Measuring health outcomes, experience of care and cost of healthcare in student-led healthcare services: A literature review

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Abstract

Introduction: In student-led healthcare services, health students take responsibility for the management and delivery of health services as part of clinical training. Like all healthcare services, student-led healthcare services need to be evaluated to ensure they provide high quality, safe and cost-effective services. The aim of this literature review was to understand how student-led healthcare services have been evaluated to date and to assess alignment of previous evaluations with the Triple Aim framework. The Triple Aim is a conceptual framework offering a systematic approach to evaluating healthcare services that may be appropriate for evaluation of student-led services.

Methods: Electronic databases were searched for articles describing a student-led healthcare service and were screened for studies that evaluated the impact of a student-led healthcare service on patient outcomes. Critical appraisal was informed by Stiefel and Nolan's (2012) IHI white paper *A Guide to Measuring the "Triple Aim"*, and each article was appraised against the Triple Aim measurement principles and dimensions of care.

Results: Fourteen of 211 identified articles met the inclusion criteria. All 14 studies met the Triple Aim measurement principles of "a defined population", "gather data over time" and "distinguish between measures", while only eight of the 14 studies achieved "comparison data". All 14 studies measured at least one or more of the Triple Aim dimensions.

Conclusions: There was little consistency across the evaluations of student-led healthcare services, limiting the extent to which the benefits of student-led healthcare services can be shown to be a valuable resource to the healthcare system. Further investigation is required to determine a suitable evaluation framework for student-led healthcare services.

Keywords: student-led healthcare service; Triple Aim; population health; patient experience; cost of care; evaluation; quality improvement

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Introduction

In Australia, there are hard to reach and underserved communities who experience inadequate access to healthcare (Stuhlmiller & Tolchard, 2018). People living in rural and remote areas of Australia generally experience lower life expectancy, higher rates of disease and injury and poorer access to healthcare services than people living in metropolitan areas of Australia (AIHW, 2020). There are growing concerns over differences in health outcomes for these communities, and there is a need to identify unique models of healthcare delivery that will address health disparities (Kenny et al., 2013). Student-led healthcare services are one possible solution to an "increasingly fractured health system, rising costs, huge needs of underserved populations, and limited access to care" (Stuhlmiller & Tolchard, 2018, p. 193).

In student-led healthcare services, health students take responsibility for the management and delivery of health services as part of their clinical training (Stuhlmiller & Tolchard, 2018; Suen et al., 2020). Student-led healthcare services vary from other forms of service-based learning in that they are purposely designed to provide continuous healthcare services to the community. Exposure to real-life clinical environments through clinical placement is integral to preparing healthcare students for practice (Atakro et al., 2019). Authentic environments such as those provided within student-led healthcare services allow students to improve their understanding of the social determinants of health and other barriers to healthcare access (Rockey et al., 2021), while contributing to the development of competency within the healthcare systems they intend to practise in (Froberg et al., 2018). However, to substantiate student-led healthcare services as quality providers of clinical education and promote their use as clinical placements, student-led healthcare services must be first substantiated as quality providers of healthcare.

Another purpose of student-led healthcare services is to fill the gaps in healthcare service provision in areas where attracting healthcare professionals may be difficult (Stuhlmiller & Tolchard, 2015). This is crucial in regional, rural and remote areas, where retaining healthcare professionals with varying levels of expertise is difficult, supporting the need for healthcare systems to move away from traditional models of healthcare and adopt innovative systems of healthcare practice (Panzera et al., 2016). Despite the potential benefits that student-led healthcare services can provide to underserved communities, there are challenges in successfully establishing and operating these unique healthcare services. Primarily, students on placement within student-led healthcare services may not have the knowledge or experience necessary to care for patients effectively (Atakro et al., 2019; Simmons et al., 2009). However, when a student is provided with support and gradual exposure to the healthcare environment, competence can improve, influencing the overall quality of the services they provide (Manoochehri et al., 2015; Simmons et al., 2009).

To justify and validate student-led healthcare services as both providers of care and clinical education, evaluation of student-led healthcare services is growing. Initial studies have found that student-led healthcare services contribute to student learning and result in health improvements and patient satisfaction (Clark et al., 2014; Ouyang et al., 2012; Schutte et al., 2018). However, whether student-led healthcare services produce equivalent health outcomes when compared to their professional counterparts is still unknown, with many studies lacking the research design to answer this question (Clark et al., 2014).

Student-led healthcare services also face challenges of financial viability (Frakes, Brownie, et al., 2014; Kent, Drysdale, et al., 2014; Ojeda et al., 2014). A potential risk to the sustainability of student-led healthcare services is the ongoing need to demonstrate their feasibility to funders, with a successful bid being sensitive to stakeholders' powers and priorities (Frakes, Brownie, et al., 2014). Threats to service continuity are a concern for under-resourced regions relying on student-led healthcare services. Accordingly, consideration must be given to financial sustainability in the ongoing management of student-led healthcare services. Like all healthcare services, student-led healthcare services should also be subject to rigorous performance assessment through audit and evaluation processes to ensure services provided to the community are delivered at a professional standard. To ensure student-led healthcare services maintain high standards of care and operation, an evaluation framework used to ensure quality of mainstream healthcare services is also applicable to student-led healthcare services.

The Institute of Healthcare Improvement (IHI) adopted the "Triple Aim" as a performance framework to reinvigorate a focus on quality in healthcare (Stiefel & Nolan, 2012) and is an overarching framework that guides healthcare services on what is important to measure when evaluating healthcare. The Triple Aim includes three domains of measurement: population health, experience of care and per capita cost (Stiefel & Nolan, 2012). To measure population health, the Triple Aim stipulates factors influencing health as either upstream or downstream determinants—with individual factors such as behavioural and psychological factors describing upstream factors, disease burden and health and function demonstrating more intermediate outcomes and quality of life (QoL) and mortality demonstrating more downstream health outcomes (Evans & Stoddart, 1990). To measure experience of care, the Triple Aim promotes the patient as being best placed to assess their experience of care and recommends the use of patient satisfaction surveys looking at likelihood to recommend, quality and satisfaction of healthcare received (Stiefel & Nolan, 2012). To assess experience of care from a provider's perspective, the Triple Aim promotes using the Institute of Medicine's (IOM) (2001) six aims of improvement, focusing on safe, effective, patient-centred, equitable, timely and efficient healthcare. The Triple Aim considers three perspectives when measuring per capita cost: the supply lens (hospitals, community healthcare services, etc.), the demand lens (consumers and/or purchasers of

services) and the intermediary lens (health insurers). The summation of costs from all three lenses is the total cost of care (Stiefel & Nolan, 2012).

The Triple Aim framework allows different healthcare services to use different methods of evaluation to achieve the Triple Aim while providing consistent information about healthcare service performance. The benefit of using the Triple Aim framework in comparison to other approaches to healthcare service evaluation is that it can be applied across a healthcare system, providing opportunities for comparison regardless of service structure and therapeutic focus. Additionally, the Triple Aim has been operationalised within healthcare services across the United States of America, the United Kingdom, Canada, Germany, Spain, New Zealand and Australia (IHI, 2017; Obucina et al., 2018), supporting its international relevance and allowing comparison of healthcare services and systems across countries.

A common aim of student-led healthcare services is to support healthcare systems in meeting the needs of underserved populations (Stuhlmiller & Tolchard, 2018). To prove their legitimacy as authentic healthcare providers, student-led healthcare services need an appropriate evaluation framework, focusing on healthcare quality, patient experience and cost effectiveness (Clark et al., 2014; Frakes, Brownie, et al., 2014; Kent, Lai, et al., 2016; Simmons et al., 2009). The Triple Aim is a framework that is designed to address these identified needs of student-led healthcare services through its assessment of health outcomes, patient experience and cost of healthcare, enabling comparison between services and providing evidence of their true impact within the healthcare system.

This literature review aims to determine the extent to which the evaluation of student-led healthcare services currently aligns with the recommendations of the IHI Triple Aim of Healthcare Improvement.

Methods

Search strategy

Three databases were searched using Ovid Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Scopus from inception to August 2021. The development of the search strategy was undertaken by one author (LS) with the guidance of an independent research librarian. A combination of subject headings (MESH terms) and keywords were used in each search. Search terms were divided into three groups: the type of healthcare service (e.g., student-led, student-assisted), study design (e.g., evaluation study) and study outcome measures (e.g., health outcomes, patient experience, cost of healthcare). The Boolean phrase "AND" was used between groups and the phrase "OR" was used within groups. Search results were collated and duplicates removed (see Appendix A: Literature search strategy (Medline)). Additional articles were identified through pearling, whereby citations and reference lists of included studies were scanned to identify studies for inclusion. One reviewer applied the search strategy and screened titles

(LS). Abstracts and full texts were reviewed by authors (LS, RB, EC) to identify studies for inclusion. An independent reviewer was also enlisted to ensure consensus against the eligibility criteria.

Study selection

Studies that met the inclusion criteria were limited to those describing established student-led healthcare services providing services to the community on an ongoing basis; articles applying measures that align with the Triple Aim domains (i.e., health outcomes, patient experience and cost effectiveness), even if the Triple Aim framework was not explicitly referred to; and those that used either a pre-post intervention design or a comparative analysis as their method to evaluating outcomes (see Appendix B: Student-led health service evaluations inclusion criteria).

Critical appraisal

The Triple Aim framework was chosen to guide the critical appraisal due to its alignment with the evaluation needs of student-led healthcare services. The methodology of each study was assessed using a critical appraisal tool (CAT) that was developed specifically for this review and based on Stiefel and Nolan's (2012) IHI White Paper: *A Guide to Measuring the "Triple Aim"* and uses a similar approach to critical appraisals conducted by Prior et al. (2014) and Obucina et al. (2018). The critical appraisal tool assessed each article based on its ability to achieve the Triple Aim measurement principles of "defining the population", "gathering data over time", "distinguishing between measures" and incorporating "comparison data", in addition to the Triple Aim dimensions of "population health", "experience of care" and "per capita cost". One reviewer (LS) completed the critical appraisal, with additional reviewers (RB, EC, FB) contributing to the overall analysis and conclusions of the appraisal.

Data extraction

Data extraction involved use of a review matrix where one reviewer (LS) extracted data from the included studies and additional reviewers (RB, EC, FB) confirmed the accuracy of the data. Reviewers deliberated regularly throughout the data extraction phase, re-evaluating and amending review matrices to ensure the accuracy of the data extracted. Data synthesis and critical appraisal also followed a process of continual review to ensure the resulting outcome and recommendations remained true to the overall aims of the literature review. Table 1 summarises characteristics of the included studies.

Table 1

Study Characteristics

Author	Study Type	Student Profession/s	No. of Patients	Type of Service/Intervention
Adams et al. (2015)	Pre and post intervention measures; comparative analysis	Pharmacy	200	A student-led pharmacy intervention based inside a professionally led medical centre; students undertook medication reviews on patients diagnosed with type 2 diabetes mellitus.
Butala et al. (2013)	Comparative analysis	Pre-clinical health professions	469	HAVEN Free Clinic, a student-led, free clinic affiliated with local university & community health centre located in New Haven, Connecticut, USA; provides uninsured adults with primary care, wellness education and assistance in securing healthcare; implemented a student medical records specialist role to improve service's adherence to national preventative service guidelines.
Clark et al. (2014)	Comparative analysis	Medical	43	Jackson Free Clinic (JFC), a student-led, free clinic located in Jackson, Mississippi, USA; provides care to uninsured, unemployed and homeless patients; student services involve providing patient interviews and physical exams, deliberation at the team level and developing treatment plans.
Gorrindo et al. (2014)	Pre and post intervention measures	Medical	45	Shade Tree Clinic, a student-led, free clinic affiliated with Vanderbilt University School of Medicine, located in Nashville, Tennessee, USA; provides medications, laboratory services, immunisations, social services and disease management to uninsured and underserved patients.
Lawrence et al. (2015)	Comparative analysis	Nurse practitioner and medical	127	Case Western Reserve University (CWRU) student-led healthcare service; free clinic affiliated with CWRU School of Medicine, located in Cleveland, Ohio, USA; provides acute care services to the underserved populations.
Lee et al. (2017)	Pre and post intervention measures	Medical	Not reported	The Keeping Neighbors in Good Health Through Service (KNIGHTS) Clinic, a student-led, free clinic coordinated and staffed by medical students from the University of Central Florida, providing services to the underserved community of Orlando, Florida, USA.
Liberman et al. (2011)	Comparative analysis	Medical	49	The East Harlem Health Outreach Partnership (EHHOP) student-led, free clinic, affiliated with Mount Sinai School of Medicine, located in New York City, USA.

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Author	Study Type	Student Profession/s	No. of Patients	Type of Service/Intervention
Mann et al. (2019)	Comparative analysis	Medical	79	Provides primary healthcare and mental healthcare for highly disadvantaged residents, predominantly indigent, immigrant, Hispanic and uninsured; offers both a primary care (PC) clinic and a mental health (MH) clinic.
Martin et al. (2015)	Pre and post intervention measures	Pharmacy	48	Penobscot Nation Health Centre, a student-led service within established centre, affiliated with Husson University School of Pharmacy, located in Bangor, Maine, USA; provides diabetes management services.
Meek et al. (2013)	Comparative analysis	Medical and nursing	734	Dandenong Hospital Emergency Department (ED), a student-led healthcare program affiliated with Monash University, located in Melbourne, Victoria, Australia; student teams manage four ED beds.
Nuffer et al. (2012)	Pre and post intervention measures	Pharmacy	417	Twelve student-led healthcare service sites affiliated with University of Colorado, located in rural Colorado, USA; provides self-care management education to patients with diabetes.
Stuhlmiller & Tolchard (2018)	Comparative analysis	Student professions not defined	2,086	A student-led healthcare service serving a population living in an underserved region located in West Tamworth, New South Wales Australia; provides primary health, social care, health education, harm minimisation and mental health services.
Thakkar et al. (2019)	Pre and post intervention measures	Medical	796	The Crimson Care Collaborative (CCC), a Harvard Medical School-affiliated network of seven student-led healthcare services providing after hours primary care to residents in Boston, Massachusetts, USA.
Wahle et al. (2017)	Pre and post intervention measures; comparative analysis	Medical	64	The Indiana University Student Outreach Clinic (IUSOC), a student-led free clinic providing services to Indianapolis, Indiana, USA; allows professional students training in pharmacy, law, dentistry, social work, physical therapy, occupational therapy, public health and nursing through contributions in patient care.

Results

The database and pearling search generated 211 articles, with 105 full texts reviewed (Figure 1). Fourteen articles met the inclusion criteria. Eleven studies were conducted in the United States (Butala et al., 2013; Clark et al., 2014; Gorrindo et al., 2014; Lawrence et al., 2015; Lee et al., 2017; Liberman et al., 2011; Mann et al., 2019; Martin et al., 2015; Nuffer et al., 2012; Thakkar et al., 2019; Wahle et al., 2017), two studies were conducted in Australia (Meek et al., 2013; Stuhlmiller & Tolchard, 2018) and one study was conducted in the United Kingdom (UK) (Adams et al., 2015). Study design and intervention characteristics are shown in Table 1.

Alignment with Triple Aim measurement principles

All 14 studies focused on evaluating outcomes of a sub-population, which was defined either as the local population in which the healthcare service was located or by a specific health condition/disease (Table 2). Sample sizes in the included studies were not calculated statistically to determine power. Instead, sample size was commonly determined as all patients receiving care from the healthcare service, whether that was calculated at a single time-point (e.g., all patients of the service up until a point in time) or over a specified period (e.g., all patients between 2009 and 2016) (Table 2). Mann et al. (2019) reported broadening their inclusion criteria to increase power however did not include a power calculation or a population size required to be met. Being a pilot study, Adams et al. (2015) did not undertake a power calculation however, instead, calculated sample size through estimating the effect of the intervention based on 95% CI and difference in means of the continuous variable (i.e., glycosylated hemoglobin A1c (HbA1c)) between intervention and control groups. Additionally, Lee et al. (2017) did not provide clear information about the number of patient encounters reviewed when analysing patient visit times in their study.

Data in included studies were gathered over different periods using different study methods (Table 2). Eight of the 14 studies gathered data by analysing patient records retrospectively (Butala et al., 2013; Gorrindo et al., 2014; Liberman et al., 2011; Mann et al., 2019; Meek et al., 2013; Stuhlmiller & Tolchard, 2018; Thakkar et al., 2019; Wahle et al., 2017). Three studies used a combination of retrospective and prospective techniques (Lee et al., 2017; Martin et al., 2015; Nuffer et al., 2012). The remaining three studies administered outcome measures and/or collected data prospectively (Adams et al., 2015; Clark et al., 2014; Lawrence et al., 2015). Timeframes for data collection varied amongst studies, with eight studies reviewing data from 12 months or more (Butala et al., 2013; Gorrindo et al., 2014; Lee et al., 2017; Liberman et al., 2011; Mann et al., 2019; Stuhlmiller & Tolchard, 2018; Thakkar et al., 2019; Wahle et al., 2017), five studies collecting data over approximately 6 to 10 months (Adams et al., 2015; Clark et al., 2014; Lawrence et al., 2015; Nuffer et al., 2012) and one study reviewing data over 6 weeks (Meek et al., 2013) (Table 2).

Figure 1

PRISMA Flow Diagram of Article Inclusion Process

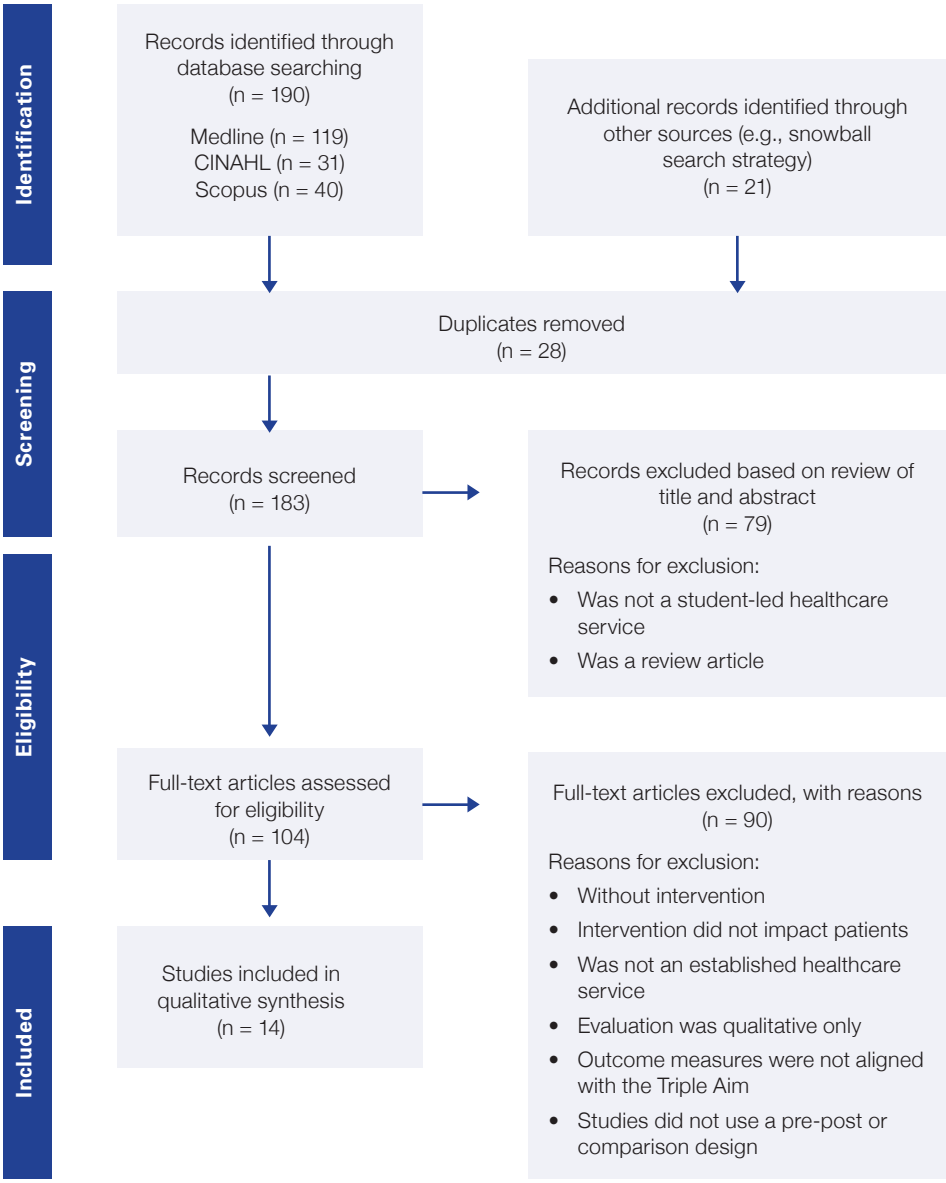

Table 2

Analysis of Articles Against the Triple Aim Measurement Principles

	Triple Aim Measurement Principles			
Authors	A defined population	Gather data over time	Distinguish between measures	Comparison data
Adams et al. (2015)	Patients (n = 200) with a diagnosis of type 2 diabetes attending one of five Norfolk medical practices	Measures were taken at baseline and at 6 months post intervention	Diabetes-related clinical data (glycosylated hemoglobin A1c (HbAlc), blood pressure and lipid profile), quality of life (EQ-5D), patient reported beliefs (The Beliefs and Medicines Questionnaire), adherence (MARS) and satisfaction with medicines (DTSQ) collected; patient behavioural characteristics recorded	Not included in study design
Butala et al. (2013)	Uninsured adults living in New Haven Connecticut in receipt of preventive healthcare services; demographic data collected for pre- and post-intervention analysis	Retrospective patient record reviews conducted pre intervention (2008–2009) and post intervention (2010–2011)	Number of screening/preventative tests and appropriateness of screening based on patient characteristics	Comparison data comprised of patients receiving services from HAVEN 12 months prior to the implementation of the intervention.
Clark et al. (2014)	Uninsured, unemployed and homeless population living in Jackson and receiving care from the JFC, with 16 examined by physicians and 27 examined by student groups	Weekly patient satisfaction surveys for 6 months; each patient completed only one questionnaire throughout the study period; surveys completed on site prior to consultation completion	PCAS aligned IOM formal definition of primary care	Patient experience of care with student group compared to care with a trained physician; PCAS were administered at the same time for physician consults
Gorrindo et al. (2014)	All patients with established care at Shade Tree Clinic after 2008 with a diabetes diagnosis	Retrospective patient record reviews of diabetic patients conducted 2008–2011	HbA1c collected at initial presentation and post (12 ± 3 months); presence/absence of required HbA1c measures within the 12-month measurement period; student–patient relationship examined by reviewing documented patient encounters	Not included in study design

Triple Aim Measurement Principles				
Authors	A defined population	Gather data over time	Distinguish between measures	Comparison data
Lawrence et al. (2015)	Patients receiving healthcare services at CWRU student-led healthcare service (n = 87) and a professionally led free medical service (n = 40)	Patient surveys facilitated over 10-month period; Different facilitation methods used between intervention and control	Two separate surveys developed based on Health Centre Patient Satisfaction Survey developed by the US Department of Health & Human Services: 28-item student-led survey; 21-question professionally led survey	A professionally led free medical service, dually located with the student-led healthcare service
Lee et al. (2017)	All patients receiving care from KNIGHTS Clinic in 2014/2015 following implementation of a quality improvement intervention; all patients receiving care in 2015/2016	Pre-intervention data collected retrospectively; post-intervention data collected prospectively	Process measures include availability and variety of services provided and patient wait and consultation times	Not included in study design
Liberman et al. (2011)	Disadvantaged adult patients living in East Harlem receiving healthcare services from EHHOP who have a diagnosis of depression	Conducted a point-in-time retrospective patient record review; all patient records reviewed to identify those who met inclusion criteria.	Data analysed based on HEDIS; parameters included demographics; diagnosis method; pharmacological treatment type; referral to specialty care; and patient adherence to follow-up care and pharmacologic treatment	Available HEDIS data on Medicaid and commercially insured populations in New York City and New York State (NYS) available from NYS Managed Care Plan Performance 2007 dataset
Mann et al. (2019)	Disadvantaged patients living in East Harlem with a diagnosis of major depression, adjustment disorder, dysthymia or depressive disorder not otherwise specified (NOS) receiving care from the MH Clinic within EHHOP	Conducted a point-in-time retrospective patient record review; all patient records were reviewed between 2009 and 2016 to identify those who met inclusion criteria	Data analysed based on HEDIS; adherence to antidepressant medication at 3 and 6 months was analysed against treatment response	Patients receiving care from the EHHOP PC Clinic, Liberman et al. (2011) data and available 2014 HEDIS data on Medicaid and commercially insured populations in NYS accessed from NYS Department of Health
Martin et al. (2015)	Penobscot Nation members with diabetes receiving healthcare services at Penobscot Nation Healthcare Centre; sample included patients with controlled diabetes (HbA1c < 7%; n = 30) and uncontrolled diabetes (HbA1c ≥ 7%; n = 18)	Retrospective patient record reviews to identify pre HbA1c values; patient experience surveys completed after each visit with healthcare provider	Pre-measures identified from previous HbA1c values and post HbA1c measures; patient satisfaction surveys completed	Not included in study design

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Triple Aim Measurement Principles				
Authors	A defined population	Gather data over time	Distinguish between measures	Comparison data
Meek et al. (2013)	Patients presenting to Dandenong Hospital Emergency Department (ED) over a 10-week period in 2012; patients triaged based on presenting need, allocated to the next available bed: a student-led bed (n = 369) or standard care (n = 365)	Retrospective data accessed from patient records over five 2-week blocks May–September 2012; outcome measure data for all patients who had a length of stay (LOS) of at least 1 hour, assigned to either a student-led bed or standard care	ATS and Commonwealth Department of Health and Ageing ED access targets; ATS measures included time to nurse, time to doctor, time to inpatient referral and time to inpatient bed request	Four control beds matched for patient acuity and managed as per usual care (professionals)
Nuffer et al. (2012)	Adults with a diagnosis of diabetes receiving care at one of the 12 student-led clinics in rural Colorado	Retrospective patient record review over a 6-month period	HbA1c, BP, fasting total cholesterol (TC) and blood lipids; values obtained at visit 1 (pre measure) and 6 (post measure)	Not included in study design
Stuhlmiller & Tolchard (2018)	All patients receiving healthcare services from the Coledale student-led clinic	Data gathered through a point-in-time review of patient records	Behavioural factors such as smoking and drinking; physiological health outcome measures such as BMI, BP, body circumference, BGL and blood lipids	Two patient groups were compared: those receiving care for ≤ 12 months and those receiving care for > 12 months
Thakkar et al. (2019)	All adult patient receiving care from CCC	Retrospective patient record review over a 5-year period	ED utlisation rates obtained; socioeconomic status approximated and CCI used for health status	Not included in study design
Wahle et al. (2017)	Patients being treated for hypertension at IUSOC between January 2013 and March 2014 (n = 64) with > 3 visits at the clinic	Retrospective patient record review over 13-month period	Physiological health outcome measures such as BMI and BP; Data on behavioural factors, such as smoking and drinking, also collected	Hypertension control data collected from patients receiving care from the IUSOC Clinic and compared to available NHANES datasets

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Table 3

Analysis of Articles Against the Dimensions of the Triple Aim

	Dimensions of the Triple Aim		
Authors	Population health	Experience of care	Cost of healthcare
Adams et al. (2015)	Upstream measures, including behavioural characteristics, i.e., exercise, diet and smoking status, and physiological measures i.e., HbA1c, blood pressure and lipid profile included; EQ-5D used to measure downstream measure of QoL	Global experience of care was assessed using the DTSQ, which also measures timeliness of services; treatment effectiveness was measured using MARS	Measures cost from a supply lens, calculating resource utilisation costs
Butala et al. (2013)	Not assessed	Service effectiveness assessed via adherence to National Preventive Service guidelines for HIV testing, fasting lipid panel, fasting blood glucose and Pap smear; every patient file assessed for indicators of specific preventative services (as per a defined criteria) and delivery of that service	Not assessed
Clark et al. (2014)	Upstream health outcomes assessed via patient demographic and socioeconomic data	Service effectiveness, timeliness, patient-centredness and affordability assessed via the PCAS	Not assessed
Gorrindo et al. (2014)	Physiological health outcomes assessed by HbA1c	Service effectiveness measured via the process measure of the presence/absence of required HbA1c measures; every patient file assessed for indicators of specific services (as per a defined criteria) and delivery of that service; patient-centredness assessed via review of patient interactions	Not assessed
Lawrence et al. (2015)	Not assessed	Service timeliness and global experience of care assessed via a modified version of the Centre Patient Satisfaction Survey	Not assessed
Lee et al. (2017)	Not assessed	Service efficiency/timeliness assessed through increased consultation availability and variety, as well as change in patient wait times/total visit duration	Not assessed

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	Dimensions of the Triple Aim		
Authors	Population health	Experience of care	Cost of healthcare
Liberman et al. (2011)	Not assessed	Service effectiveness assessed via HEDIS measures	Not assessed
Mann et al. (2019)	Not assessed	Service effectiveness assessed via HEDIS measures	Not assessed
Martin et al. (2015)	Physiological health outcomes assessed by HbA1c	Global experience of care assessed using a patient experience survey	Not assessed
Meek et al. (2013)	Not assessed	Service efficiency and timeliness assessed via measures aligned with the ATS and Commonwealth Department of Health and Ageing ED access targets	Not assessed
Nuffer et al. (2012)	Physiological health outcomes measures of HbA1c, BP and blood lipids	Not assessed	Not assessed
Stuhlmiller & Tolchard (2018)	Physiological health outcomes assessed by BMI, BP, body circumference, BGL and blood lipids; behavioural characteristics assessed via smoking and drinking	Equity assessed by stratifying all measures into identified subpopulations differentiated by gender, age and racial groupings	Not assessed
Thakkar et al. (2019)	Upstream health outcomes assessed via patient demographic data and estimated socioeconomic status; downstream health outcomes estimated using Deyo et al. (1992) adaptation of the CCI	Effectiveness of service measured through change in ED utilisation rates; equity assessed by stratifying all measures into identified subpopulations differentiated by gender, age and racial groupings	Estimation of cost savings through the median cost per ED visit for each visit avoided (accounting for inflation)
Wahle et al. (2017)	Upstream health outcomes assessed through patient demographic data and insurance status; physiological health outcomes assessed by BMI and BP; behavioural characteristics assessed via smoking and drinking behaviours	Not assessed	Not assessed

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Nine of the included studies used outcomes measures either through patient experience surveys (Clark et al., 2014; Meek et al., 2013) or by measuring physiological parameters, behavioural characteristics or health and functional status (Adams et al., 2015; Gorrindo et al., 2014; Martin et al., 2015; Nuffer et al., 2012; Stuhlmiller & Tolchard, 2018; Thakkar et al., 2019; Wahle et al., 2017). Interestingly, Adams et al. (2015) reported changing the version of the QoL tool used to assess health and functional status from the five-level adaptation (i.e., EQ-5D) at baseline to the three-level adaptation (i.e., EQ-3D) at 6 months post-intervention follow up. Consequently, the authors acknowledged that any change in QoL cannot be attributed to the intervention. Six studies used process measures such as the Healthcare Effectiveness Data and Information Set (HEDIS), emergency department (ED) utilisation rates, the Australian Triage Scale (ATS) guidelines and visit duration (Butala et al., 2013; Clark et al., 2014; Gorrindo et al., 2014; Lee et al., 2017; Liberman et al., 2011; Mann et al., 2019) (Table 2).

Eight studies incorporated a comparison into their research design, such as a control group, standard care or available population health datasets (Table 2). Two studies had a sample size in the intervention group that was approximately double that within the control/standard care group (Clark et al., 2014; Lawrence et al., 2015). One of these studies (Lawrence et al., 2015) also used different adaptations of their patient satisfaction survey between comparison groups, wording questions differently between surveys as well as omitting some questions altogether. Two studies (Liberman et al., 2011; Mann et al., 2019) compared their intervention data to that of the Healthcare Effectiveness Data and Information Set (HEDIS), however the comparison data was not appropriate as population characteristics such as age, race, gender and diagnosis were not matched. One study (Wahle et al., 2017) compared hypertension control data to the National Center for Health Statistics, National Health and Nutrition Examination Survey (NHANES) datasets.

Dimensions of the Triple Aim

Eight studies measured the Triple Aim dimension of population health, predominantly using measures focused on evaluating upstream health outcomes (Table 3). Evans and Stoddart's (1990) "Model of Population Health Components and Relationships" distinguishes between health determinants and health outcomes. Health determinants include both upstream factors (socioeconomic factors and physical environment) and individual factors (genetic endowment, behavioural and psychological factors), while health outcomes include intermediate health outcomes (disease burden and injury) and downstream health outcomes (QoL and mortality) (Evans & Stoddart, 1990). In this review, one study (Clark et al., 2014) relied on demographic and socioeconomic data as their sole measure of population health. Four studies (Adams et al., 2015; Gorrindo et al., 2014; Martin et al., 2015; Nuffer et al., 2012) measured physiological factors, including HbA1c, blood pressure (BP), body mass index (BMI) and blood lipids. Two studies (Stuhlmiller & Tolchard, 2018; Wahle et al., 2017) gathered data on patient

demographic information, behavioural traits such as smoking and drinking and physiological measures such as BMI and BP, with Stuhlmiller & Tolchard (2018) also measuring body circumference, blood glucose levels (BGL) and blood lipids. Two studies (Adams et al., 2015; Thakker et al., 2019) measured downstream factors influencing health either via a QoL tool or by estimating mortality through a comorbidity index. The remaining six studies did not measure population health (Table 3). The combined results of the studies that measured health outcomes show improvements in health outcomes through physiological measures such as blood glucose, blood pressure, waist circumference and lipid values (Adams et al., 2015; Butala et al., 2013; Gorrindo et al., 2014; Martin et al., 2015; Nuffer et al., 2012; Stuhlmiller & Tolchard, 2015), as well as behavioural characteristics such as smoking and drinking (Adams et al., 2015; Stuhlmiller & Tolchard, 2018).

Three studies (Adams et al., 2015; Lawrence et al., 2015; Martin et al., 2015) evaluated the experience of care from the perspective of the patient. In one study (Lawrence et al., 2015), the Health Centre Patient Satisfaction Survey was used to measure patient experience. These domains were grouped into three themes: accessibility, licensed provider and facility quality. The patient satisfaction survey used by Martin et al. (2015) was poorly defined, with patients being provided with the opportunity to rate their healthcare providers as being helpful, respectful or knowledgeable, in addition to providing an overall rating of satisfaction of the healthcare service. The remaining study (Adams et al., 2015) used the Diabetes Treatment Satisfaction Questionnaire (DTSQ) to measure patient experience and asked global patient satisfaction questions related to willingness to refer and continue accessing services.

Nine of the included studies measured the experience of care through the perspective of the provider (Table 3), four of which (Butala et al., 2013; Gorrindo et al., 2014; Liberman et al., 2011; Thakker et al., 2019) measured service effectiveness. Furthermore, one study (Adams et al., 2015) measured timeliness and effectiveness, and one study (Clark et al., 2014) measured effectiveness, timeliness, affordability and patient-centredness. Additionally, two studies (Lee et al., 2017; Meek et al., 2013) measured efficiency and timeliness, and two studies (Stuhlmiller & Tolchard, 2018; Thakker et al., 2019) measured equity.

Many of the student-led healthcare services described in the current literature review provided healthcare services free of charge to the patient and were funded by either government or an affiliated university and, in some cases, were funded by both. Interestingly, 12 out of the 14 studies did not incorporate any type of economic evaluation into their measures. Adams et al. (2015) and Thakkar et al. (2019) were the only studies that incorporated a cost analysis into their research design, focusing on measuring cost of healthcare from a supply lens. By measuring resource utilisation costs, Adams et al. (2015) were able to determine the cost of a student-led service per patient, taking into account costs such as student training requirements and preceptor time to oversee service

provision. However, Adams et al. (2015) did not undertake a similar analysis of cost for a professional service or a standard care option, and therefore, cost effectiveness was not determined. Similarly, Thakker et al. (2019) calculated costs saved due to ED visits voided as a result of attending the student-led healthcare service. However, without calculating the costs associated with resourcing the student-led healthcare service, cost effectiveness of such services cannot be determined.

Discussion

The findings of this review indicate that, currently, the evaluations of student-led healthcare services do not consistently align with the recommendations of the IHI Triple Aim of Healthcare Improvement. Out of the 14 studies appraised, only two studies (Adams et al., 2015; Thakker et al., 2019) successfully achieved all three domains of the Triple Aim. It is promising, however, that a total of 12 studies included in this review applied a focus on experience of care, either by measuring experience of care from the perspective of the patient or from the perspective of the provider. In contrast, cost of healthcare was the least measured domain. Furthermore, this literature review has demonstrated that there is a lack of consistency in the measures used to evaluate student-led healthcare services and in the quality of research design. This suggests that any findings demonstrating that student-led healthcare services lead to an improvement in health outcomes or experience of care are preliminary, and further investigation of student-led healthcare services is required.

With respect to calculating the sample sizes, the included studies did not undertake a statistical calculation determining power, suggesting inadequately powered samples (Nayak, 2010). Even in pilot designs, sample size justification supporting the reasons for choosing a particular size is required (Whitehead et al., 2016). The timeframes of measurement also varied between studies. It is recommended to collect data at multiple points to gain insight into the relationship between interventions and effects and to better understand time lags between cause and effect (Stiefel & Nolan, 2012). Limiting points of measurement before and after the intervention weakens a study's ability to assign causality (Portela et al., 2015). Comparing outcome data to other healthcare services or using available benchmark data is advocated for within the Triple Aim framework (Stiefel & Nolan, 2012). Due to identified limitations in study design across many of the studies in this review, overall validity of their data is compromised, influencing the comparability of their findings across groups (Portela et al., 2015).

Concerning the measurement of population health outcomes, priority was given to measuring socioeconomic factors, behavioural traits and physiological outcomes. Such factors are considered upstream factors influencing population health (Braveman & Gottlieb, 2014), whereas measuring more downstream factors, such as mortality, QoL, health and functional status and their combination (i.e., healthy life expectancy), allows for comparison of alternative practices, evaluation of disparities and guidance of resource

allocation (Stiefel et al., 2010). Adams et al. (2015) was one of two studies that measured downstream factors through the use of a QoL tool. However, any observed changes in QoL could not be attributed to the intervention due to a change in the version of the tool from baseline to post intervention. Thakker et al. (2019) also measured downstream factors influencing health using an adaptation of the Charlson Comorbidity Index (CCI), a popular index used to assign mortality risk (Deyo et al., 1992; Hall et al., 2019). Being derived from administrative databases, the utility of a comorbidity score is dependent on the quality of information used (Hall et al., 2019), and some authors suggest that continuous measures of disease might outperform the CCI (Austin et al., 2015). There are challenges to implementing measures of downstream influences in healthcare service evaluations, as no one healthcare service is the same and, thus, tools of measurement may vary greatly between services. In contrast, using more universal functional health and QoL tools that can be applied across populations and disease groups does provide opportunity for comparability across services (Chen et al., 2005; Stiefel & Nolan, 2012; Frendl & Ware, 2014).

The experience of care is best measured using global questions in patient satisfaction surveys (Stefel & Nolan, 2012). Incorporating the patient's perspective into quality improvement initiatives is critical in achieving patient-centred care (Al-Abri & Al-Balushi, 2014). Additionally, evidence supports a correlation between measuring patient satisfaction, continuity of care and improved health behaviour (Mohan & Kumar, 2011; Schoenfelder et al., 2011), as well as being a reflection of health practitioner communication (Schoenfelder et al., 2011). While most of the included studies in this review measured the experience of care, only three studies focused on evaluating the experience of care from the patient's perspective. The remaining 11 studies either solely examined experience of care from that of the healthcare provider's perspective or did not measure experience of care, demonstrating limited input from patients in the quality appraisal of student-led healthcare services. This also doesn't address potential safety concerns patients and professional providers of care may hold when a student independently coordinates and delivers care.

The concept of equity is in relation to access and use of services and is directly related to need of care (Levesque et al., 2013). Despite all reviewed studies describing student-led healthcare services providing healthcare to underserved or disadvantaged populations, Stuhlmiller and Tolchard (2018) and Thakkar et al. (2019) were the only studies that measured equity. Without specifically measuring equity, the impact of student-led healthcare services on the underserved and/or disadvantaged populations they intend to serve will not be able to be understood. Student-led models of healthcare have enormous potential to supplement the healthcare system in areas where healthcare professional retention is low and health services are sparse (Frakes, Tyack, et al., 2011). This is particularly important in a world responding to increased healthcare demand due to the COVID-19 pandemic, where now more than ever, healthcare services are experiencing

shortages in capacity to deliver care (Rasmussen et al., 2020). As healthcare services struggle to adapt to increases in demand, student-led services are appropriately placed to adequately address patient care requirements (Vahidi et al., 2020). However, without having a clear understanding of the true impact of student-led services and concerns being raised around potential safety risks in a COVID-19 world (Vahidi et al., 2020), there is still some work required to understand the value of student-led healthcare services. Additionally, there is little work around the cost or economic value involved in delivering services through student-led healthcare models. As many of the studies included in this literature review were funded either through government or an affiliated university, justification of cost efficiency or cost effectiveness is essential to securing ongoing funding and ensuring continued operation (Boxall, 2011; Cowing et al., 2009). As a result, student-led healthcare services will continue to face difficulties in demonstrating their contribution to the healthcare system from an economic perspective (Frakes, Brownie, et al., 2014; Kent, Drysdale, et al., 2014; Ojeda et al., 2014).

Since its proposal in 2008, the Triple Aim has sought to simultaneously improve population health, enhance experience of care and reduce the cost of healthcare (Whittington et al., 2015). Following on from this, the IHI has recruited over 140 organisations worldwide involving healthcare systems, hospitals, healthcare insurers and other organisations involved in providing healthcare in their quest to improve healthcare quality (Whittington et al., 2015). Nonetheless, the Triple Aim has received criticism for its inability to consider the provider and their experience and how these influence overall quality of care (Bodenheimer & Sinsky, 2014). As such, authors have suggested introducing a fourth aim, which acknowledges providers of care as the backbone of the healthcare system, to be included (Bodenheimer & Sinsky, 2014; Valaitis et al., 2020). When considering how student-led healthcare services are resourced, it is also important to consider the experience of the provider. Students are developing healthcare professionals, and their experiences have significant influence on their skills and future provision of care (Burgess & Mellis, 2015). The evidence supporting the use of student-led healthcare services as clinical placement providers is mixed, and although students value the exposure to authentic healthcare environments (Fröberg et al., 2018), the learning experience is highly dependent on the student's sense of responsibility to their patient and an effective collaboration between the student and the healthcare professional (Schutte et al., 2018). The Triple Aim is designed to specifically evaluate healthcare services as providers of care and doesn't consider that these healthcare services hold additional roles, such as providers of clinical placement. For this reason, the Triple Aim is not comprehensive in its current form to effectively evaluate student-led healthcare services. An evaluation framework that not only considers the impact on the community but also the experience and learning needs of the student is required to effectively evaluate student-led healthcare services and the benefits they provide.

In Australia, the Australian Health Performance Framework (AHPF) is designed to support system-wide reporting on population health and healthcare performance, the

assessment and evaluation of value and sustainability, as well as the identification of priorities for improvement and development (NHIPPC, 2017). The AHPF houses five domains, including the determinants of health, the health system, health status, the health system context and equity, most of which align to the Triple Aim domains of population health, experience of care and cost of healthcare. However, in contrast to the Triple Aim, the AHPF does place emphasis on the health system context in which workforce, infrastructure, governance, structure and the sustainability of the Australian health system are acknowledged as additional factors influencing population health outcomes (NHIPPC, 2017). Nevertheless, as student-led healthcare services are unique both in their model and workforce, further investigation is required to ensure all elements of student-led healthcare service performance and impact are considered, in addition to identifying appropriate measures for comprehensive evaluation.

In order to identify a comprehensive evaluation framework for evaluation of student-led healthcare services, consensus needs to be reached on how to evaluate student-led healthcare services, not just from the perspective of healthcare provision but also provision of clinical education. If researchers used a common set of measures and gathered data at agreed time-points, results could be compared across different types of services and placement types, pooling data for meta-analyses (Bernhardt et al., 2017). For student-led healthcare services to become authentic and credible models of care within the broader healthcare system, it is crucial to prescribe to a set of standards similar to that utilised in mainstream healthcare but specific enough to consider the needs of the students.

Limitations

The findings of this review must be considered in light of its limitations. In this review, medical and healthcare databases (i.e., Ovid Medline, CINAHL and Scopus) were searched. It is possible that additional articles may have been identified had an educational database been considered. However, pearling of included articles was conducted to minimise the likelihood of missing eligible articles.

Conclusion

Currently, evaluation of student-led healthcare services does not consistently align with the recommendations of the Triple Aim, and the current literature needs to be strengthened to support student-led healthcare services as a valuable resource to the healthcare system. Student-led healthcare services need to pursue a broader system of linked goals to ensure their accountability to the community they serve, as well as their comparability to the healthcare system they support. Clearly, when adopting the Triple Aim framework, there will be elements of student-led healthcare services that will go unmeasured. Therefore, consensus on what is an appropriate evaluation framework for student-led healthcare services needs to be achieved before their value within the healthcare system can be demonstrated.

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Appendix A

Literature Search Strategy (Medline)

#	Search Statement
1	("student-led" or "student led" or "student-assisted" or "student assisted" or "student run" or "student-run" or "student facilitated" or "student-facilitated").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
2	exp Students/ or exp Students, Health Occupations/
3	exp "Delivery of Health Care"/ or exp Community Health Services/
4	1 AND 2
5	3 AND 4
6	exp Evaluation Studies/
7	exp Clinical Trial/
8	exp Cohort Studies/
9	exp Retrospective Studies/
10	exp Comparative Study/
11	exp Follow-Up Studies/
12	exp "Outcome Assessment (Health Care)"/ or exp "Outcome and Process Assessment (Health Care)
13	exp Patient Satisfaction/
14	exp "Costs and Cost Analysis"/
15	exp "Quality of Health Care"/ or exp Health Status/ or exp "Quality of Life"/
16	6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12
17	13 OR 14 OR 15
18	16 OR 17
19	5 AND 18

Appendix B

Student-Led Health Service Evaluations Inclusion Criteria

- Is in a peer reviewed journal
- Is not a review article
- Describes a student-led health service and/or intervention
- Intervention impacts:
  - Patients receiving student-led healthcare services as inpatients OR outpatients OR from community-based healthcare service
- Are established healthcare services that provide ongoing services and include one or more of the following characteristics:
  - Provides continuity of care by providing ongoing healthcare services to the community
  - Exposes students to the operational environment of healthcare and/or clinical services
- Primary outcome focuses on evaluating one or more of the following elements:
  - Patient health outcomes
  - Patient experience/satisfaction
  - Patient cost
  - Provider cost
  - Cost effectiveness
- Evaluates the intervention (may be retrospective or prospective) by:
  - collecting pre-intervention and post-intervention data

  OR
  - comparing the intervention to a control (e.g., other models of care and/or types of healthcare services).