |X_{ij}^{(t)} - T_j^{(t)}|}{j^{(t)}}$$

where $X_{ij}^{(t)}$ is the estimated probability of dying for the j th patient summary, by the i th participant at t ; $T_j^{(t)}$ is the experts' mean estimate for the j th patient summary at time t and $J^{(t)}$ is the total number of patient summaries evaluated at time t .

The greater the MAD, the larger the degree of difference between the novices (the medical students) and the experts (the specialist palliative care doctors).

To measure the impact of the online training resource on the level of agreement, the main analysis is based on a regression model for the MAD at ($t=2$) by intervention arm. The model for the agreement adjusting for baseline MAD, is given by

$$\text{MAD}_i^{(2)} = \alpha + \beta \text{MAD}_i^{(1)} + \delta_{\text{MAD}} Z_i + \varepsilon_i$$

where Z_i is the intervention assigned to the i th student, taking value 1 if i th student is assigned to intervention group and 0 if assigned to control group and ε_i is the error term.

The parameter of interest in order to evaluate the efficacy of the intervention is δ_{MAD} . This is the difference in MAD between the intervention and control group.

Secondary outcome analysis

The maintenance effects were assessed similarly to the primary outcome, with the MAD at ($t=3$) as the dependent variable, adjusting for baseline MAD.

To assess the individual 'judgement policy', a linear mixed model for each participant was fitted, using the estimated probability of dying as the dependent variable and the values of the different cues as independent covariates. The experts' and participants' standardised coefficients were compared in a descriptive fashion, as well as the maintenance effect of the judgement policy at ($t=3$).

The level of expertise was measured using the CWS score.²⁰ The CWS score is calculated as the ratio of discrimination and inconsistency. The discrimination refers to the individual participant's differential assessment of the various vignettes. The inconsistency refers to the individual participant's assessment of the same vignette over time. The higher the CWS score, the less inconsistent and more discriminating the student. t -tests were completed to explore if the scores of the intervention and control group at each time point were statistically different.

As the study was powered for the primary outcome measure, all analyses of secondary endpoints, including hypothesis tests, must be considered exploratory, rather than providing firm conclusions.

Results

The website was open to recruitment from 5 April 2018 until the minimum sample size of 64 complete cases per

study arm was achieved. The website was closed to new participants from 30 June 2018 and was shut completely once the last participant completed the 2-week follow-up (12 August 2018).

Baseline data

Out of the 168 participants who accepted the invitation to participate, 165 were randomised to one of the study arms; 82 in the intervention group and 83 in the control group. Figure 2 shows the number and reasons for exclusion at each time point of the trial.

There were 135 participants included in the analysis (80% completion rate); 66 in the intervention arm, 69 in the control arm. Table 2 presents the baseline demographics of all participants who completed the trial. From visual inspection, there was no evident disproportion between the two groups.

Intervention

The participants in the intervention group spent a median time of 2.65 min (IQR 1.90; 3.90) reviewing the training resource after ($t=1$). During ($t=2$), 41 participants (63%) in the intervention group accessed the training material once more. A total of 17 participants (26%) accessed the training material twice more, and 7 (11%) accessed the material more than twice, with the most being five more times.

Primary outcome

Table 3 describes the MAD scores; by group and by time point. As the table shows, the participants who received the intervention displayed more agreement with the experts than the control group at ($t=2$).

Figure 3 shows the results of the main analysis. The mean of the MAD in the intervention group was significantly less than in the control group, post intervention ($\delta_{\text{MAD}} = -3.43$, 95% CI -0.11 to -0.34 , $p < 0.001$).

Secondary analyses

Level of expertise. The CWS score was calculated at the three time points of the trial ($t=1$, $t=2$ and $t=3$). Table 4 describes the results for each group. The vignettes viewed at ($t=1$) and ($t=2$)/($t=3$) were different and therefore results can only be compared within the final two time points with higher indices scores representing higher expertise levels. At ($t=1$), the mean CWS scores were similar (intervention = 153.67 (SD 64.33), control = 168.22 (SD 101.27), $p=0.32$). The intervention and control groups did not differ with regard to CWS score at $t=2$ ($p=0.10$), but the intervention group was significantly more expert in their decision-making (higher CWS scores) versus controls at $t=3$ ($p=0.01$).

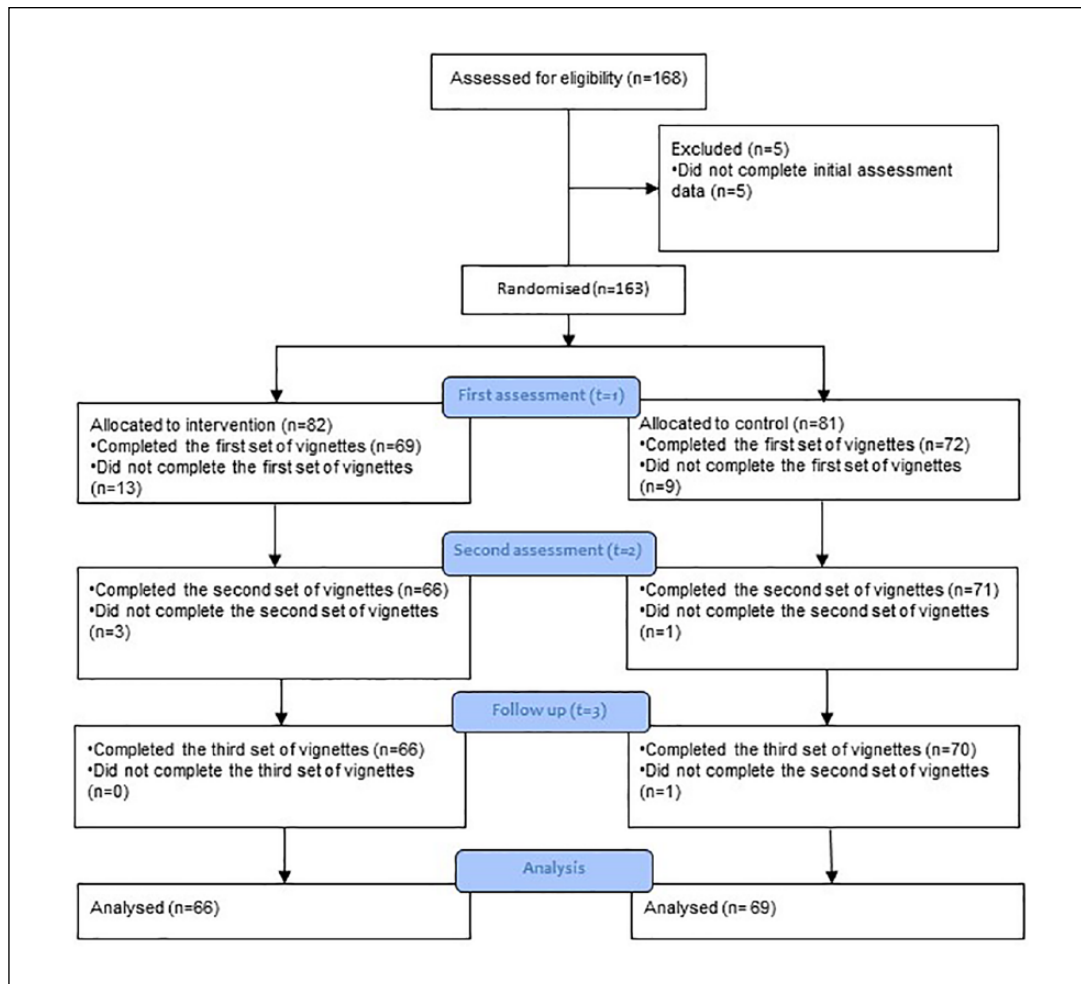


Figure 2. CONSORT flow diagram.

Table 2. Baseline demographics of the participants who completed the trial.

	Overall	Intervention	Control
Total	135	66	69
Gender (n, %)			
Male	72 (53)	35 (53)	37 (54)
Female	63 (47)	31 (47)	32 (46)
Age, median (IQR)	23 (23, 24)	24 (23, 24)	24 (22, 24)
Ethnicity (n, %)			
White (British, Irish, other)	101 (75)	52 (80)	49 (71)
Other	34 (25)	14 (20)	20 (29)
School (n, %)			
Brighton and Sussex	20 (15)	8 (12)	12 (17)
Hull York Medical School	62 (46)	32 (48)	30 (44)
Imperial College London	18 (13)	9 (14)	9 (13)
St Georges Medical School	18 (13)	8 (12)	10 (14)
UCLH	17 (13)	9 (14)	8 (12)
Year of medical school (n, %)			
Penultimate	74 (55)	36 (55)	38 (55)
Final	61 (45)	30 (45)	31 (45)

(Continued)

Table 2. (Continued)

	Overall	Intervention	Control
Received any formal teaching of palliative care (<i>n</i> , %)			
Yes	130 (96)	66 (100)	64 (93)
No	5 (4)	0 (0)	5 (7)
Experience of caring for a dying person (<i>n</i> , %)			
Yes	55 (41)	29 (44)	26 (38)
No	80 (59)	37 (56)	43 (62)
Completed any placement in a palliative care setting (<i>n</i> , %)			
Yes	102 (76)	52 (79)	50 (72)
No	33 (24)	14 (21)	19 (28)
Confidence of working with a patient who has palliative care needs (<i>n</i> , %)			
Very confident	1 (1)	0 (0)	1 (1)
Fairly confident	46 (34)	20 (30)	26 (38)
Not very confident	81 (60)	45 (68)	36 (52)
Not at all confident	7 (5)	1 (2)	6 (9)

IQR: interquartile range; UCLH: University College Hospital.

Table 3. Mean Absolute Difference scores.

	Pre intervention (<i>t</i> = 1)		Post intervention (<i>t</i> = 2)		2-week follow-up (<i>t</i> = 3)	
	Mean	SD	Mean	SD	Mean	SD
MAD ^a						
Overall	17.12	6.66	16.58	7.12	18.09	8.35
Intervention	16.52	6.23	14.46	6.30	16.91	8.64
Control	17.69	7.04	18.61	7.31	19.22	7.96

^aReflecting the degree of agreement between the experts' estimates and the students.

Cue weighting and judgement policies. Table 5 presents the cue weightings of the seven cues presented in the vignettes. The first two columns present how the experts in our previous study weighted the information. The standardised coefficients (due to the inclusion of both dichotomous and ordinal data) indicate how influential each factor was in the model; Palliative Performance Score (PPS) was the most influential in the experts' decision-making. The same analysis was completed using the data from the intervention and control arms at (*t* = 1) and (*t* = 2). Students in the intervention arm adjusted how they weighted the information to become more similar to the experts at (*t* = 2); focusing on the same four factors that the experts did. The results suggest that the students who received the training overemphasised the weighting of the factors presented. The analysis of the cue weightings at (*t* = 3) repeated the trend from the (*t* = 2) analysis for the top four cues.

MAD at the 2-week follow-up. Table 3 summarises MADs by group at (*t* = 3). Whilst there is a similar trend to the

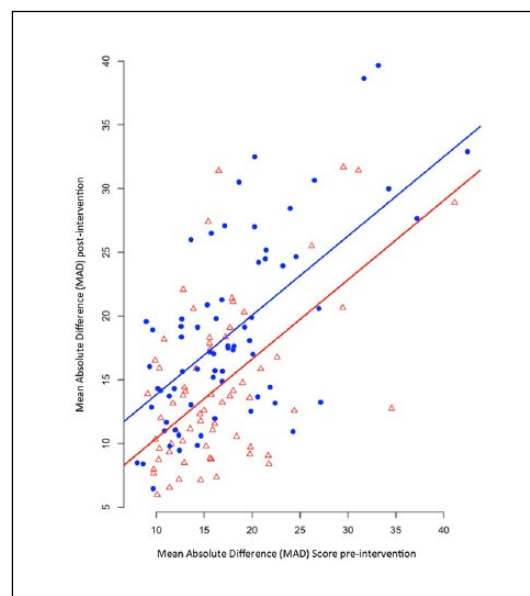


Figure 3. Scatterplot of MADs at time 1 and 2, by assignment group (red for intervention, blue for control). The two lines represent the fitted values given by model for primary analysis.

Table 4. Level of expertise by group and time point.

	Pre intervention ($t=1$)		Post intervention ($t=2$)		2-week follow-up ($t=3$)	
	Mean	SD	Mean	SD	Mean	SD
CWS ^a						
Intervention	153.67	64.33	146.04	140.21	128.88	84.00
Control	168.22	101.27	110.75	104.05	95.1	57.01

^aThe level of expertise calculated from inconsistency (denominator) and discrimination (numerator).

primary analysis, there is no evidence of a learning effect on the MAD scores from the intervention ($\delta'_{MAD} = 1.50$, 95% CI -0.87 to 3.86 , $p=0.21$).

Discussion

Main findings

The main finding is that medical students can be taught to recognise dying in a similar manner to expert palliative care doctors through the use of an online training resource; in that they are more discriminating and discerning in their use of prognostic factors. The results provide evidence that the medical students who received the intervention became more expert in their decision-making at the 2-week follow-up assessment. 'More expert', in this context, means that they were less inconsistent in their responses and better able to discriminate between vignettes than their peers. However, it should be noted that consistency alone is not acceptable as a measure of expertise, as novices can be consistently wrong.²²

The results of the trial suggest that post intervention, students overemphasised the weighting of the factors presented in the training resource and underemphasised other factors. A potential explanation for this is that students were only learning to 'game' the assessment, similarly to the process of learning how to maximise scores on multiple choice exams. If this was the case, it would support the possibility that students were gaining only superficial learning using the tool post intervention, applying the rules, rather than internalising the training and gaining a deep understanding of the content.²³ Further research is needed to understand how to improve the training and refine students' decision-making.

The trial found that improvements in the primary outcome were not maintained after 2 weeks. This is a finding that is often found in other extended learning studies.²⁴ A potential explanation for this is that the participants did not have access to the training tool at this final time point. In addition, post intervention, participants did not frequently access the training material. Previous research has highlighted that retention could be improved by emphasising the clinical relevance of the training²⁵ or providing feedback.²⁶ The results may have been different if the incentive offered as part of this trial had been based on performance rather than completion.

Strengths and weaknesses/limitations of the study

This is the first online training resource specifically designed to help medical students recognise dying patients. The design of the trial was robust and adhered to randomised controlled trial principles including blinding and the inclusion of a follow-up to assess the maintenance effect.

As this was an online trial, there were limitations to the ecological and face validity that should be considered before applying our results to the clinical setting. The vignettes were artificial and very simple in format. In real life, patients will routinely present with more signs and symptoms, which are often more complex. However, experts are known to use less information to make more accurate predictions.²⁷

Due to the design of the study, there is potential for contamination of the blinding. While participants were not informed what group they were assigned, and they were asked to complete the trial independently, there is the potential that participants completed the trial in groups and therefore participants assigned to the control group might have been aware of, or accessed, the training. Despite the low-level deception, those in the control arm were likely aware that they were designated to that group, however as this was never stated, it is possible that they will have considered the practice in making decisions on the vignettes themselves as the training.

As the vignettes were hypothetical, there was no way to determine whether the students' estimates actually became more accurate, just that they became more like the experts'. However, the experts in this study were specialist palliative care doctors who had previously been the most accurate at recognising dying, compared to their peers, on a prognostic test using real vignettes.¹³

What this paper adds?

There is currently inconsistent training available for medical students to improve their ability to recognise dying patients. This online training resource offers the opportunity for medical students to practice making decisions on predicting dying in preparation for their clinical training.

The GMC has recently requested all medical schools to report the frequency with which students receive training placements in hospices or palliative care settings. These

Table 5. The judgement policies of the experts and medical students in the two study arms.

	Experts from a previous study (n = 14)		Intervention (n = 66)						Control (n = 69)					
	Std. coeff.	β	Pre intervention (t = 1)		Post intervention (t = 2)		2-week follow-up (t = 3)		Pre intervention (t = 1)		Post intervention (t = 2)		2-week follow-up (t = 3)	
			Std. coeff.	β	Std. coeff.	β	Std. coeff.	β	Std. coeff.	β	Std. coeff.	β	Std. coeff.	β
Patient information	0.48	6.10**	0.30	3.71**	0.54	6.97**	0.47	6.31**	0.29	3.69**	0.28	3.73**	0.26	3.58**
PPS	0.30	15.39**	0.24	12.71**	0.44	20.45**	0.29	13.97**	0.21	11.27**	0.33	15.96**	0.29	14.16**
Cheyne–Stokes breathing	0.23	11.51**	0.22	11.58**	0.32	14.73**	0.30	14.61**	0.25	13.83**	0.34	15.95**	0.36	17.48**
Decline in condition	0.23	4.31**	0.26	4.51**	0.20	3.83**	0.22	4.26**	0.22	4.06**	0.18	3.55**	0.19	3.82**
RASS	0.12	5.91**	0.16	8.22**	0.02	0.78	0.04	2.07*	0.17	9.39**	0.17	7.96**	0.14	6.73**
Noisy respiratory secretions	0.11	5.40**	0.11	5.66**	0.06	2.85**	0.04	1.92*	0.14	7.78**	0.11	5.12**	0.12	5.68**
Cyanosis	0.01	0.39	0.13	6.72**	0.00	-0.00	0.05	2.34*	0.10	5.65**	0.12	5.58**	0.13	6.13**
Urinary output														

Std. coeff.: standardised coefficients; β : regression coefficients; PPS: Palliative Performance Score; RASS: Richmond Agitation–Sedation Scale.* $p < 0.05$.** $p < 0.001$.

placements can be extremely difficult and challenging to find due to limited resources.²⁸ The online environment, while unable to replace direct clinical contact, could be used to facilitate learning in this complex area, and provide a complementary education approach to clinical training.

Further research is needed on the content of the training, improvements in deeper learning, and reliability of the training resource.

Acknowledgements

The authors would like to thank the medical schools and the medical students who participated in the trial. The authors would like to thank Olivia Baker for reviewing the trial recruitment documents and providing valuable feedback, and Sean O'Donnell who reviewed the documents in addition to helping recruitment. The authors would like to thank Victoria Vickerstaff for repeating the analysis of the primary outcome.

Authorship

P.H. and P.S. conceived the idea for the trial. N.W. produced an initial draft of the protocol which all authors subsequently contributed to and L.O., N.W. and P.S. formed the working group that refined the trial protocol and set up the trial. All other members of the Trial Management Group (P.H., S.Y., C.T., F.R. and H.G.) provided input in the protocol design and trial logistics. N.W., P.H., L.O. and P.S. were involved with developing the intervention. O.M., B.C., J.B. and S.Y. approved the protocol and obtained local site approval. C.T. developed and maintained the trial website and the randomisation process. L.O. and N.W. were responsible for recruitment and data monitoring. All authors provided input for the recruitment strategies. F.R. devised the statistical analysis plan with input from H.G., and completed the data management and analyses. N.W. produced the first draft of the paper. S.Y. provided medical educational expertise. All authors refined the paper and approved the final version for submission. L.O. is the trial manager, P.S. is the guarantor of the trial.

Data management and sharing

The link to the anonymous experts' judgement policy data can be accessed via figshare at: [10.6084/m9.figshare.7732265](https://figshare.com/10.6084/m9.figshare.7732265). The link to the anonymous baseline and primary data can be accessed via figshare at: [10.6084/m9.figshare.7732244](https://figshare.com/10.6084/m9.figshare.7732244).

Declaration of conflicts of interest


The author(s) declared the following potential conflicts of interest with respect to the research, authorship and/or publication of this article: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare no support from any organisation for the submitted work; C.T. has received research payment from UCL to complete the online platform and database, no other relationships or activities that could appear to have influenced the submitted work.


Funding


The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Marie Curie I-CAN-CARE Program grant (MCCC-FPO-16-U).

Professor Stone is supported by the Marie Curie Chair's grant (MCCC-509537). N.W., L.O., P.S., F.R. and S.Y. are partly supported by the UCLH NIHR Biomedical Research Centre. The funder had no role in trial design, data collection and analysis, decision to publish or preparation of the manuscript.

ORCID iDs

Nicola White  <https://orcid.org/0000-0002-7438-0072>

Ollie Minton  <https://orcid.org/0000-0002-4258-8995>

Jason W Boland  <https://orcid.org/0000-0001-5272-3057>

Supplemental material

Supplemental material for this article is available online.

References

- Gibbins J, McCoubrie R, Maher J, et al. Recognizing that it is part and parcel of what they do: teaching palliative care to medical students in the UK. *Palliat Med* 2010; 24(3): 299–305.
- Glare PA and Sinclair CT. Palliative medicine review: prognostication. *J Palliat Med* 2008; 11(1): 84–103.
- Ellershaw J and Ward C. Care of the dying patient: the last hours or days of life. *BMJ* 2003; 326: 30–34.
- General Medical Council. Tomorrow's Doctors: outcomes and standards for undergraduate medical education, 2009, http://www.ub.edu/medicina_uniteducaciomedica/documentos/TomorrowsDoctors_2009.pdf
- Neuberger J, Guthrie C and Aaronovitch D. More care, less pathway: a review of the Liverpool Care Pathway (ed. *Department of Health CC*), 2013, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/212450/Liverpool_Care_Pathway.pdf
- Parry R, Seymour J, Whittaker B, et al. *Rapid evidence review: pathways focused on the dying phase in end of life care and their key components*. Nottingham: University of Nottingham, 2013.
- Leadership Alliance for the Care of Dying People. One chance to get it right: Improving people's experience of care in the last few days and hours of life, 2014, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/323188/One_chance_to_get_it_right.pdf
- Walker S, Gibbins J, Paes P, et al. Palliative care education for medical students: differences in course evolution, organisation, evaluation and funding: a survey of all UK medical schools. *Palliat Med* 2017; 31(6): 575–581.
- Lloyd-Williams M and MacLeod RD. A systematic review of teaching and learning in palliative care within the medical undergraduate curriculum. *Med Teach* 2004; 26(8): 683–690.
- Walker S, Gibbins J, Barclay S, et al. Progress and divergence in palliative care education for medical students: a comparative survey of UK course structure, content, delivery, contact with patients and assessment of learning. *Palliat Med* 2016; 30(9): 834–842.
- Walker S, Gibbins J, Paes P, et al. Preparing future doctors for palliative care: views of course organisers. *BMJ Support Palliat Care* 2018; 8(3): 299–306.

12. Francis R. *Report of the Mid Staffordshire NHS Foundation Trust public inquiry: executive summary*. London: The Stationery Office, 2013.
13. White N, Harries P, Harris AJ, et al. How do palliative care doctors recognise imminently dying patients? A judgement analysis. *BMJ Open* 2018; 8:e024996. doi: 10.1136/bmjopen-2018-024996.
14. Harries P, Davies M, Gilhooly K, et al. Educating novice practitioners to detect elder financial abuse: a randomised controlled trial. *BMC Med Educ* 2014; 14: 21.
15. Harries P, Gokalp H, Davies M, et al. Enhanced referral prioritisation for acute adult dietetic services: a randomised control trial to test a web-based decision training tool. *Clin Nutr* 2017; 37: 1456–1461.
16. Harries P, Unsworth C, Gokalp H, et al. A randomised controlled trial to test the effectiveness of decision training on assessors' ability to determine optimal fitness-to-drive recommendations for older or disabled drivers. *BMC Med Educ* 2018; 18(1): 27.
17. Consort: Transparent reporting of trials; Flow chart. <http://www.consort-statement.org/home> (accessed 1 June 2018).
18. Oostendorp L, White N, Harries P, et al. Protocol for the ORaCIES study: an Online Randomised controlled trial to improve Clinical Estimates of Survival using a training resource for medical students. *BMJ Open* 9: e025265.
19. IBM Corporation. *IBM SPSS statistics for windows*. Armonk, NY: IBM Corporation, 2013.
20. Weiss DJ and Shanteau J. CWS: A user's guide, 2005. https://s3.amazonaws.com/academia.edu.documents/30710491/using_cws.pdf?response-content-disposition=inline%3B%20filename%3DCWS_A_user_s_guide.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20191004%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20191004T092408Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=b0b7e68bf11b177de11f27b4cd18ab0f05111aff5d5c06e2e6904ace92d5efff
21. Willmott CJ and Matsuura K. Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance. *Climate Res* 2005; 30(1): 79–82.
22. Shanteau J, Weiss DJ, Thomas RP, et al. Performance-based assessment of expertise: how to decide if someone is an expert or not. *Eur J Operat Res* 2002; 136(2): 253–263.
23. Entwistle NJ and Entwistle A. Contrasting forms of understanding for degree examinations: the student experience and its implications. *Higher Educ* 1991; 22(3): 205–227.
24. Kerfoot BP, DeWolf WC, Masser BA, et al. Spaced education improves the retention of clinical knowledge by medical students: a randomised controlled trial. *Med Educ* 2007; 41(1): 23–31.
25. Malau-Aduli BS, Lee AY, Cooling N, et al. Retention of knowledge and perceived relevance of basic sciences in an integrated case-based learning (CBL) curriculum. *BMC Med Educ* 2013; 13: 139.
26. Yeh DD and Park YS. Improving learning efficiency of factual knowledge in medical education. *J Surg Educ* 2015; 72(5): 882–889.
27. Kahneman D. *Thinking, fast and slow*. Reprint edition. London: Penguin Group; 2012.
28. General Medical Council. Medical school annual return 2017/2018, 2018, <https://www.gmc-uk.org/education/reports-and-reviews/medical-school-reports>